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Notes.

The Peace Treaty.

THE Peace Treaty, the full text of which has now been published, contains a great deal of commercial and industrial interest. Apart from political and military clauses, and those referring to reparation, there are important sections dealing with commercial relations, debts, property, contracts, railways and labour. It is impossible to refer to all these in any detail, and it will be necessary for our readers to study the document itself if they are interested in any particular direction. There are, however, a few points of very general interest. For example, there are two articles dealing with the question of unfair competition. According to one of these Germany undertakes to prohibit the importation, exportation and manufacture of goods so made or marked as to convey, directly or indirectly, a false indication of the origin of such goods. According to another article, regional appellations are to be respected. These two articles are undoubtedly important, for our trade has suffered in the past from non-observance of such rules. For example, we believe that spurious "Sheffield steel," and other articles made in Germany, have been imported into this country and elsewhere and sold to unsuspecting purchasers, who were under the impression that such articles were genuine. There should be such a thing as morality in trade.

Labour Under the League of Nations.

ANOTHER important section is that dealing with labour. No detailed conclusions have been reached on this subject, but an organisation is provided and methods of procedure are laid down. In future there is to be an annual labour conference recognised by the signatories of the present Treaty, and the first of these will be held at Washington during the present year. The agenda is announced, and includes the application of the principle of the eight-hour day or the 48-hour week; the prevention of, or provision against, unemployment; the employment of women; the employment of children; and the prohibition of night work for women employed in industry. The guiding principle is laid down that labour should not be regarded merely as an article of commerce. Although it is admitted that strict uniformity of conditions of labour will be difficult of immediate attainment, the adoption of an eight hour day is nevertheless to be sought as the standard to be attained, together with a weekly rest of at least 24 hours. The principle that men and women should receive equal remuneration for work of equal value is accepted. Nothing is said in regard to wages, nor will it be possible to lay down any such principle of uniformity. In all probability labour in countries where it is most highly paid will desire to bring about an equality of wages, by their increase, throughout all the countries included in the League of Nations. That course, however, would be impracticable, because the cost of living varies from one country to another. This fact will render it very difficult for the workers who are highly paid in one country to protect themselves from the product of labour in another country where the rates of wages are low. For example, the cost of labour in Japan is very much lower than in this country, and is likely to remain so. We shall, therefore undoubtedly feel the competition of Japan in the future, and it is difficult to see how this can be balanced except by means of tariffs, or by employing labour-saving methods to the highest extent.

The Victory Loan.

THE time that is available for subscribing to the new Victory Bonds or to the Funding Loan is now running on, and it may be well to remind our readers that the list will close on the 12th inst. This fact is no doubt realised by those who are able to invest considerable sums, but not necessarily by those of smaller means. We therefore think it is desirable to remind employers that they have an opportunity of influencing their employees in a matter of this kind. During the war many millions of pounds were invested by the workers in war savings certificates and in bonds through the Post Office. Some may not realise the importance of the new Victory Bonds or of the Funding Loan in adding to the financial stability of the country. It would be well, therefore, if employers would point out that war savings certificates may be used for the new loan in addition to the older bonds, and that conversion is highly desirable. It may be necessary to explain that the holder does not necessarily have less income from a 4 per cent. than from a 5 per cent. investment, for such matters are not readily grasped by those of small means, who nevertheless may see the desirability of saving. If employers would call their employees together and explain the matter, we think that considerable good might be done in getting a proper support of the new loans by a large proportion of the workers.

The "Cheap Electricity" Bill.

NOW that this drama is at last staged, it may be interesting to take stock of the *dramatis personæ*—those before the footlights and also the modest "prompters" whose habitat is the obscurity of the "wings." Of the former, collectively called

"Committee B." the most prominent will be the Home Secretary, whose ambition presumably it is to get the Bill through the committee stage with as little mutilation as possible. There will be his henchmen, of course, and certain laodicean members who will choose the "primrose path" of compliance with the Government's wishes as the easiest route. There will be some free lances, and then the members who will be putting forward amendments on behalf of the various associations. As regards the latter, the municipal undertaking view has been handled by the I.M.E.A., and that of a section by the Lancashire and Cheshire Undertakings Association, which, however, includes certain company interests. The companies' case has been shaped chiefly by the Provincial Electric Supply Committee of the United Kingdom, with whom the London Companies and Power Companies appear to have acted in concert as regards the chief part of the programme. The Institution of Electrical Engineers will, of course, have something to say sooner or later, and we may look forward to a dignified and sententious report, as befits the deliberation of a learned society.

Companies v. Municipalities.

Fortunately, in the present Bill, the interests of the companies and municipalities do not necessarily conflict. The chief point on the clauses, for each of these, is the purchase terms for the generating stations—but there is no conflict of interests as to what may be paid to each of these respectively. Of course, as regards the exact constitution of District Boards there must be a certain passage of arms as to proportion of representation. But this difference is capable of commonsense adjustment. The most judicious arrangement is obviously to leave the question as open as possible, the understood basis being that it shall reflect the proportion of the interests in the particular locality under consideration. Some districts will be almost solely municipal, some company, some hybrid in varying proportions; no fixed proportion could be fixed. As regards the clauses ruling the general procedure, both parties would be well advised to leave as wide a margin of discretion as possible to the Electricity Commissioners. The more elastic the new Act the greater the chance there is that the new schemes will fit in naturally with the widely varying conditions in the different districts.

Co-operation in Production.

It is of extreme importance at the present time to secure the ready co-operation of Labour in obtaining a maximum output from our factories and to place matters on such a footing that the workers feel they have a direct interest in increased output. Many schemes have been proposed with this end in view, but there are few that have been so successful as that now in force at the works of Messrs. Priestman Brothers, of Hull. Briefly, the method consists in determining what is the ordinary output for the works for a certain number of man-hours per month on the basis of ordinary time rates. If this standard output is exceeded, then the wages or salary of everyone in the establishment is correspondingly increased during the following month. Since this increase applies to every employee it follows that everyone is anxious to do their best, and even if increased effort has been impossible on the part of certain workers they nevertheless benefit. In the case of Messrs. Priestman's works the results have proved to be extremely satisfactory, being beneficial equally to Labour, Management and Capital. Although we do not believe that any one system can be generally applied to commercial or manufacturing enterprises, we nevertheless feel that every effort should be made to introduce schemes of this nature. Not only do they lead to more harmonious working, but they necessarily give very much greater prosperity.

Illuminating Engineering Society (U.S.A.)—The 1919 Convention will be held at the Hotel Sherman, Chicago, Ill., on October 20-23. The chairman of the Convention Committee is Mr. Homer Neisz, and the secretary Mr. Edwin D. Tillson.

British Scientific Products Exhibition.—The British Scientific Products Exhibition was opened at the Central Hall, Westminster, S.W., yesterday (Thursday) by the Marquis of Crewe, K.G., President of the Exhibition, who was supported by Lord Moulton, F.R.S., and Sir Alfred Keogh, Vice-Presidents; Lord Sydenham, President of the British Science Guild, occupied the Chair. The Exhibition will remain open for one month.

Royal Society of Arts.—The Council have awarded the silver medal for the following Papers read before the Society during the past session: Sir Frank Heath, K.C.B., Secretary, Department of Scientific and Industrial Research, on "The Government and the Organisation of Scientific Research"; Walter L. Lorkin, A.M.I.E.E., on "Electric Welding and its Applications"; and Prof. John C. McLennan, O.B.E., Ph.D., F.R.S., on "Science and Industry in Canada."

The Practicability of Transmission Lines at Highest Voltages in this Country.—*Erratum.*—We regret that there was a small omission in the article by Mr. G. V. Twiss in our last issue. On page 735, line 12 from the bottom of the left-hand column reads: "This really increases the actual factor of safety on the larger ones." This should read: "This really increases the actual factor of safety on small wires, and provides an equal factor of safety on the larger ones."

"The Electrician" Front Cover.—For the first time since its publication The Electrician appears this week with the announcement of only one advertiser on its front cover. It is interesting to recall the fact that Messrs. Johnson & Phillips and W. T. Henley's Telegraph Works have shared this space (with other advertisers) since 1878. Their particular announcements have been published for nearly 2,200 consecutive issues and we believe that this is something of a record. In future our front cover will be occupied by a single announcement.

Conjoint Board of Scientific Societies.—The report of the Board for the year 1918 has been issued, and contains some details of the work of the various committees. Some of the reports of the committees have already been published. The Watching Committee on Education have adopted certain resolutions (accepted by the Board) in regard to Civil Service examinations, and have emphasised the desirability of science occupying a more important position in Government departments. It is suggested that all candidates for the Civil Service should be required to show that a course of science extending over several years has formed a part of their education. A committee has been formed to consider the prevention of overlapping among scientific societies. The metric system has been considered by a special committee, and a report has been issued on the subject, but the matters dealt with are highly controversial, and a decision has not yet been reached. A committee, with Sir Robert Hadfield as chairman and Mr. W. R. Cooper as secretary, has also had under consideration a scheme for joint buildings for certain scientific and technical societies.

Royal Society Conversazione.—At the conversazione of the Royal Society last week a number of interesting exhibits were shown. Among these was the transmission of speech by light, as described by Dr. A. O. Rankine at a recent meeting of the Physical Society. A full-size model of an 18 in. shell was shown, we believe, for the first time, by Sir Robert Hadfield. The shell weighs $1\frac{1}{2}$ tons and at 10 miles it is capable of perforating 22 in. of hard-faced armour. A demonstration of directional wireless telegraphy was given by Mr. A. A. Campbell Swinton. An interesting new form of cinematograph was shown by Mr. A. Mallock. In this instrument the screen is illuminated continuously, the images replacing one another without any dark intervals. This is secured by placing on a part of the circumference of a wheel at half the radius of this wheel a number of plain mirrors, each placed so as to form a polygonal cylinder about the axis. The virtual images are at the axis, and being, therefore, stationary can be projected on the screen by a fixed lens. The pictures can be shown at any desired rate because there is no longer any flickering due to intermittent illumination. Mr. E. A. Griffiths, a former member of the staff of the National Physical Laboratory, and now at the Air Board, showed a direct reading liquid depth indicator for indicating the depth of petrol in tanks of aircraft, &c. The device is based on the principle that the heat loss from a wire is greater when immersed in a liquid than when exposed to air or vapour. A hot wire of platinum or nickel is arranged as one arm of a Wheatstone's bridge. The resistance of the wire is a measure of its average temperature, which is a function of the depth of immersion in the liquid. Compensation for extraneous temperature changes is obtained by having an identical wire in a sealed tube alongside, forming a second arm of the bridge. When using a very robust type of moving coil instrument it is possible to obtain ample sensitivity with a temperature elevation of the wire of less than 20°C. and a current of about 0·5 ampere. An iron wire ballast resistance is used to maintain a constant current in the bridge circuit. As the indicator can be placed away from the tank the device should find an application in industries where it is frequently necessary to observe the depth of liquid in tanks at a distance.

Obituary.

LORD RAYLEIGH.—We regret to record the death of Lord Rayleigh, O.M., which took place on the 30th ult. at Terling Place, Witham, Essex.

John William Strutt, the third Baron Rayleigh, was born on Nov. 12, 1842. Entering as a Fellow Commoner at Trinity College, Cambridge, in 1862, he graduated in the Mathematical Tripos as Senior Wrangler in 1865 and also won the first Smith's Prize of the year. In 1866 he obtained a Fellowship at Trinity, which he held till 1871. On the death of his father in 1873 he succeeded to the title. The same year he was elected a Fellow of the Royal Society. In 1879 he succeeded Clerk Maxwell in the Chair of Experimental Physics at Cambridge and director of the Cavendish Laboratory. Lord Rayleigh now set himself to organise a system of practical teaching in experimental physics, and his success may be gauged by the fact that the Natural Science Tripos attracted in 1884 (the year in which he resigned) more than three times as many candidates as in 1879. In 1884 he served as President of the British Association at Montreal, and soon after his return from Canada he was elected one of the secretaries of the Royal Society, a position he held until 1896. In 1887 he became Professor of Natural Philosophy at the Royal Institution in succession to Tyndall, and held this position until 1905, when he became President of the Royal Society, and three years later he became Chancellor of the University of Cambridge.

Lord Rayleigh's work in physics has been of a varied and thorough character. His first scientific paper appeared in 1869, and in the following year he published an important paper on resonance, in which he developed a method of calculating approximately the resistance of conductors of any form. In 1871 his reputation was made by a series of Papers on optical questions, which appeared in the "Philosophical Magazine." In 1872 he discussed the copying of diffraction gratings by photography, and in 1877-78 he published the first edition of his well-known work on the theory of sound. During the five years he spent at the Cavendish Laboratory he continued a series of Papers on "Acoustical Observations," which he had begun in 1877, and published a number of Papers in optics, with special reference to the spectroscope and the resolving power of optical instruments. Some of the consequences of self-induction and the effects of rapidly alternating currents in producing magnetism are amongst the subjects discussed in various Papers dealing with electromagnetic phenomena, which were published about this date. It was during his tenure of office as Director of the Cavendish Laboratory that the various electrical standards were accurately determined. The B.A. unit in terms of the ohm was given in 1883 as 0·9868; later on the electro-chemical equivalent of silver was found to be 0·0011179, and the electromotive force of the Clark cell, prepared and set up as directed, was found equal to 1·4345 volts at 15°C. In his presidential address to the mathematical and physical section of the British Association in 1882 Lord Rayleigh expressed the opinion that the time had come for a redetermination of the density of the principal gaseous elements. This work occupied his attention for the next 10 years or so, and led (in conjunction with the late Sir W. Ramsay) to the discovery in 1894 of argon. As our readers know, Sir Wm. Ramsay subsequently discovered three other equally inert new gases—neon, crypton, and xenon. Lord Rayleigh made other researches in pure mathematics, electricity, the dynamical theory of gases, hydrodynamics, thermodynamics, the mechanical principles of flight, photography, the theory of the telephone, the distribution of alternating electric currents in conductors, the laws of the pressure of gases below atmospheric pressure, &c. Four volumes of his collected scientific papers, which were published in 1899-1903, contain no fewer than 272 papers. The scope, the amount and the quality of Lord Rayleigh's scientific investigations stamped him as one of the foremost British mathematical physicists of his generation. He was chairman of the Treasury Committee which recommended the establishment of the National Physical Laboratory, and after its foundation he presided over its Executive Committee. He acted as Chief Gas Examiner under the Metropolitan Gas Acts, and he sat on the Board of Trade Committee which reported on the methods of testing gas. He was one of the 12 distinguished men upon whom the Order of Merit, instituted by King Edward VII. on June 26, 1902, was bestowed. He was also the recipient of the Prussian Order Pour le Mérite in 1903, and was awarded the Nobel prize for Physics in 1904. He was one of the 12 foreign associates of the French Académie des Sciences. Numerous academic honours were conferred on him by the Universities of Oxford, Cambridge, Dublin, Glasgow, &c. The Royal Society bestowed on him its Royal medal in 1882 and its Copley medal in 1899. He served as Lord Lieutenant of Essex from 1892 to 1901. He is succeeded in the title by his eldest son, the Hon. Robert John Strutt, F.R.S., who was born in 1875, and who has made a name for himself in the scientific world by his researches on radio-activity and other subjects.

We regret to record the death of Mr. W. M. MURPHY, the tramway and railway contractor, of Dublin, in his 75th year. Deceased was chairman of the Dublin United Tramways Company and a director of the Cork Electric Tramways & Lighting Company, the Isle of Thanet Electric Tramways and Lighting Company, and other industrial undertakings. Mr. Murphy was a pioneer in electric tramway construction, and among other undertakings he was responsible for the construction of the tramways in the Isle of Thanet, Dublin and Cork.

The death is announced of Sir John T. Brunner, the founder and chairman of the well-known firm of Brunner, Mond & Company.

We regret to record the death of Mr. HORACE GEORGE BARWELL, O.B.E., until recently superintendent of the Eastern Telegraph Company at Malta.

Personal.

Prof. F. SODDY has been elected a foreign member of the Swedish Academy of Sciences.

Lieut. Sir Arthur Whitten Brown, K.B.E., and Capt. Sir John Alcock, K.B.E., D.S.C., were the principal guests of Past and Present Westinghouse Colleagues at dinner in the Holborn Restaurant, London, on Wednesday. Sir Arthur Brown (who was in the British Westinghouse Company's service prior to the war) and Sir John Alcock were the navigator and pilot, respectively of the Vickers-Vimy-Rolls aeroplane which recently made a non-stop flight across the Atlantic from Newfoundland to Ireland. Prof. Miles Walker presided at the dinner. Mr. W. W. Blount, in proposing the health of Sir Arthur Brown, referred to his connection with the British Westinghouse Company from 1902 until the outbreak of the war, when he joined the Royal Flying Corps, subsequently being taken prisoner by the Germans. Major Sippé proposed the toast of Sir John Alcock, and said although not a Westinghouse man, he was the next best thing, a Lancashire lad. The Chairman, on behalf of the Past and Present Westinghouse Colleagues, made a presentation of silver and glassware to Sir Arthur Brown and his fiancée, Miss Kennedy. He said he recognised that his words of appreciation were only like a murmur compared to the thunderous applause Sir Arthur Brown had received from all over the world, but Westinghouse men claimed a sort of proprietary interest in him

Arrangements for the Week.

MONDAY July 7th.

NEW TRANSPORT COMPANY.

8.30 p.m. At Caxton Hall, Westminster. London, S.W. Subject: "The Transport Bill and Housing Bill," by Mr. Roy Horniman.

WEDNESDAY, July 9th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

11 a.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Papers to be read on "Women's Work in Engineering and Shipbuilding during the War," by the Hon. Lady Parsons; and "Shipbuilding and Marine Engineering done on the North-East Coast during the War," by Mr. A. H. J. Cochrane.

THURSDAY, July 10th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

11.45 a.m. and *3.0 p.m.* At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Papers to be read on "Aviation during the War and its Possible Future"; Lecture by Prof. J. C. McLennan; "Dazzling of Ships," by Lieut.-Commander N. Wilkinson; and "The Limits of Thermal Efficiency in Diesel and other Internal Combustion Engines," by Sir Dugald Clerk.

OIL AND COLOUR CHEMISTS' ASSOCIATION.

7.30 p.m. At the Food Reform Club, 2, Furnival-street, London, E.C. Paper on "Measurement of Temperature," by Mr. R. S. Whipple.

FRIDAY, July 11th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS & SHIPBUILDERS.

10 a.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Papers to be read: "Ship Repairing during the War," by Mr. M. C. James and Mr. L. E. Smith; and "Transmission of Power," by Mr. G. Constantinesco.

The Oscillatory Valve Relay: A Thermionic Trigger Device.*

By Captain L. B. TURNER.

Summary.—In his introductory remarks the author distinguishes between relays and amplifiers, and explains the triode. Various types of valve relays for acoustic frequencies for high frequency signals and for wireless signals are described, and reference is also made to the use of the relay for steady or slowly varying currents. Finally, an analysis is made of the sensibility and selectivity of the pre-tuned high frequency valve relay, and the general limitations on sensitivity and speed of working are discussed.

1. INTRODUCTION. RELAYS, TRIODES, AMPLIFIERS.

The nature of the instrument to be described will be grasped more easily after an explanation of the respective functions of relays and amplifiers. In wire telegraphy the relay plays a prominent part. It acts usually as an automatic switch, the arrival of a relatively feeble signal closing or opening the circuit of a local battery able to perform tasks for which the power of the incoming signal is insufficient. The local current is merely started or stopped by the signal current. There is a threshold strength of signal below which no local effect is produced, and above which the magnitude of the effect is independent of the strength of the controlling signal.

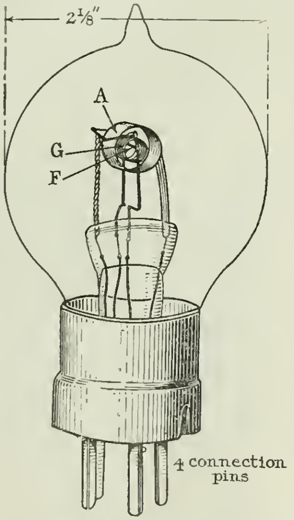

FIG. 1.—A COMMON PATTERN OF TRIODE.

Amplifiers, unlike relays, only recently attained a widespread use. Perhaps the Heurtley hot wire and the Brown microphonic contact instruments are the best known; but with the introduction a few years before the war of the three-electrode thermionic tube (De Forest Lieben-Reisz), and subsequently of tubes depending on pure electron discharge, electric amplifiers have assumed great importance in wireless telegraphy. Let us briefly consider the action of such amplifying "triodes." Fig. 1 shows a triode of a pattern produced by the French early in the war at the "Télégraphie Militaire." *F* is the "filament," a tungsten wire brightly incandescent; *G* the "grid," an open helix of nickel wire concentric with the filament; *A* the "anode," an outer concentric cylinder of nickel. These are supported in a glass bulb exhausted to the best obtainable vacuum. Such triodes are fairly well suited to a great variety of uses, and many hundreds of thousands have been used during the war.

If the anode is maintained at a fixed potential, v_a, above the negative end of the filament, and the potential v_g of the grid is varied, the anode current i_a varies as shown by the curves in Fig. 2. Over the steep straight parts of the curves we have large changes of anode current in a high-voltage circuit produced by small changes of potential of the grid. The relation is a linear one, expressible as increment of anode equals a constant g times the increment of grid potential producing it; or

$$\frac{\partial i_a}{\partial v_g}\cdot\delta v_g=g(\delta v_g).$$

An increment of anode potential also produces an approximately proportional increment of anode current, the relation being similarly expressible as

$$\frac{\partial i_a}{\partial v_a}\cdot\delta v_a=a(\delta v_a).$$

Hence we may write

$$\delta i_a=g(\delta v_g)+a(\delta v_a).$$

A rise of anode current produces a fall of anode potential equal to the ohmic drop in the resistance R; so that

$$\begin{aligned}\delta v_a&=-R(\delta i_a)\\&=-Rg(\delta v_g)-Ra(\delta v_a),\end{aligned}$$

$$\therefore\quad\frac{\delta v_a}{\delta v_g}=-\frac{Rg}{1+Ra}.$$

If R becomes large compared with the anode resistance $1/a$, this amplification ratio approximates to g/a. In the pattern of triode we are considering $g=0{\cdot}3$ milliampere per volt, and $a=0{\cdot}04$ milliampere per volt approximately, so that amplifications up to 8 may be obtained.

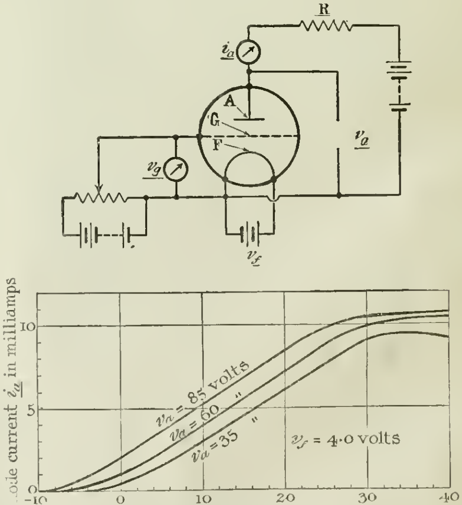

FIG. 2.—TRIODE CHARACTERISTICS.

Such a device has been termed a "thermionic relay," but this is an undesirable term. The distinction between relay and amplifier is a useful one, and should not be allowed to disappear.

2. PRINCIPLE OF THE VALVE RELAY.

Various methods of grouping several triodes have been evolved, and amplifiers suitable for frequencies ranging from units to millions of periods per second have been constructed. They are chiefly characterised by the smallness of the input powers dealt with. The oscillatory valve relay is a relay, not an amplifier; but it depends on a triode as the link between the "in" and the "out" circuits, and shares with modern amplifiers something of their extraordinary sensitivity, robustness and flexibility.

Let us next consider the circuits shown in Fig. 3. Under suitable conditions, such a system becomes self-oscillatory, drawing the necessary energy from the battery B_a in the anode circuit. Suppose the circuit L_1C_1 is set into its free oscillation, such that approximately $p=2\pi n=\sqrt{(L_1C)}$.

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* Abstract of Paper read before the Institution of Electrical Engineers.

Then, if R_1 is small compared with pL_1, and if pL_2 and R_2 are small compared with the anode resistance $1/a$, there is a quadrature E.M.F. pL_1i_1 in the grid circuit producing in the anode circuit an alternating current, gpL_1i_1, also in quadrature with i_1. With mutual inductance M (of the right sense) between the two coils, there is induced in the grid coil an in-phase E.M.F., $Mgp^2L_1i_1$. If this is equal to the energy-consuming constituent R_1i_1 of the E.M.F. in the L_1C_1 circuit, energy losses are just compensated, and the oscillation persists unchanged in amplitude. The critical condition for an infinitesimal oscillation, when once started, to persist unchanged is thus

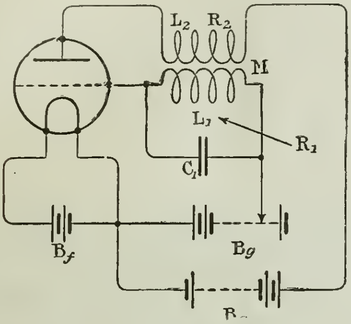


FIG. 3.—SELF-OSCILLATING TRIODE SYSTEM.

$$Mgp^2L_1i_1=R_1i_1,$$

$$g=\frac{R}{Mp^2L_1}=\frac{R_1C_1}{M}.$$

If g is less than this critical value, a small oscillation cannot be self-sustaining; if g exceeds the critical value, any oscillation, however small, will increase in amplitude up to an equilibrium value at which the losses in the triode circuits are equal to the power supplied from the high-tension battery B_a.

Suppose in Fig. 3 the grid potential is gradually increased from a low value. The value of the parameter g, which is the slope of the curve at the representative point (Fig. 4), gradually increases until it reaches the critical value R_1C_1/M. Let OQ be the critical grid potential. At this point oscillation sets in, and is built up to some such amplitude as QR, QS, the anode current changing suddenly from the steady value OT to a pulsating current of mean value OU. The oscillation once set up persists, even through the mean grid potential be reduced much below the threshold OQ.

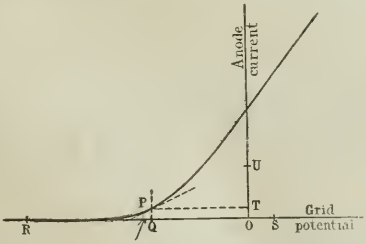


FIG. 4.—INCEPTION OF OSCILLATION IN VALVE RELAY.

Fig. 5 shows how such an arrangement may be utilised as a self-restoring relay operated by signal currents of frequencies of hundreds or thousands of periods per second. The grid potential is adjustable on the potentiometer P, and when it is set a small amount, called the "margin," below the critical value, called the "threshold," any signal applied to the transformer T_pT_s producing in T_s a momentary E.M.F. of the right sense, and exceeding the margin in amplitude, sets the system into oscillation. The rise of current in the coils of the electrochemical relay pulls over the tongue T short-circuits the anode reaction coil, and thereby quenches the oscillation, which is only re-ignited on the arrival of another signal in the transformer primary T_p. The opening of the contact between T and S may be used to control any indicating or other relaying apparatus.

In the form of valve relay sketched in Fig. 5 we are not interested in frequency, merely arranging that there shall be a suitable rise of mean anode current. However, it is convenient to make the frequency high, much greater than frequencies of signal currents. In the valve relay described in the next section the frequency is about 4×10^6 periods per second.

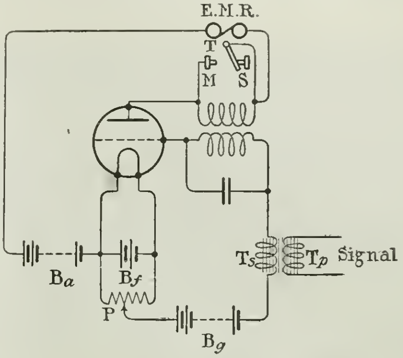


FIG. 5.—CIRCUITS OF VALVE RELAY FOR LOW-FREQUENCY SIGNALS.

As already shown, the threshold potential is that at which the slope g of the characteristic (Fig. 4) is $g=R_1C_1/M$. The triode and its batteries having been selected, we are still able to determine the critical value of g by suitable choice of R_1, C_1 and M. A large rise of anode current at oscillation is obtained only if the threshold P is well down to the foot of the concave portion. It is possible to go too far down. The best combination of sensitivity and stability is obtained when the slope varies most rapidly with the potential—*i.e.*,

$$\frac{dg}{dv_g}=\frac{d^2i_a}{dv^2_g}$$

should be large. In Fig. 6 the foot of one of the three curves of Fig. 2 is enlarged, and its second derivative relating d^2i_a/dv^2_g with v_g is obtained. This shows that the best sensitivity is obtained when the threshold occurs at $-3\frac{1}{2}$ volts. But no fine choice is necessary, and in order to get a large ratio between mean anode currents before and after oscillation has set in, it is well to choose a threshold further down the foot of the curve. Thus a suitable compromise might be $-5\frac{1}{2}$ volts. The mean anode current would then jump from 0·08 milliampere before, to perhaps 2 milliamperes after, the arrival of the operative signal.

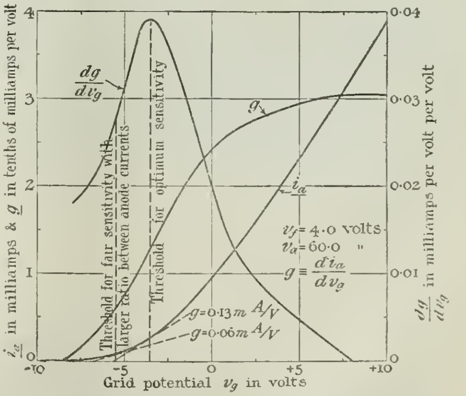


FIG. 6.—METHOD OF CHOOSING THRESHOLD POTENTIAL.

(Enlargement of middle curve of Fig. 2 with two derived curves.)

(*To be concluded.*)

The New Power Station at Rotherham.

Concluded from p. 760.

Condensing Water.

A concrete sump, 20 ft. by 11 ft. 6 in., is built in the river, the water being allowed to enter the sump through sluice gates which allow it to flow through a 20 ft. diameter revolving screen by F. W. Brackett & Company, Ltd. The screening disc revolves partly in and partly out of the water, being motor driven through a worm and worm wheel. As the perforated disc revolves it carries the undesirable matter clear of the water when high-pressure water jets, suitably arranged behind the screening disc, discharge the foreign matter into a hood and receiving trough.

The sump is in communication with two inlet suction culverts 8 ft. 3 in. by 8 ft. 3 in., being circular at the top and running the whole length of the engine room, including probable extensions. The water is discharged into a similar culvert 10 ft. by 10 ft.

The circulating pumps are of the Rees Roturbo patent self-regulating medium lift type, each capable of handling 19,200 gallons of water per minute. There are four duplicate pumps direct coupled to 510-b.h.p., 580/610 revs. per min. B.T-H. motors, (Figs. 18 and 19). A Rees rotary priming pump driven by means of a 12 b.h.p. 2 000 revs. per min. motor is located near the circulating pumps.

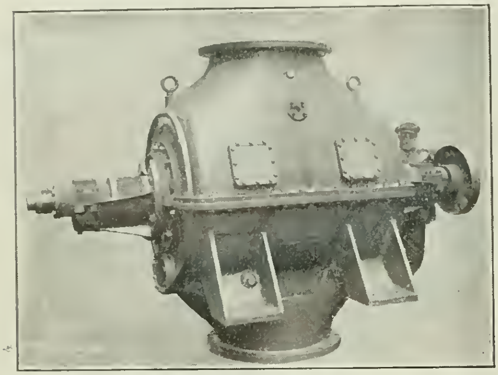


Fig. 18.—Horizontal Type Circulating Pump, 19,200 g.p.m., 50 ft. Head, 580 r.p.m., 440 b.h.p.

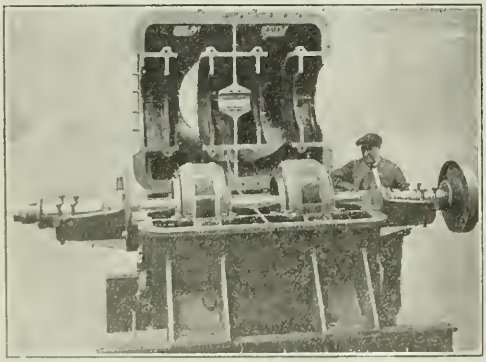


Fig. 19 The Circulating Pump (Fig. 18) shown open.

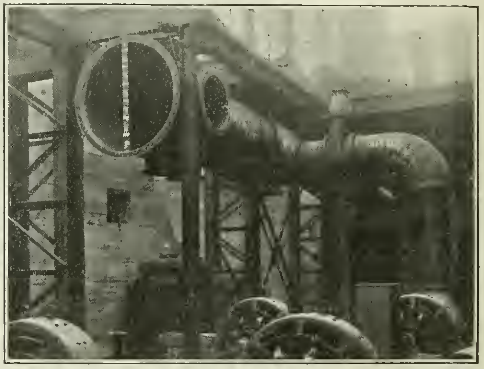


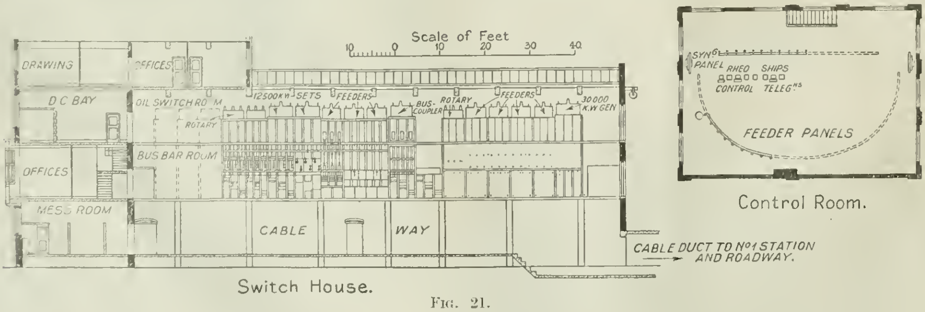
Fig. 20.—View showing Circulating Water Main.

The whole of the circulating pumps are arranged to discharge into one main, tapering from 78 in. diameter to 39 in. diameter (see Fig. 20), branches being taken from this main to the respective condensers. All water pipework and valves are manufactured by Messrs. Aiton & Company, Ltd., of Derby, excepting such portions as form an integral part of the condenser contracts.

Switchgear and Accessories.

The switchgear is of the British Thomson-Houston Company's make and has been laid out to deal with a plant capacity for the generating station of 125,000 kw.

It is housed in an annexe to the generating station, the extra-high-tension portion of the gear being distributed over three floors, the control panels and apparatus being accommodated in a separate control room at one end of the annexe. A



Switch House.

Control Room.

Fig. 21.

sectional elevation is given in Fig. 21, and a cross-section is shown in Figs. 22 and 23.

The design is such that the switchgear will ultimately be divided into four sections, bus-bar reactances being employed between sections. The present instalment consists of two sections only, embodying three turbo-alternator equipments, two rotary converter equipments, one interconnector transformer equipment, one bus coupler equipment, and 15 split conductor feeder equipments.

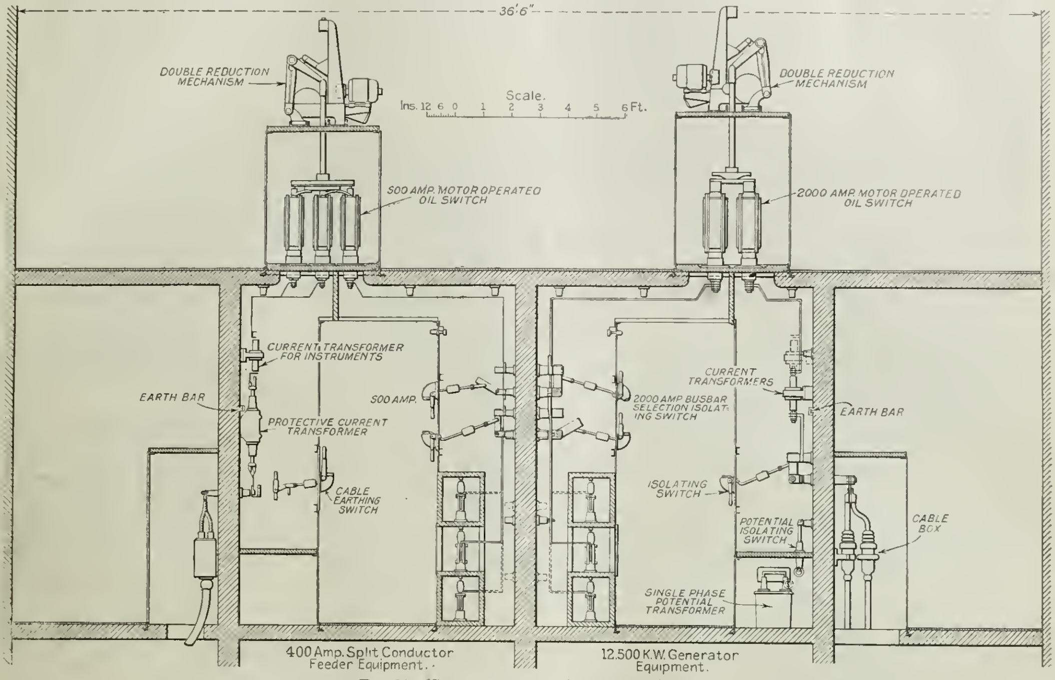
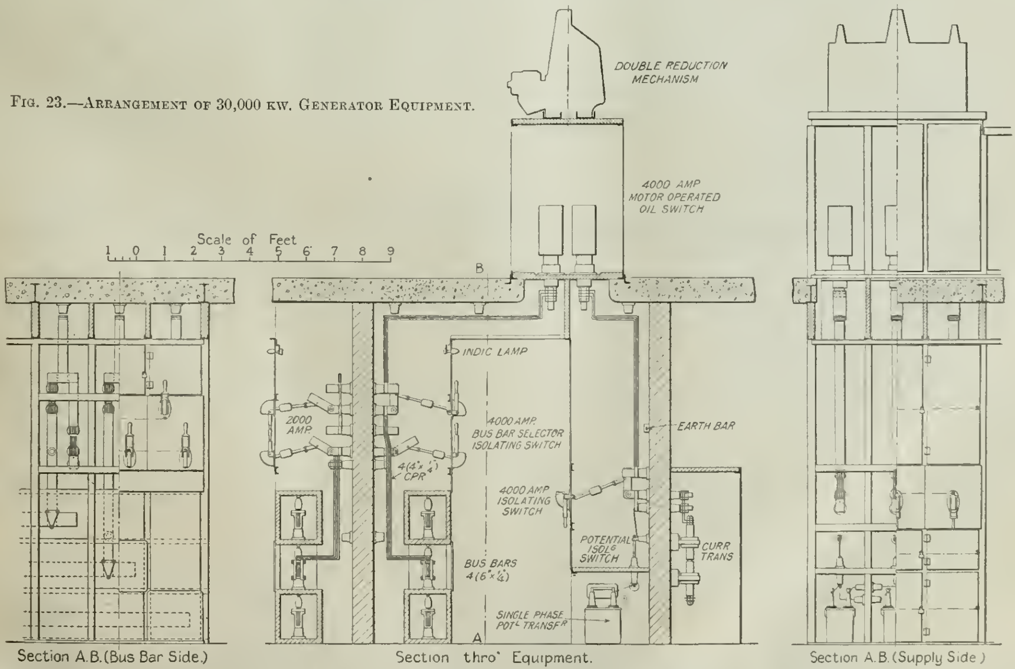

36′6″
DOUBLE REDUCTION MECHANISM
Scale.
Ins. 12 6 0 1 2 3 4 5 6 Ft.
DOUBLE REDUCTION MECHANISM
500 AMP. MOTOR OPERATED OIL SWITCH
2000 AMP. MOTOR OPERATED OIL SWITCH
CURRENT TRANSFORMER FOR INSTRUMENTS
EARTH BAR
500 AMP.
PROTECTIVE CURRENT TRANSFORMER
CABLE EARTHING SWITCH
CURRENT TRANSFORMERS
2000 AMP BUSBAR SELECTION ISOLATING SWITCH
EARTH BAR
ISOLATING SWITCH
POTENTIAL ISOLATING SWITCH
CABLE BOX
SINGLE PHASE POTENTIAL TRANSFORMER
400 Amp. Split Conductor Feeder Equipment.
12,500 K.W. Generator Equipment.

Fig. 22.—Section through Switchgear House.

Fig. 23.—Arrangement of 30,000 kw. Generator Equipment.


DOUBLE REDUCTION MECHANISM
4000 AMP MOTOR OPERATED OIL SWITCH
Scale of Feet
1 0 1 2 3 4 5 6 7 8 9
B
INDIC LAMP
2000 AMP.
4000 AMP. BUS BAR SELECTOR ISOLATING SWITCH
EARTH BAR
4(4″×¼″) CPR
4000 AMP ISOLATING SWITCH
POTENTIAL ISOLG SWITCH
CURR TRANS
BUS BARS 4(6″×¼″)
SINGLE PHASE POTL TRANSFR
A
Section A.B. (Bus Bar Side.)
Section thro' Equipment.
Section A.B. (Supply Side.)

The extra-high-tension portions of the switchgear are housed in a reinforced stone structure of cellular type, suitable doors and screens being provided for the cubicles where necessary.

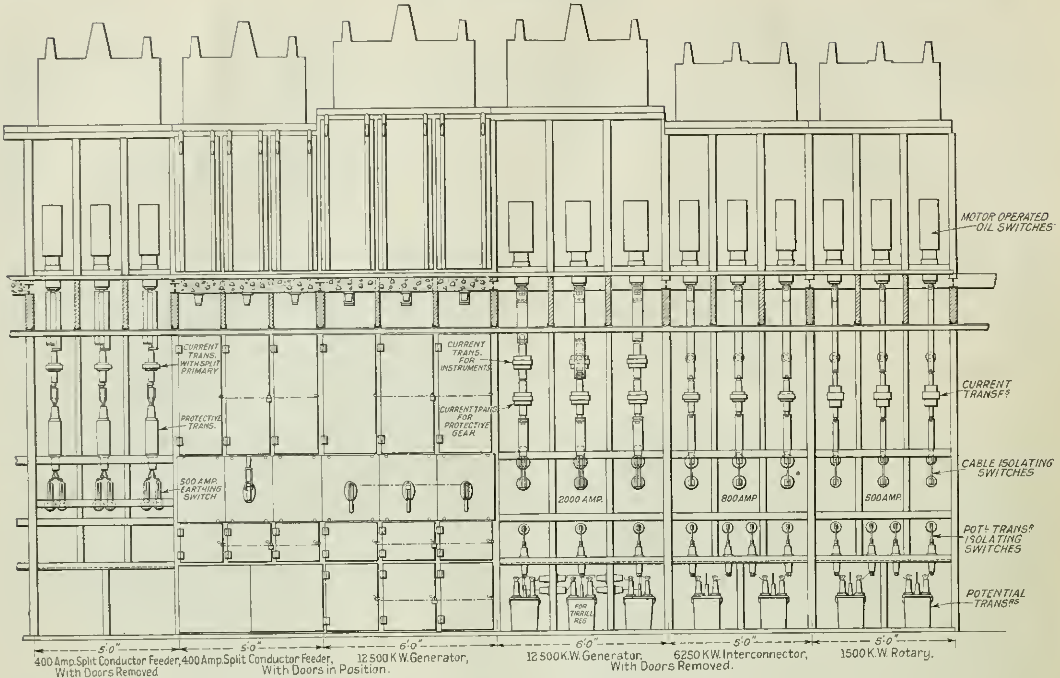

MOTOR OPERATED OIL SWITCHES
CURRENT TRANS. WITH SPLIT PRIMARY
PROTECTIVE TRANS.
500 AMP. EARTHING SWITCH
CURRENT TRANS. FOR INSTRUMENTS
CURRENT TRANS. FOR PROTECTIVE GEAR
CURRENT TRANSF^S
CABLE ISOLATING SWITCHES
2000 AMP.
800 AMP
500 AMP.
POT^L TRANS^R ISOLATING SWITCHES
POTENTIAL TRANS^RS
FOR TIRRILL REG
5'0"
400 Amp. Split Conductor Feeder, With Doors Removed
5'0"
400 Amp. Split Conductor Feeder, With Doors in Position.
6'0"
12 500 K.W. Generator,
6'0"
12 500 K.W. Generator, With Doors Removed.
5'0"
6250 K.W. Interconnector,
5'0"
1500 K.W. Rotary.

Fig. 24.—Back Elevation of E.H.T. Switchgear.

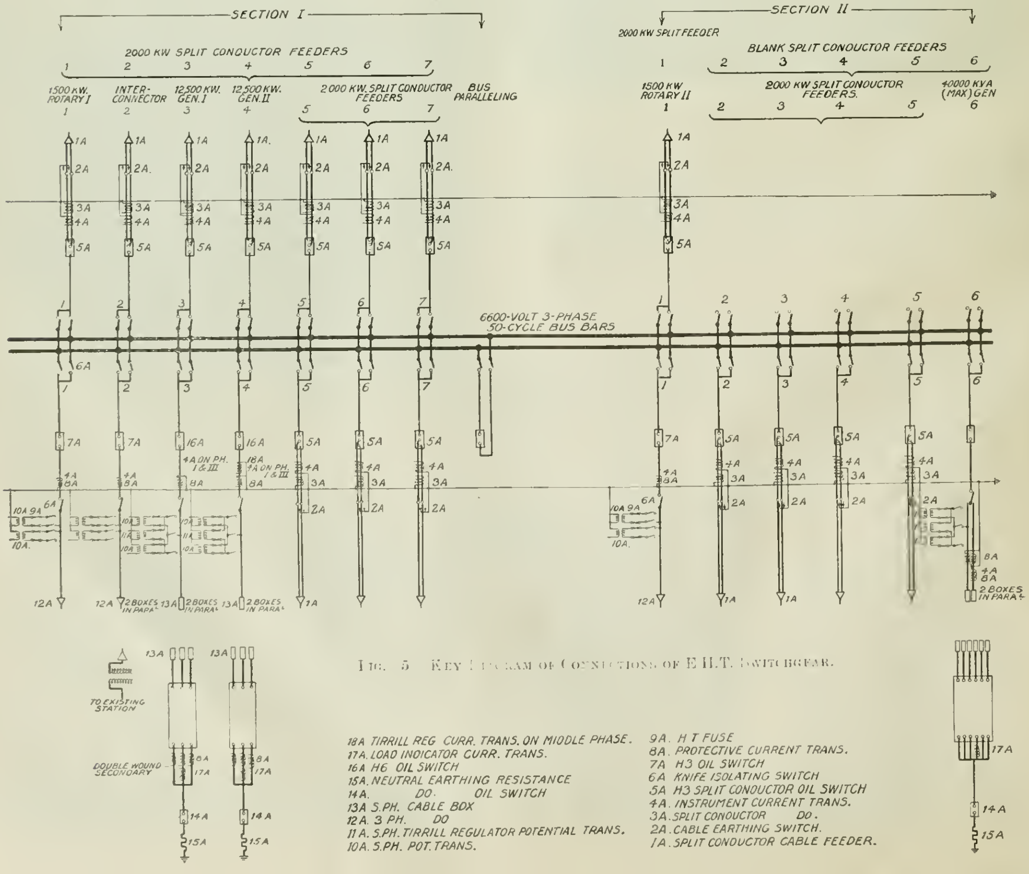


Fig. 25.—Key Diagram of Connections of E.H.T. Switchgear.

18A TIRRILL REG CURR. TRANS. ON MIDDLE PHASE.
17A. LOAD INDICATOR CURR. TRANS.
16A H6 OIL SWITCH
15A. NEUTRAL EARTHING RESISTANCE
14A. DO. OIL SWITCH
13A S.PH. CABLE BOX
12A. 3 PH. DO
11 A. S.PH. TIRRILL REGULATOR POTENTIAL TRANS.
10A. S.PH. POT. TRANS.
9A. H T FUSE
8A. PROTECTIVE CURRENT TRANS.
7A H3 OIL SWITCH
6A KNIFE ISOLATING SWITCH
5A H3 SPLIT CONDUCTOR OIL SWITCH
4A. INSTRUMENT CURRENT TRANS.
3A. SPLIT CONDUCTOR DO.
2A. CABLE EARTHING SWITCH.
1A. SPLIT CONDUCTOR CABLE FEEDER.

The arrangement of the extra-high-tension gear is shown in Figs. 22 and 23, and diagrammatically in Fig. 25. It will be seen that the cubicles have been arranged in two banks, the top floor containing the oil switch only, the middle floor the bus bars, isolating switches and instrument transformers, while the basement is reserved for future bus bar reactances with the necessary switchgear; also earthing resistances and isolating switch pedestals for same and for outgoing cables.

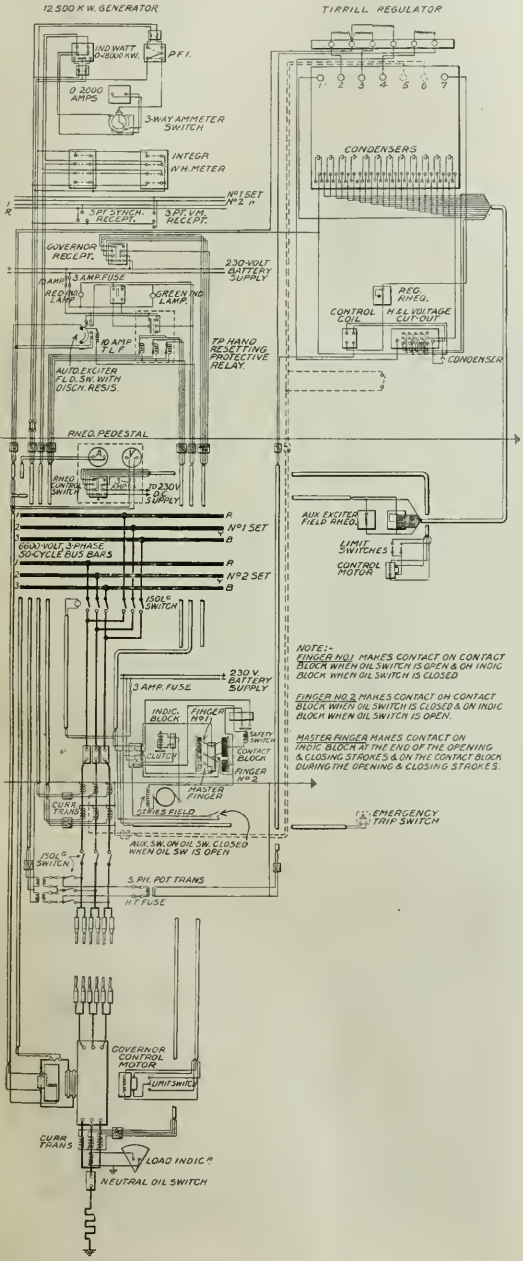


Fig. 26.—Diagram of Connections of 12,500 kw. Generator and Tirrill Regulator.
Viewed from Engine Room. Front View of Panel.

The oil switches are of the makers' motor-operated H type, similar to those already installed in many of the largest power statinos in this country.

Duplicate bus bars are provided, the selector switches for these being operated by means of handles externally to the cells. An indicating lamp at the selector switch handle indicates the position of the main oil switch.

The 'bus-bars themselves are carried on duplicate insulator supports of special design to ensure that there is no possibility of any movement of the bus bars in the event of a very bad short circuit taking place on the system. This type of support also allows for any busbar expansion.

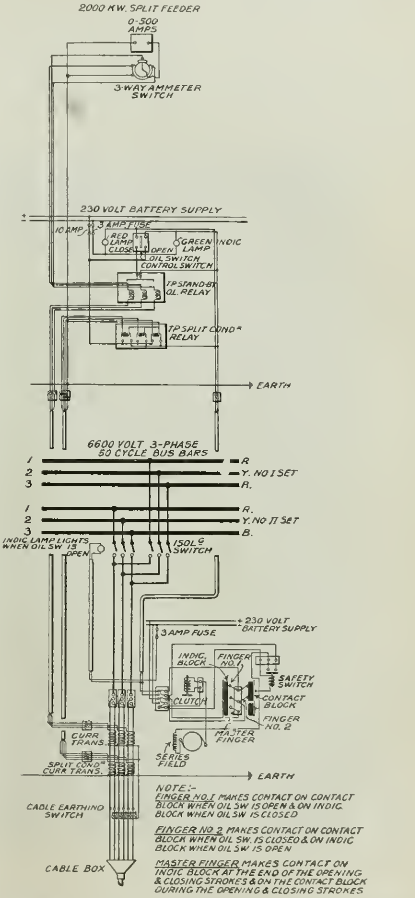

2000 KW. SPLIT FEEDER
0-500 AMPS
3-WAY AMMETER SWITCH
230 VOLT BATTERY SUPPLY
10 AMP
3 AMP FUSE
RED LAMP
CLOSE
OPEN
GREEN INDIC LAMP
OIL SWITCH CONTROL SWITCH
TP STAND-BY OL. RELAY
TP SPLIT CONDR RELAY
EARTH
6600 VOLT 3-PHASE 50 CYCLE BUS BARS
1 2 3
R
Y. NO I SET
B.
R.
Y. NO II SET
B.
INDIC. LAMP LIGHTS WHEN OIL SW IS OPEN
ISOLG SWITCH
+ 230 VOLT BATTERY SUPPLY
3 AMP FUSE
INDIC. BLOCK
FINGER NO. 1
SAFETY SWITCH
CONTACT BLOCK
CLUTCH
FINGER NO. 2
MASTER FINGER
CURR. TRANS.
SERIES FIELD
SPLIT CONDR CURR TRANS.
EARTH
NOTE:-
FINGER NO. I MAKES CONTACT ON CONTACT BLOCK WHEN OIL SW IS OPEN & ON INDIC. BLOCK WHEN OIL SW IS CLOSED
FINGER NO 2 MAKES CONTACT ON CONTACT BLOCK WHEN OIL SW. IS CLOSED & ON INDIC BLOCK WHEN OIL SW IS OPEN
MASTER FINGER MAKES CONTACT ON INDIC BLOCK AT THE END OF THE OPENING & CLOSING STROKES & ON THE CONTACT BLOCK DURING THE OPENING & CLOSING STROKES
CABLE EARTHING SWITCH
CABLE BOX

Fig. 27.—Diagram of Connections of E.H.T. Split Feeder viewed from Engine Room. Front View of Panel.

The feeder oil switches are all duplicates of one another and are arranged with split contacts, suitable for working with the protective gear for split conductor feeders. In addition to split conductor protection, on each feeder a definite time limit relay is provided to ensure that in the event of excessive overload the feeder shall be isolated after a definite time has elapsed.

Each generator equipment is provided with circulating current protective gear in conjunction with automatic field circuit-breakers, an earthing resistance of suitable capacity with oil-immersed isolating switch; a load indicator and an emergency trip pedestal at the turbine stop valve to trip the generator oil switch.

The control boards consist of black enamelled slate panels. The generator control panels and equipments are arranged as one board; the feeder control panels are arranged as a separate board and in a semi-circle facing the generator control board, as indicated in Fig. 21.

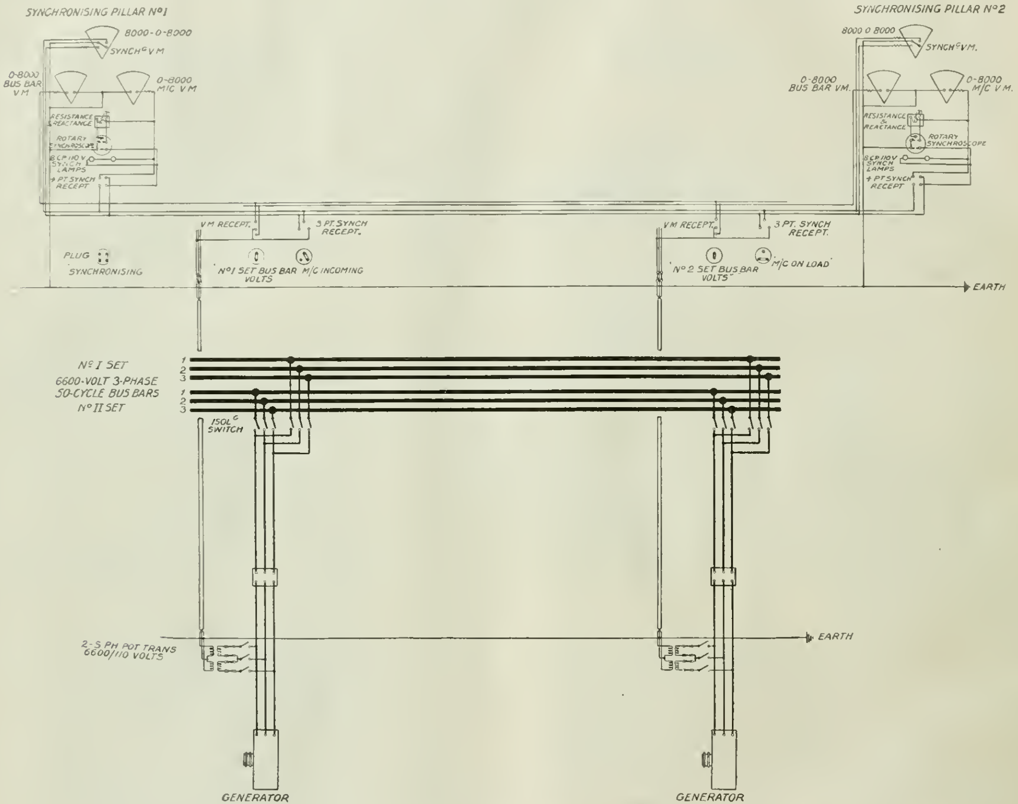


Fig. 28.—Diagram of Connections of Synchronising Arrangement

A duplicate synchronising equipment is provided, and a Tirrill regulator has also been installed with each alternator equipment. The alternator exciter field rheostats are electrically operated.

Diagrams of connections are given in Figs. 25-28.

The direct-current supply for operating the oil switches, indicating lamps, &c., is taken from a 250 ampere-hour secondary battery, which is reserved for this purpose, and for a certain portion of emergency station lighting.

The auxiliary plant will be supplied from two 1,500 kw., 500 revs. per min., six-phase rotary converters (also by the British Thomson-Houston Company, Ltd.), in conjunction with Westinghouse transformers, stepping down from 6,600 volts three-phase to a direct-current voltage of 460/520. By a system of change-over switches the same machines may, in case of need, be utilised on the traction feeders at 520/600 volts.

The supply from the above two 1,500 kw. rotary converters is distributed from the main distribution board, consisting of 16 panels. This is installed in the converter annexe, as previously mentioned. With this arrangement it will be possible to keep the supply of power for auxiliaries entirely separate from the old generating station direct-current system if necessary. This board (seen in Fig. 30) distributes power for the whole of the auxiliaries in the engine room and boiler houses, the cable connections being shown in Fig. 29.

For the boiler-house auxiliaries and coal-handling plant, power is taken by means of two feeders to two separate distribution boards installed in a sub-station between the two boiler houses, one board feeding the auxiliaries for one boiler house and one board feeding the auxiliaries for the other boiler house. Each board consists of seven panels.

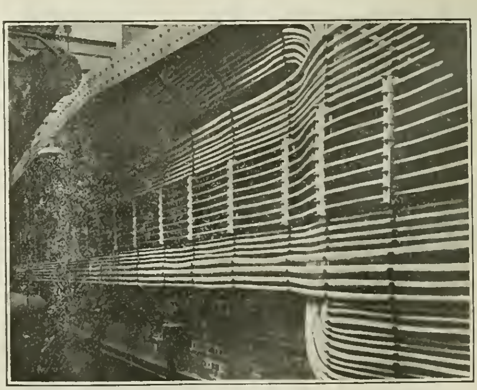


Fig. 29.—View showing the Cables from the Main Distribution Board to Auxiliary Plant.

Motor-control panels for the whole of the auxiliaries are placed as near as possible to their respective motors.

The board is also provided with a second set of bus bars and an interconnector to the old generating station, so that direct-current power can be exchanged at any time.

Chadburn's ship telegraphs and Graham loud-speaking Navy telephones are provided between the control room and each turbo-alternator and boiler house, while a sysetm of automatic telephones is being provided between all departments.

A motor-driven air-compressor is provided, consisting of a horizontal single-stage unit capable of delivering 82 cubic ft. of free air per minute to a pressure of 80 lb. per square inch when running at a speed of 185 revs. per min. This is coupled to a 21 H.P. B.T.-H. motor. A main air pipe is run from this unit to certain fixed points in the station, flexible hose connections being provided at these points for local use.

The whole of the cables for the station are of Messrs. Callender's Cable & Construction Company's manufacture, the extra-high-tension cables between the alternators and the switch being special flexible single-core cables erected in reinforced concrete supports fixed to the building structure. Each support is provided with a porcelain tube in the centre, the cables being separated from each other by means of a spreader. Each support carries three cables, the number of cables per phase for the 12,500 kw. turbine being two of 0·8 sq. in. section, and for the 30,000 kw. turbine four of 0·9 sq. in. section, while the neutral in each case is one 0·8 sq. in. The cables are paper-insulated and lead-covered.

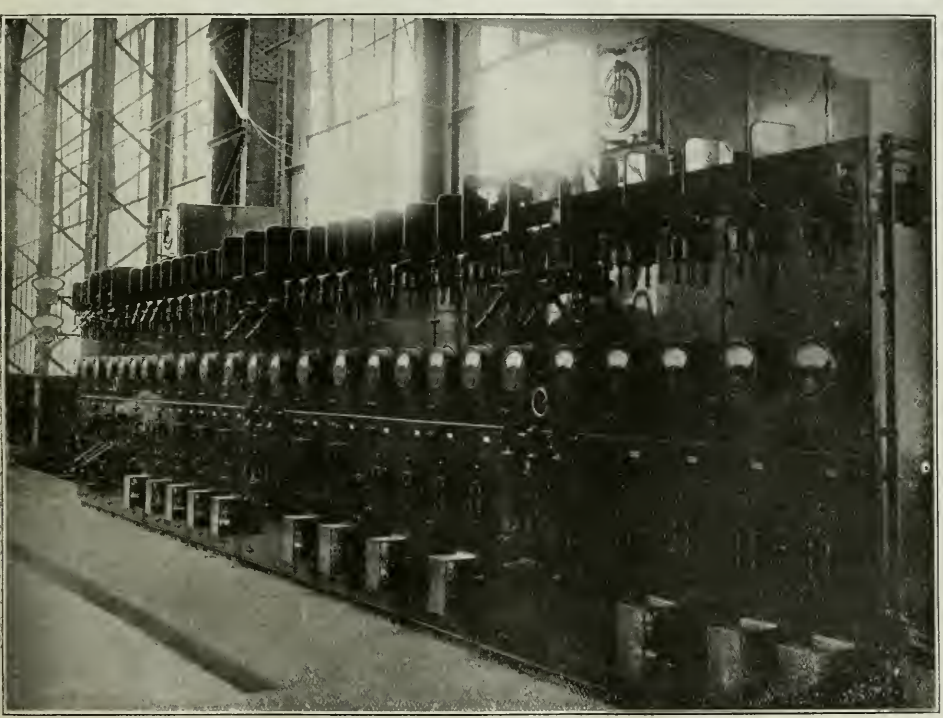


FIG. 30.—VIEW SHOWING THE AUXILIARY PLANT MAIN DISTRIBUTION BOARD, SITUATED AT THE END OF THE ROTARY CONVERTER ANNEXE.

The remaining extra-high-tension cables in the station are of the three-core paper-insulated lead-covered type, and the low-tension cables for auxiliaries are twin or multi-core V.I.R. with single-wire armour.

The whole of the lighting installation has also been carried out by the British Thomson-Houston Company, Ltd., employing principally half-watt lamps in conjunction with their standard "Mazdalux" reflector and lantern units to meet the difficulties which are found in a building of this type and size. The units have been distributed to secure a uniform distribution of light with maximum efficiency.

The source of supply is from a 230-volt two-wire direct-current 57·5 kw. motor-driven generator, with the exception that a percentage of the lighting of the whole of the buildings is permanently connected to the 250-ampere tripping battery mentioned above. This set is equipped with booster, and driven by a 115 H.P. B.T.-H. motor. In addition, the whole of the lighting circuits can, at will, be thrown by means of change-over switches on to this battery in case of emergency.

One of the special features of this lighting installation is the great height at which the lighting units in the engine room are suspended, the reflectors being designed in order to concentrate all available light on to the plant at the floor level.

INTERCONNECTOR TRANSFORMERS.

The voltage of the existing station is 3,300, whilst the voltage of the new station is 6,600. To enable an output of 5,000 kw. to be interchanged between the existing and the new station, four Ferranti single-phase transformers are installed in the basement under the rotary floor. The transformers are of the makers' standard oil-immersed self-cooled double-wound core type enclosed in plain tanks having external cooling tubes. The transformers have to step-up or step-down, three transformers to form a three-phase unit with one transformer as spare.

Each transformer has a capacity of 2,085 k.v.a., with a temperature rise of 45°C., and is capable of withstanding an overload of 10 per cent. continuously, 25 per cent. for seven hours, 50 per cent. for half-hour and 100 per cent. momentarily without undue heating.

The high-tension windings are connected in delta and the low-tension in star, with the neutral point brought out. The cases are mounted on rollers to facilitate moving.

Dessaner's High-Tension Transformer.*

By E. WALTER.

In work connected with Röntgen rays very high pressures are required, even higher than 200,000 volts. This arises specially in medical work, when studying deep-seated maladies. In cases of this kind, the ordinary forms of constructing inductors and transformers are not sufficient. This has led to Dessauer's method, which was worked out in the Frankfort University and in the laboratory of the Veifa works. It consists of a plan by which the high-tension stresses are so controlled that they are removed to a position where they can be safely dealt with. In this way a safe stress on the dielectric is always maintained.

In Röntgen ray work there are two usual forms of transformer viz., that with closed and that with open iron core. With an open iron core the separate winding elements on the high-tension side are separated from one another by specially prepared discs of presspahn. The distance of the secondary winding from the iron core increases as the pressure rises towards the ends. The primary winding is enclosed in a thick insulating tube of vulcanite or impregnated paper. Between the walls of the tube and the primary winding there is an air space for cooling and other purposes. The whole of the secondary winding is filled with a fused insulating material; in order to remove moisture and air this is dried and cooled under a vacuum. Small air bubbles do no harm, but if they are several millimetres in diameter they become so hot under the glow discharge that the insulating mass gets fused; but this does not happen if the bubbles are less than 1 mm. in diameter. A further loss from glow discharge takes place in the air space between the iron core and the insulating tube, and this affects the durability of the tube. If this space is solidified by pouring in some fused insulating material, this does not improve matters, as the stresses are displaced towards the secondary coil. In either case the insulating tube breaks down in the course of time. The critical pressure at which this destructive action of the glow currents arises is about 70,000 volts; but below this pressure transformers of this kind work perfectly well. According to the records of the Veifa works at Frankfort, 65 per cent. of the transformers which break down owe their collapse to discharges at the end of the windings.

With transformers with closed iron cores the conditions are rather different; they are mostly filled with oil. The necessary distance from the iron yoke and the high-tension winding is only to be obtained by increasing the dimensions. The difficulties are very great with spark-gaps of 30 cm. or 40 cm., and they can be overcome only at great cost. Certainly a discharge through the oil does not produce such bad results; if the transformer is switched off at once, it can be used again in a few seconds. It is quite possible that the discharge may have deteriorated the quality of the oil; but in many cases, the discharge passes between the coils and then serious damage may be done; this arises because the oil does not thoroughly penetrate through all the windings.

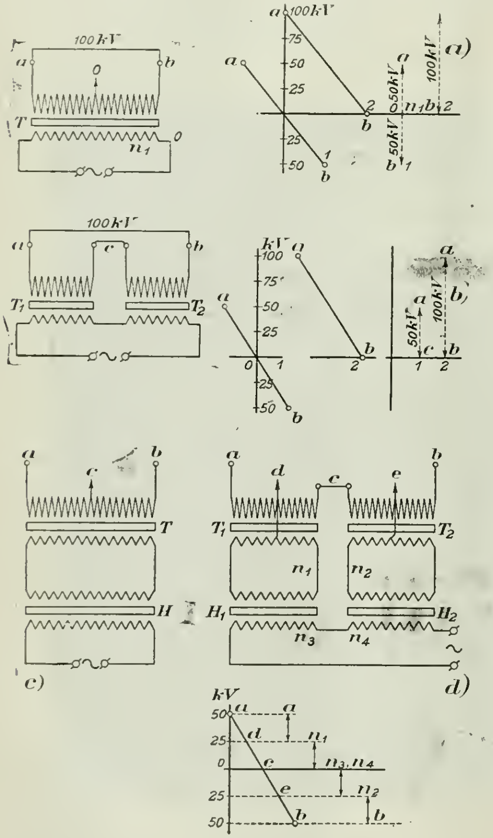


Fig. 1.—The Distribution of the Potentials on Various Systems.

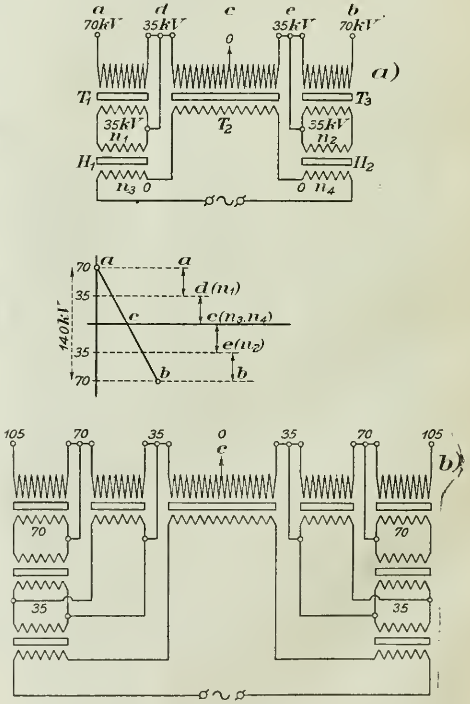


Fig. 2.—The Distribution of Potential on Dessauer's System.

Let us now consider the Dessaner system. In the normal high-tension transformer, the iron yoke and the primary winding should be at the potential of the earth. The highest difference of potential is between the ends of the high-tension winding and the iron yoke. In the most favourable case with a terminal voltage of x kilovolts, the stresses are so distributed that at both ends of the winding there is a pressure of $x/2$ kilovolts to earth. There is no advantage in joining several transformers in series. This can be seen diagrammatically in Fig. 1, A and B. Through an unsymmetrical system of earthing the stress on the ungrounded end is doubled. An apparent advantage arises from the method shown in Fig 1 at c. Here a part of the transformation ratio takes place in H and the other part in T, but as T was a continuous iron core, the stresses are actually the same as in a and b.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," Nos 38 and 39, 1918.

Let us, however, suppose that it might be possible to transfer the electric stress or a portion of it to another transformer, so that the original high-tension transformer takes very little of it; then it might be possible to safeguard the insulation. Fig. 1 shows such an arrangement at *d*. There are two high-tension transformers, T_1 and T_2, and two stress transformers, H_1 and H_2. The primary windings of the two latter transformers are in series, as also the secondary windings of the two high-tension transformers, which are earthed at their middle point *c*. Let us suppose the secondary voltage to be 100 kv.; thus *a* is 50 kv. above earth, and *b* the same amount below. Let us now suppose the middle points of the high-tension windings *e* and *d* to be joined to the corresponding points on the primary windings of the high-tension transformers. Then each of these primary windings, as well as the secondary windings of the stress-transformers, which are connected to them, have the potentials of the points *d* and *e*. The distribution of the pressures is shown in Fig. 1 at *d*. In the present case *c* is at the potential of earth. The points *d* and *e*, as well as the primary windings of the high-tension transformers, and the secondary windings of the stress transformers, are 25 kv. above or below earth. The end of the high-tension windings at *a* and *b* are 50 kv. above or below earth, but differ only by 25 kv. from the corresponding primary winding and the iron core. The maximum stress is thus only 25 kv., the total pressure being supposed to be 100,000 volts.

This advantage is obtained at the cost of two stress transformers, and a double system of transformation. The energy-loss in transformers is generally a very small percentage, and matters little in this case, especially as the loss through glow discharge is avoided. The cost of the stress transformers is very small; they can be wound with a few turns of thick wire, a closed iron yoke, and oil insulation. Seeing that the stress in the high-tension transformer is halved, its cost will be more than halved. Consequently the new system is very little more expensive than the old for moderate voltages, and on very high voltages it is cheaper; there is no comparison from the point of view of safe working.

A further decrease in cost can be brought about by using a third transformer, because then a third stress transformer is not needed. Fig. 2 *a* shows this arrangement. This is designed for a total pressure of 140 kv., and the maximum stress is 35 kv. Fig. 2 *b* shows a total pressure of 210 kv., which has no greater stress between neighbouring points than 35 kv. It is noticeable that this plan is on the lines of Fig. 2 *a*, and is fitted for the higher pressure merely by adding new members. The original members move outwards, and their places are taken by the new ones. For testing purposes this is important; higher pressures can be dealt with by already existing apparatus and at little extra cost. In case of a breakdown only a portion of the apparatus will be injured; and if the broken down portion is cut out of action, the rest is serviceable for a lower pressure.

The second half of the author's Paper deals with tests which were carried out on Dessauer's system in order to determine the dielectric and glow losses and the no-load currents. This part of the Paper is not here reproduced.

Machine Tools.*

By Sir ALFRED HERBERT, K.B.E.

Man, it has been truly said, is distinguished from the lower animals, perhaps more completely than in any other respect, by the fact that he is a tool user. His domination over other forms of life on this planet has been largely because—although inadequately provided with natural means of asserting his superiority—he developed weapons and tools of a constantly, though slowly, improving type. Probably in the potter's wheel is to be found the first germ of the machine tool itself. It is no great step to the invention of the first crude wood-working lathe; but the modern machine tool is a product of comparatively recent times. The production of the steam engine was rendered extremely difficult by the lack of means for accurately machining its parts.

To Maudslay and Whitworth we, as users of machine tools, owe the greatest debt. Maudslay is credited with the production of the first slide rest; it was Whitworth who, by his accurate plane surfaces, and by his wonderful progress in exact measurements, became the father of mechanical accuracy. Given the ability to produce reasonably accurate cylindrical and plane surfaces, and given the slide rest, the evolution of machine tools became simply a question of time.

The lathe undoubtedly was the first real machine tool. It is of all machine tools even to-day the most important and the most universal. In direct line of descent from the lathe we find the milling machine, the boring machine, the drilling machine, the screwing machine, the capstan lathe, the automatic screw machine, the automatic turning machine, the universal and plain grinding machine and the boring and turning mill. From the shaping machine are descended the slotting machine, the planing machine and the surface grinding machine. To-day the machine tool family is enormous, both in range and in variety.

In earlier days the amount of work done in the drawing office was relatively small; now the drawing office is not only the "designing" department, but the "thinking" department. In earlier days the drawing office was called upon simply to produce designs; but the necessary detail involved in the carrying out of those designs was left very largely to the knowledge and memory of the foreman and principal workmen, guided by tradition of previous similar work. When new machines were introduced, detailed drawings of the most troublesome parts were, it is true, prepared; but very usually machines with which the shop had become familiar were built from the most sketchy tracings on a scale of $1\frac{1}{2}$ in. to the foot. Elaborate calculations of stresses in structural work were made, but were invariably corrected (generally for good) in the light of the mechanical instinct of the proprietor.

There was a much narrower choice as regards materials to-day, and little was known either of their chemical or physical properties. Foundry methods were extremely crude, analysis in its practical application to the foundry being unknown, and the percentage of scrap considerable. Blow-holes in castings were looked upon as inevitable, and local hardness, varying in degree from that which the tools could face with difficulty up to that which they refused to face at all, was frequent. Malleable castings of extremely poor quality and badly annealed were used to some extent; steel castings in exceptional cases only. Mild steel, mainly Bessemer, of fair quality, was available; but wrought iron was very largely used. Stampings were unknown. The only means available for hardening and tempering tools was the blacksmiths' hearth. Heat treatment and the accurate determination of temperatures was unknown, and the only guide in tempering was by the colour. The large bulk of the machine tool equipment was concentrated on, or under, a gallery, the heavy machines on the ground floor and some of the lighter tools on the gallery itself. Of measuring appliances, there was nothing more refined than a standard set of cast-iron gauges, which were used only for checking workshop gauges, made as required in cast iron. The micrometer had not made its appearance, but workmen in those days possessed uncanny skill in the use of inside and outside calipers. No tool room existed. There were no jigs or fixtures, and, in fact, no small tools in the modern acceptation of the term. Lathe and planer tools were forged to shape, hardened and tempered in the blacksmith's trough and ground on a grindstone, which it was the job of the youngest apprentice periodically to true up with a 3-square file. The author remembers no lathe which could be relied upon to turn out parallel work without constant watching and calipering; but in time one got to know the general tendency of the lathe on which one was working, and knocked the tool into the work or away from it as the job proceeded. The capstan lathe, the milling machine, the grinding machine and the gear-cutter were not represented in the shop by a single specimen. The planing machine, the shaper and the file and chisel were relied upon for work that would now be dealt with by the milling machine. In the absence of any knowledge of the cylindrical grinding machine, all shafts and spindles were finished by the file, whilst the job was revolving in the lathe, and were polished by what were known as emery clamps. These were similar to exaggerated nutcrackers, made of wood with a leather strap to act as a joint. As no gear-cutting machinery was available, all gearing was of necessity cast, usually from wooden patterns.

To those accustomed to the many refinements and conveniences of to-day, it may appear that the lot of workmen who had to struggle to produce creditable results under such conditions was a sad one; but the very lack of appliances and of adequate machine tools did, in some degree, act as a stimulus to the ingenuity and resource of the workmen,and resulted in the production of an all-round mechanic. Doubtless there are many familiar with the difficult workshop conditions of 30 years ago, and who have watched the great advances that have taken place. We should acknowledge our indebtedness to the United States for much of our progress in machine tool production and in workshop methods. American tool builders were stimulated to a great extent by the high level of wages. When labour is expensive, employers cannot afford to waste it. The introduction of American machine tools, developed under the special conditions obtaining in that country, has been of great service. Any policy which would tend to make it difficult or unduly costly for British machine tool users to obtain the best machine tools, wherever produced, would be as short-sighted as the taxation of raw material.

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* Abstract of a Paper read before the North-East Coast Institution of Engineers and Shipbuilders.

Repetition work was first seriously developed in the manufacture of small arms and of sewing machines. The manufacture of small arms, required in very great quantities and without change in design, permits the system of interchangeable production to reach its highest development. Each operation is performed on a machine specially set up for that operation, and used for no other purpose, this leading, of course, to great simplicity as regards each individual operation, but making, on the other hand, the greatest demands on the skill of the tool designer, toolmaker and gauge maker, and of the inspecting staff. In England the early importation of American machine tools soon demonstrated that there was a market here for machinery of this class, and their introduction had a valuable educative effect both on machine tool users and on the English machine tool trade. In this country the bicycle trade did much for the advancement of workshop practice and of workshop equipment, and in this field British makers were for a long time in advance of America. The motor car industry afforded another great incentive to machine tool designers and makers.

The discovery of high-speed tool steel marked an epoch in machine tool design. For years the limiting factor in the metal moving capacity of machine tools had been the endurance of the carbon steel cutting tool, which failed by softening and losing its cutting edge whenever heated by the friction of the cut sufficiently to draw its temper. The new self-hardening steels at once changed the limiting factor to the machine tool itself. The immediate result was the scrapping of machine tool patterns, and the production of new designs embodying much greater weight and stiffness, accompanied with enormously increased power. A further development was a radical change in headstock design. The all-geared head stock was introduced to give greater torque at high speeds and a larger range of speeds, and this soon demonstrated that much better gearing was needed. Thus we get the completely covered gearing, running in an oil bath, making for quietness, durability and safety to the workman.

The same ideas of power, convenience, safety and quick-changing facilities spread very rapidly through the whole range of machine-tool design, and were applied not only to main drives but to the feed motions. Of great importance also has been the general introduction of electric power transmission. When first introduced, the failures and difficulties inseparable from any revolutionary innovation rendered the general adoption of electric driving slow and tedious; but the constant improvement in electrical producing and distributing plant, and in the electric motor itself, has caused an immense extension in electrical driving; in fact, it would be exceptional to find any engineering works of importance to-day in which electrical power distribution was not in use. The general trend of experience has been, so far as the smaller types of machines are concerned, towards group driving by electric power. This reduces the number of motors required and enables a group of small machinery to be run with a smaller total motor horse-power. On larger machines it is desirable for individual motors to be used; in many cases motors are incorporated in the design of the machine, and this again has led to many modifications in order to adapt the machine more completely for electrical driving. One advantage of the individual electrical drive in the case of large machines is the facility offered for placing the machines in the most convenient situations irrespective of their distance from the power station, and also of so disposing them as to be served efficiently by cranes without the interference of belts and counter-shafts. In certain classes of machines the tendency is to go beyond the mere driving electrically, and to introduce in addition electric controls. This is well exemplified in the latest designs of planers, and the future will see further and large developments in this direction. Interesting work has also been done in the direction of hydraulic control of the various motions of machine tools. So far, work in this direction has been largely experimental. Another interesting development of comparatively recent times has been the introduction of optical methods into the more refined classes of precision machinery in connection with the production of accurate screws and the reading of close measurements.

The machine tool trade was much affected by the war, but it was spared the complete dislocation which so many other branches of engineering suffered through the necessity of changing entirely the nature of their output. At the first declaration of war there was a curious lull in the demand for machine tools; but, when every existing shell plant became occupied to its utmost capacity day and night, it was realised that further increases in shell production could be effected only as additional machine tools became available. Much valuable work was obtained from many firms who abandoned their own regular trade in order temporarily to make machine tools, and in many instances with great success. Large quantities of machinery were also imported into the country from abroad, particularly from America, though some useful machinery was obtained from Switzerland, Scandinavia and from Spain. Ultimately steps had to be taken to arrange for the manufacture of machine tools by American engineering firms who were not machine tool makers. In many cases machines were built to British designs. Finally, even after a period was reached when no further anxiety was felt in respect of shell making plant, there arose a great demand for other types of machine tools required for motor transport work, for aeroplane work, for the building of tanks, for gauge making, for optical work and for shipbuilding, &c.

All this war activity has had its effect on machine-tool production and machine-tool producers and users. Great attention has been concentrated on efforts to secure cheap and rapid production in spite of the many difficulties due to shortage of labour and to other causes. In the production of accurate screw gauges alone much valuable progress has been made which cannot fail to have a wide reaching effect in engineering generally. But with the cessation of hostilities and the cancellation of Government orders conditions are changing. Great masses of engineering plant have been thrown idle at least temporarily, and a good deal of time must of necessity elapse before useful work is found for all the available producing capacity. Manufacturing concerns are now compelled to turn their energies to the satisfactory employment of their resources on work required for peaceful purposes. This involves new designs, new patterns, new tools—jigs and fixtures, new selling organisations, and, most difficult of all, new relations with labour.

Some consideration may well be given to the general effect of the modern machine tool on labour. The advent of mechanical methods into the textile and similar trades gave rise to the wildest apprehension on the part of the hand-loom weaver that his livelihood would be taken from him, and the introduction of labour-saving machine tools gave rise to similar misgivings. But in both instances the ultimate effect was largely to increase both the demand for labour and the amount of its individual earnings. Besides the large number of highly-skilled workers required for the production of the machine tools themselves, improved tools and methods created an ever-growing demand for labour, and led inevitably to a steady increase in wages. Even before the war the earnings of a competent worker were in many cases at least twice as great as those of his predecessor of 25 years ago, and it has been rare for a really competent workman to suffer unemployment. Now a new class of labour has in fact been created. The tool maker, the jig maker, the inspector, the machine tool charge-hand, the machine tool demonstrator, the process setter and the rate fixer have all been brought into being by the modern machine tool in its application to mass production. This class of labour has been recruited from the more intelligent and thoughtful among the rank and file. It is highly paid, and enjoys many opportunities of improvement and promotion to more important responsibilities. The machine tool maker is constantly confronted by instances in which expensive machine tools are bought and installed, and from which the user does not reap the full measure of benefit which the tools are capable of giving. The future is full of opportunity for the aristocracy of labour in so controlling the selection, the setting up and the running of modern tools as to justify the capital expended in their purchase.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"The Claims of Labour and of Capital," by W. R. Cooper. (London: Constable & Co.) Pp. iv.+84. 2s. 6d. net.

"The Coal Industry: Dangers of Nationalisation," by Harold Cox. (London: Longmans, Green & Co.) Pp. 18. 6d.

"French Technical Words and Phrases: An English-French and French-English Dictionary," by John Topham. (London: E. Marlborough & Co.) Pp. 318. 5s. net. 3rd Edition.

"Physical Laboratory Experiments for Engineering Students," Part I., Mechanics, Sound, Heat and Light. By S. Sheldon Ph.D., and E. Hausmann, E.E. (London: Constable & Company.) Pp. v.+134. 6s. net.

Technical Research—The Man and the Job.

BY A CORRESPONDENT.

Having just returned from Ruhleben, where one could study at leisure (with much misgiving) the journalistic trumpeting of England's awakening to the importance of industrial research, I want to let myself go on this very important but well-worn subject. We had ample time to compare notes and discuss the matter there, and most of us knew Germany well. Many of us had drifted over there, years before, to remain because our services were desired, valued, and well paid there ; most particularly, however, because we found that the heads of the firms we had to deal with had a full comprehension of our point of view and type of mind. After all, none of us had foreseen that the work we had done would one day be an asset for an enemy of our country. As the matter stood, the inventions we had made, and the factories we had built, were very decidedly assets. We had a grievance against England, therefore, for not having kept us at home. Nor did we promise ourselves any great good fortune upon our return at the end of the war. For we felt somewhat doubtful whether the "will to research" in England would survive a victorious war, and quite certain that, if it did, all the wrong people would get the direction of research, while we (by hypothesis the right ones) wouldn't have the ghost of a chance.

For technical research is a matter of the right man in the right place. You must get the right man (and to do that you yourself must be the right man for the job of selection) and you must make the place right for him. How his laboratory is arranged, what it is paved with, even how much money you decide to set aside for research ; all these are quite minor matters. What sort of a man is the right man ?

He is born, not made. He has the creative gift, the faculty of seeing new combinations and possibilities where the most accomplished technician without the gift sees only known ones. He has a first-class education in pure science, and a wide experience in works ; he has further taken the trouble to master the technique of business, costing and selling. Good if he has managed a department and had to make it pay. He retains in spite of all this so incurable an interest in experimenting that he is willing to sacrifice the joys and emoluments of managerial power to it. Not the man who is no use anywhere but in the "lab," but the man who prefers the "lab" in spite of prospects of success in management—that is the man you want. Or the consultant who is earning a good, if precarious, living at all sorts of small jobs, and taking out ingenious patents which he has neither time, means, nor opportunity to develop to full success. Many such a man would be worth his money ten times over to a firm which would tempt him with salary and prospect of royalties to stay and devote himself to mastering thoroughly one branch of technical work and being in the very forefront of that. It is pure nonsense to represent German industrial research as the work of dull, patient, uncreative plodders ; the kind of people a Briton will not descend to being. The men of ideas are given plodders to work for them, but a man of proved creative capacity is sought after, you might almost say courted. At the termination of the war, before I left Germany, I was offered an excellent salary, with good royalties on results, and unlimited means for research, by two of the largest German firms, and this in spite of my nationality. This accounts for the absence of consultants in Germany ; they are offered better terms to work at their own ideas for the big firms. The German firms pay the doctors to keep them well ; the English only call in the expert when they are driven to it, and half-a-dozen totally incompetent persons have wasted the firm's money on trying to solve the problem.

So much for the man. Now for the place.

How many firms "don't put down money for experimenting" ?—as one of the most flourishing wrote me before the war. Answer : None. They *all* experiment. Technical managers of departments spend thousands and tens of thousands a year on experimenting. Only it is called by another name. Push, business capacity, the power of bringing themselves prominently before the heads of the firm, the power of running men, makes these men what they are. So that the heads of the firm, even if they have an idea how much is being spent on experimenting, feel sure that it cannot be being wasted. As a matter of fact it is, very often indeed. For want of a sound scientific grounding, the excursions of these men into the unknown and untried are very often costly futilities. Even a special order, involving only very slight departures from standard, may mean the pure waste of many times the amount quoted from the office. And it is human nature that the man who has set his whole ambition on being "boss" would nevertheless like to add to his glory a little of the glamour of the inventor. Of course, I don't mean to say that managers of departments never make valuable inventions. But I do mean that a man may be a success as a manager and a wretched failure as an inventor. He will solve problems in a costly and clumsy manner, where the man of ideas would strike out a new line, and perhaps add a permanent profit-earner to the firm's catalogue.

The place of the research man is to control all the funds expended on experimenting ; to have all the problems coming from outside and inside put to him ; to weigh and test all suggested solutions, and direct the initial stages of all innovations. He should be fully up in the costs of all departments which concern him, watching especially such items as repairs under guarantee, and men sent out to put trouble right. He brings his own, and all other ideas which come his way, freely forward for criticism by those who know the market. He reads complaints, and the travellers drop in on him for a talk whenever they come back to headquarters. He is absolutely up to date in all published pure and technical scientific research in his field. In fact, the final triumph of the big firm is to have at its disposal, more clearly set out than in a scientific text-book, a mass of purely scientific information which the professors will not chance upon for many years to come. This is the secret of the strength of the great German chemical firms. Chemistry, as known to the most learned professors, is hopelessly out of date as measured by their archives. That involves a staff of men of university training doing research under the direction of the man of ideas. An American company took a young Englishman, part owner of a business here which he had worked up, author of valuable patents and at the same time of Royal Society Papers, and gave him £3,000 a year to run a research lab, with 20 men doing pure science, and 50 technical research, all university graduates. Any rich enough British firm could do the same. But would they pick the right man ? With the wrong man in, the very most the scheme would do for the firm as against its tremendous cost, would be to give it an advertisement. It was not the American company, but some one person in that company, which picked my young friend. That person was the multi-millionaire head, and by chance, a man of real genius and personal fascination. I am perfectly certain that 99 per cent. of English business men would simply ignore that research genius if they met him ; because in no country in the world, and quite certainly not in America, does pure but skilful bluff succeed with highly-placed and influential persons as it does in England. And a man with a genius for research has usually very little genius for bluff, because the two things are mutually antagonistic. The one is trying to get at the underlying truth, and the other is skilfully manipulating appearances. And so my final conclusion is, that, as long as there is a shortage of paper, there are more useful matters to be discussed than this one of research. The leopard does not change his spots, and British manufacturers will remain, for good and for evil, what they were before the war. Foreign manufacturers, on the other hand, will not neglect so good a recruiting ground for research workers as England, under the increased cost of living, will afford.

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London Degrees in Commerce.

It is sometimes said that the University of London is slow in meeting the changing needs of the educational world, and this has been felt in regard to degrees in commerce, which have so far been neglected. Such degrees are already available at certain other universities, such as Birmingham and Manchester, but not in London. We are, therefore, glad to find that any such reproach is to be removed in the very near future, and that university courses in the subject will be available in October next.

A little consideration leads to the conclusion that London University should be more suited to handle such degrees than any other university in the country. Not only is it our largest university, but London, as the commercial centre of the world, has a business community which should maintain such degrees at a very high level and render them more valuable than those obtainable elsewhere. As to the importance of the subject at the present moment, we need say very little. We are at the beginning of a most strenuous time in commerce, a time when it will be necessary for us to discard old, time-worn methods which are no longer of value and to adopt other up-to-date methods to enable us to maintain our position. Not only is it necessary for the commercial man in this country to be thoroughly acquainted with commercial matters, but it will also be necessary to combat an insular weakness, namely, our lack of ability to master foreign languages and lack of appreciation of their value. It is not sufficient for us to shut ourselves up in our own country and merely think in our own way. It is necessary to be thoroughly acquainted with other languages and with the thoughts and institutions of other peoples.

In instituting these degrees the various committees concerned have borne in mind, on the one hand, the necessity for training the mind so as to give flexibility, and, on the other hand, the need for acquiring really useful knowledge. It is useless to give degrees which are merely of academic value. Although the initiative came from the educational side the wise course was adopted of getting into direct touch with business people in the City of London. Thus prominent business men have been closely identified with the preliminary work throughout, and we are glad to find that the line which has been adopted is characterised by great flexibility and by a desire to include practical training. For example, a modern language will be compulsory in all branches, and not only will it be necessary for the candidate to be able to make himself understood in that language, but much greater stress will be laid upon the conversational side and a knowledge of the institutions of the corresponding people than upon the philology of the particular language selected. A strong feeling has been expressed on the part of merchants that young men should go into offices at an early age and not wait until after taking a degree at, say, the age of 23. In order to meet this requirement many part-time courses will be available, so that candidates can qualify either by taking whole-time courses or part-time courses, as they desire. A large number of lectureships and scholarships will be established, and a bureau will be set up for advising students who find it necessary to read by themselves. The degree of Master of Commerce will not be given unless the candidate has passed two years in a merchant's office under conditions which appear to have been satisfactory to the examining board. Moreover, in the case of men who have been carrying on war services, a special board will sit so that they will not need to submit themselves for the usual matriculation examination. They will be permitted to submit any subjects they desire in order to demonstrate their general standard of education.

In looking over the various reports we feel a little doubtful whether the ground of commercial activity has been completely covered. Mention is made of Australasian trade, banking, distributing trades, Eastern trade, engineering, inland transport, printing, publishing and newspaper trades, non-ferrous metals, and shipping and marine insurance, each of which have been considered by a sub-committee. It is interesting to note that candidates in the group of industries including engineering and metal trades will be required to show a knowledge of business organisation and scientific management (including such subjects as welfare work, business psychology and publicity), factory accounting, industrial law, and a modern foreign language. Obviously the effect of a syllabus of this kind is to enlarge the mental outlook of the candidate, which is all to the good. We agree with Mr. A. J. BALFOUR, who remarked at the Mansion House meeting on the subject, that commercial education is of immense value. It is no adequate reply to say that education often turns out prigs and pedants, nor to rely upon the fact that no education in the world will make up for original deficiencies.

We are glad to find that the scheme has the whole-hearted support of prominent business men and also of Ministers of the Government. In any such scheme it is necessary to have plenty of initiative, so that all needs of the times can be met. This is to be effected by having a committee of 30 members, 10 of whom will be university men and 20 will be business men. Consequently, there is no likelihood of degrees falling into an academic groove instead of being practically useful.

In launching any such scheme money is necessarily an important item. We do not think there should be any difficulty in this respect. The sum that is required will be not less than £500,000. Already, however, without any great effort a sum of approximately £300,000 is in view. London is a wealthy city, and its university, especially for work of this kind, should not be lacking in funds. We commend the scheme to those citizens who are in a position to give adequate support, and we hope that they will respond. Not only will these degrees be of great utility to the commercial world, but we do not doubt that they will do much to clear up the idea of what commerce is in the eyes of the general public. At present, ideas are very often nebulous on the subject. Everyone knows how a boy is to become a doctor or a lawyer or enter some other profession, but when it comes to commerce there is no such clear-cut method of approach. The establishment of these degrees will do much to indicate the route and will serve to attract good brains in a direction where they will be needed. Several large firms already see the importance of the scheme and have expressed themselves willing to take graduates and to give them really reasonable starting salaries. Undoubtedly this scheme has been brought forward in the proper way, and, judging by the preliminaries, we feel little doubt that it will be fully supported as soon as it is launched.

Electric Welding: Its Theory, Practice, Application and Economics.*

By H. S. MARQUAND.

(Continued from Vol. LXXXII., page 707.)

Summary.—In the present article the author deals with the preparation of welds and then passes on to certain properties of iron and mild steels which have a marked bearing on the methods adopted. The welding of copper and copper alloys has not received very much attention, but electric welding is nevertheless applicable to such work. Finally, examples are given of various types of welding.

Welding of Cast Iron.

Even to-day many experienced welders, and a large number of engineers, hold the opinion that good and reliable welding of cast iron is next door to impossible, at least in so far as the art of to-day is advanced. Nevertheless, let it be known that these only lack technique and greater reflection. In point of fact the welding of cast iron is far easier than of all other metals, inasmuch as, in the case of good workmanship, the piece repaired is generally of superior quality to the rest of the piece, and surely more than this cannot be desired.

Considering everything, and after reflection on what has already been said upon the science of metals and their behaviour under heat, it will be seen that the difficulties to be overcome are neither very numerous nor insurmountable.

General Properties of Cast Iron Apropos of Welding.

Cast iron is a compound of carbon and iron in which the proportion of carbon lies between 2 and 6 per cent. Cast iron cannot, we all know, be forged or worked, and in consequence articles of this metal are shaped or obtained by casting in moulds.

Commercial cast iron usually contains from 3 to 4 per cent. of carbon, which may be preesnt in very different states, either combined with the iron, or dissolved in the metal, giving same a very hard nature ; or, again, in the free state in the form of particles of graphite distributed in the mass of the metal.

The former variety is known as white iron ; it is hard and difficult to work.

In the latter variety the metal is soft and easy to work ; it is known as grey cast iron.

In nearly every case the line of weld requires to be worked after completion of welding, and hence the new metal should be of *grey iron.*

Now, it is well known that rapid cooling of the fused metal tends to enhance the combination of the carbon with the iron, resulting in the formation of "white iron." On the other hand, slow cooling or reheating tend to bring about the precipitation of carbon flakes, and thus to produce "soft grey iron."

If silicon is introduced into the weld in the form of ferro-silicon it naturally displaces the carbon, combining with the iron in its place, and forces the carbon to be precipitated in the form of graphite. Manganese, on the contrary, opposes the precipitation of graphite and assists the formation of "white iron."

Thus, to produce a soft weld that can be filed and machined it is only necessary to bear in mind three principles :—

1. Slow cooling ;
2. Introduction of silicon in the added metal.
3. Total absence of manganese.

The latter point is emphasised for the reason that this element is very common in cast iron in sufficient quantity to promote the formation of "white iron" during the execution of the weld.

The melting point of cast iron is about 300°C. lower than the melting-point of pure iron, being between 1.030°C. and 1.200°C. The oxide of iron formed when welding cast iron melts at about 1.300°C. to 1.400°C., and hence is not easily dispersed as in the case of pure iron or steel by the action of the arc. The oxide forms a crust or an agglomerate which settles on the surface and hinders the execution of a good weld.

Obviously this oxide so formed must be destroyed by a suitable cleaning flux. Further, this oxide tends to interpose itself in the weld, and to prevent the perfect joining of the fused portions of the metal, and to destroy to a considerable degree the action of the silicon.

It is not necessary for welders to prepare their own flux, as the mixing of fluxes is now done commercially and expertly, and they can be obtained of suitable compositions for most metals.

Many welders are in favour of using borax, but this practice cannot be recommended, as borax lacks the important quality of neutralising the decarbonisation of the cast iron which takes place through oxidation. Also the flux powder (generally used) should never be thrown into the molten metal while welding ; the filling rod, warmed and dipped into the flux, will provide all that is required.

Cast iron is one of the worst conductors of heat, and is devoid of elasticity and elongation before rupture. If, therefore, the shape of the piece to be welded opposes free play of the metal on heating or cooling, it is necessary to foresee in what direction contraction or expansion stresses will cause ultimate fracture.

The prevention of contraction breaks can often be avoided by locally heating the piece to be welded at opposite points and uniformly cooling. When the article is made up of different sections of metal, or has heavy bosses or lugs, rims, &c., it is best to pre-heat the whole mass, execute the weld quickly while the mass is at a cherry red, and cool off very uniformly and slowly.

It is most important that all cold draughts be excluded, as they prove extremely troublesome.

When the article can be pre-heated the weld can be done with advantage by graphite arc process.

However, many jobs can be done successfully without pre-heating if the chill is first taken off. The metallic arc is here the better system to adopt, though thin metal can often be best welded with the graphite arc, using anything from 5 to 50 amperes, according to the delicacy of the work. Of course, the filling rod must be in proportion to the current used.

Arc welding can score over all other systems of welding cast iron in that, by means of the metallic arc system, work can be performed in any position relative to the operator.

In certain special cases of heavy sections, a sound weld is rendered more certain by previously inserting a few staggered steel or iron studs, which will materially assist when the weld contracts from the state of fusion.

Unfortunately, cast iron is far more affected in its internal mass than pure iron or steel by gradual deterioration. For instance, many cast-iron articles are used in processes which necessitate their being frequently heated to a high temperature. When this is done the cast iron undergoes internal oxidation, and frequently it is found, when preparing an article for welding, that the nature of the metal has been altogether changed. It is useless to try and weld iron of this kind, for it will absolutely refuse to be welded.

Cast iron which has been constantly subjected to salt water deteriorates internally, and the welding of such iron is also impracticable.

Again, certain cast irons known as "tenacious cast irons" are most difficult to work, and in most cases prove impossible to weld.

Fortunately, however, these unweldable cast irons are the exceptions and not the rule. Nevertheless, it is wise to know of their existence, and to be prepared for failures in the actual execution of welds.

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THE WELDING OF COPPER AND COPPER ALLOYS.

The autogenous welding of copper and its alloys has received very little attention up to the present day, and, so far as the author is aware, is practised very, very little commercially. However, copper can be welded successfully if its technique is thoroughly understood; and, indeed, excellent results can be obtained with both pure copper and many of its alloys. It may be of interest if a few facts and hints are given.

As is well known, copper is a metal of reddish colour, and when fractured it shows a rose hue. Yellow copper contains oxide of copper in the dissolved state.

Copper is a hard metal, tenacious, having a tensile strength at ordinary temperature of about 33,000 lb. per square inch (which rapidly diminishes under the effect of heat); elastic up to 40 per cent. elongation and has a density of 8·9.

The presence of sulphur, antimony or lead in the metal makes it brittle, and copper oxide dissolved in the metal causes it to lose many of its good mechanical characteristics.

The heat conductivity of copper is very high, which makes the welding very difficult, as the contraction after welding is very rapid; and, as we have pointed out, at this temperature, the tenacity of the metal is very low, and thus contraction-fractures along the line of weld are difficult to avoid.

For these reasons, if possible, the articles should be preheated to dull redness before welding is commenced; the final execution of the weld should be as rapid as possible, and the whole mass slowly cooled.

The line of weld should be briskly hammered, taking great care that the metal is not too hot. This mechanical treatment restores the nature of the copper, which is almost destroyed by the action of the heat.

The oxide of copper formed while welding is readily dissolved in the molten metal, and hence a flux is not of great assistance. A filling rod should be used which has a strong reducing agent incorporated with it.

Again, copper, when in the state of fusion, very freely absorbs gases which promote blow holes on cooling. Phosphorus incorporated in the welding rod prevents the absorption of gases, and, in addition, acts as a deoxidiser.

Method of Welding.

The parts to be welded should be prepared in much the same way as that given for iron and steel, and according to the methods we have described in the general section on "The Preparation of Welds."

However, as copper in the state of fusion is very viscus, it is necessary to support the under side of the weld in case of fracture or such like, or if a new part is to be built on, a mould should be built round the portion to be built up to prevent the added metal from running away. If the resultant weld is to be perfectly homogeneous and free from blow holes, the parts under weld, supporting material or mould must be very clean and free from organic matter.

We emphasise again that the fusion of the metal should not be commenced until the edges of the weld and their vicinity have been raised to a high temperature.

The welding should be undertaken with the graphite arc, which should be longer than would be used for welding iron, and should be freely played about the line of weld in a circular motion to prevent the burning of the copper. The fusion of the part to be welded and the melting of the phosphuretted welding rod should be undertaken simultaneously in a regular and continuous operation. The welding rod should never be allowed to be added in drops.

As soon as welding is commenced the completion should be attained as rapidly as possible, taking care to regularly fuse both the edges, and to add new metal in regular increments; also to add excess metal to permit of working the line of weld afterward.

All special forms of welding rods should be strictly avoided, and nothing but *pure* phosphuretted copper should be used.

The secret of success very largely depends upon the preheating of the article to a high temperature, maintaining the heating after the operation and very slow and uniform cooling. After welding and cooling in this manner, the line of weld, which will consist of coarse cast metal, should be vigorously hammered together with the metal adjacent to the weld, which, due to the high temperature to which it has been subjected, is highly crystallised. If the sections are heavy, the hammering can be done hot, though care must be taken that the temperature is only moderate.

After this mechanical treatment the copper is best heated to about 500 deg. and then plunged into cold water.

The author has had many welds made on copper strictly following the above directions, which give a tensile test of from 31,000 lb. to 33,000 lb. per square inch, with an elongation of from 20-27 per cent.

Welding of Brass.

The general principles and precautions indicated for the welding of copper apply equally to the welding of brass. However, the welding of brass is accompanied by three distinct phenomena which render the successful operation a very much more difficult one than in the case of pure copper. These are:—

1. Absorption of gases.
2. Volatilisation of zinc, tin or lead.
3. Oxidation.

The welding rod should be very pure, and contain a very small amount of aluminium, which is necessary to deoxidise the welds. A cleaning flux is again indispensible, which, in addition to the properties already indicated, should have the function of dissolving the alumina produced during the deoxidising process. One of the best fluxes for copper and its alloys is made up of a powder of chloride of sodium, sodium borate and boracic acid.

The conductivity of brass as compared with that of copper is appreciably lower, and its tenacity when heated is higher. These two facts considerably help the operation of welding.

It is a good scheme to coat very thinly the exterior of the filling rod with the flux before welding, and thus ensure a clean and uniform application of the rod and flux. The same mechanical and thermal treatment of the weld is advisable for brass as for copper welds.

Bronzes.

Bronzes are alloys of copper and tin. The malleability of bronze decreases with the increase in the content of tin, and above 20 per cent. of tin the elongation is negligible. The heat conductivity of bronze is considerably less than that of copper, and when heated its strength almost completely disappears; thus, great care must be taken to support the weld and not overheat.

The same cleaning flux used for copper and brass can be used for bronze. The filling rod should be of first class manufacture, and contain a small quantity of phosphorus and aluminium.

The best advice the author can give for the general procedure in the welding of bronzes is to treat them as cast iron and to carefully follow the directions laid down for the welding of that metal.

(To be continued.)

Electric Rivet Heating in Shipbuilding.—An interesting series of articles on the above subject, by Mr. F. E. Rogers, has been appearing in "Industrial Management." Among other matters discussed are the case of electric rivet heating and electric welding. The Ford engineers have found that electric heating for rivets, in particular, gives good results. The energy cost forms only 6·6 per cent. of the total, and the saving in labour, constancy of results, and ease of manipulation are great advantages. A feature of the process is the preliminary removal of oxide or scale from rivets, which is apt to cause local overheating and burning, and may also lead to rivets working loose. This cleaning is effected by agitating the rivets in motor-driven tumbling barrels.

Heating and Cooking Notes.

The electric iron has long since been a popular domestic article among consumers of electricity, and it is interesting to notice that several firms are producing new patterns of electric irons amongst the first of the post-war products. A new comer to the field is the "Xcel" iron, manufactured by a firm who until recently were entirely engaged on munitions, and the whole of the output of these irons is to be sold through the following firms: Berry's Electric, Ltd., Downs & Davies, Drake & Gorham, Siemens Bros. Dynamo Works, Ltd., and the Sun Electrical Company, Ltd. Other popular lines of table apparatus will follow at a later date. The "Xcel" iron is illustrated in Fig. 1. It is well finished, and the main features are an easily replaceable element: a specially designed connector to take up slack in the flex, and protected with a metal housing, a permanent stand-piece or bracket fixed at the back end of the iron permits the iron being stood on end. Strip terminals are employed. It is made in two weights, 5 lb. and 6 lb. respectively, but the external dimensions are the same in each case, the difference being made in the iron clamping piece. This is a good idea with a view to standardisation and quantity production. The loading is 450 watts.

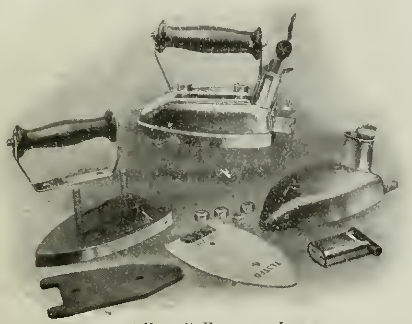


Fig. 1.—"Xcel" Electric Iron.

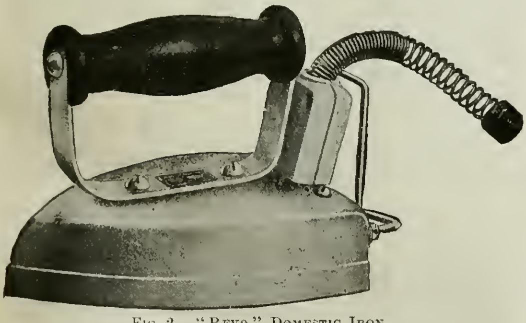


Fig. 2.—"Revo" Domestic Iron.

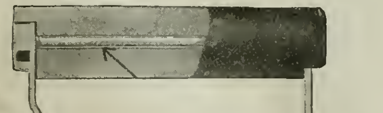


Fig. 3.—Plexsim Electric Iron.

Another new pattern is the "Revo" Electric Iron, manufactured by the Cable Accessories Company, Ltd., Tipton, Staffs. Here particular attention has been devoted to obtaining good point heat. Three elements are employed, one at each side, and a third placed transversely across the front. The elements are clamped between the sole and a clamping plate and the top surface of the sole and bottom surface of the clamping plate are machined to provide good thermal conductivity. Positive connection is made between the elements and the back of the iron. The connector is provided with a metal housing and a spiral wire guard protects the flex. A heavy gauge wire bridge piece forms a stand when the iron is stood on end. Faulty elements can be quickly replaced.

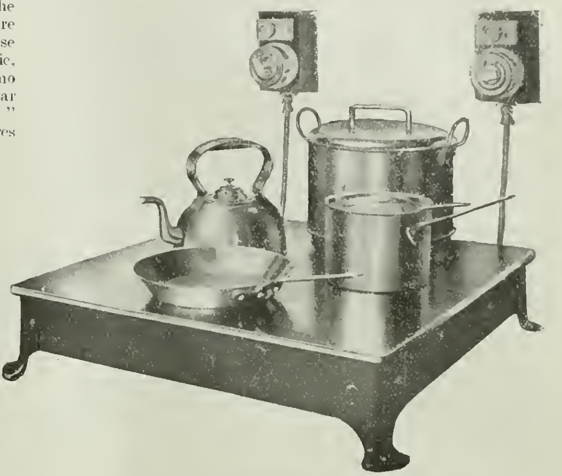


Fig. 4.—"Tricity" Boiling Plate.

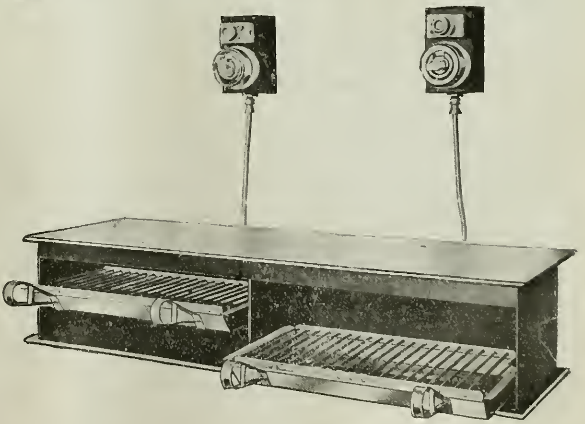


Fig. 5.—"Tricity" Grill.

The Plexsim Electric Iron, supplied by Messrs. Simplex Conduits, Ltd., is of most sturdy construction, a good feature in view of the rough handling some irons receive, especially in blouse factories and similar establishments. The element is easily replaceable, and is clamped between a pressure plate and the base of the iron. An asbestos pad is employed at the top of the pressure plate to prevent the passage of heat from the base to the top of the iron. The connection between the terminals and the heating element is positive, good contact being obtained by clamping the connecting strip to the terminal stud by means of a heavy nut. The handle is secured by a bolt which goes right through the handle. This forms a much more suitable fixing than wood screws, which often work loose. Cylindrical terminal pins are used, and the connector is provided with a metal housing and a spiral wire guard for the flex.

New "Tricity" Appliances.

The British Electric Transformer Company, Ltd., have still further extended their line of Tricity heating and cooking appliances, and seem to be changing their policy of design from the extension hot-plate to a larger type of boiling plate in the form of a hob. This has many advantages from the user's viewpoint. It provides a more stable and convenient support for the cooking utensil, and various utensils can be moved about as required to various parts of the boiling plate. This piece of apparatus is supplied complete with control panel, consisting of two three-heat switches and two "Zed" fuses. The top is ground to provide good thermal contact with the base of the cooking utensils and measures 24 in. by 24 in. It is mounted on a frame provided with four feet, and stands 4¾ in. high. The loading is 2½ kw.

The "Tricity" Grill shown in Fig. 5 consists of two sections, each separately controlled by a three-heat switch and "Zed" fuse. The top is in one piece, 6 in. by 12 in., and made of cast iron. It is supported by a sheet steel frame, divided into two sections to form the two grilling compartments. Each compartment is provided with a radiant grill element loaded to 2 kw., making a total loading of 4 kw. for the two sections.

In a recent issue we gave a sketch of the Fish Spine beads. This, however, was not correct. A section of the beads, as made by Taylor, Tunnicliff & Company, is shown in Fig. 6. From this it will be seen that when the wire is bent the beads still remain in contact, and thus afford protection.

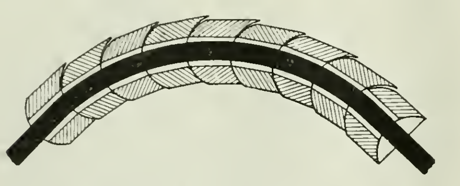


Fig. 6.—Section of Fish Spine Beads on a Bent Wire.

Correspondence.

OVERHEAD TRANSMISSION LINES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In the interesting article by Mr. Twiss, in the current number of your paper, he refers to some comparative figures for the costs of overhead and underground 20,000-volt lines which I gave in an I.E.E. Paper in 1914.

Except by those who are in close touch with these matters, it is not recognised what a tremendous increase has taken place in the cost of construction of overhead lines in this country since August 1914. In support of this statement I can quote, as one out of a number of instances, the case of a contract carried out in 1918-19 for the laying of a 20,000-volt split conductor cable and the erection of an equivalent split conductor 20,000-volt overhead line. Reference to the actual costs shows that the overhead line cost £50 per mile more than the cable.

On the general question of cables versus overhead lines for *main line* transmission work in this highly industrialised country, and in view of the discussion which is now going on as the result of Mr. Pearce's I.M.E.A. Paper, I have seen no reason to change the view expressed in my article in The Electrician for June 28th, 1918, that "with our present experience of the reliability of cables it is almost certain that the main transmission of large powers over the short distances required in the industrial areas of this country will be done by means of cables laid underground, and that no 'spare' cables will be provided."

For the conditions obtaining in other countries overhead lines are doubtless suitable.

I may add that these are my considered views as an engineer, and they are not unduly coloured by the fact that I am connected with an important firm of cable manufacturers.—I am, &c.,

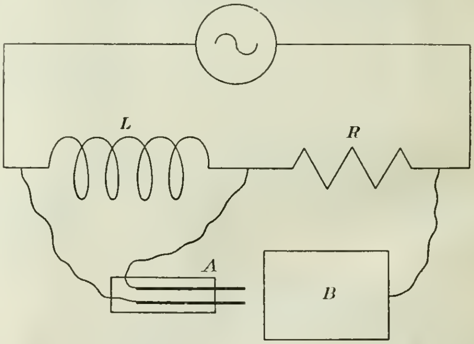
Prescot, July 1. B. Welbourn.

THE DEMONSTRATION OF PHASE DIFFERENCE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The description in your issue of March 14th of Mr. J. H. Buchanan's device for demonstrating lagging currents leads me to call attention to a simple electrolytic method for the same purpose.

Two stiff wire prongs are fastened side by side on a small wooden block, *A*, which serves as a handle. *B* is a piece of sheet metal on which is laid a strip of paper moistened with a solution of starch and potassium iodide. *L* is an inductive coil, and *R* a resistance of a few ohms, connected to a source of alternating current. *A* and *B* are connected to the circuit as indicated in the figure. When the prongs are drawn rapidly along the paper, two parallel broken lines result, one produced by a current in phase with the E.M.F. of the circuit, the other by a current in phase with the current through *R*, which lags behind the E.M.F. by an amount depending upon *R* and *L*. The segments of the two lines thus appear staggered with respect to each other. A lamp or other high resistance should be inserted in each of the two leads running to *A*, such resistances being selected as will make the two lines of approximately equal intensity.



The phase difference between the two circuits of a two-phase system may be similarly demonstrated.

The writer has used this demonstration for several years. After the class have seen the records prepared, strips of paper may be passed from hand to hand or projected on to a screen.—I am, &c.,

Middletown, Conn., U.S.A., May 30. Walter G. Cady.

TEN-WATT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: We are told on all sides to economise, and as a step in that direction I like to use, and encourage the use of, 10-watt lamps; but I yesterday failed to obtain even the promise of any delivery of some for 200-volt circuits from three makers in London, including the G.E.C.

Here is a line that D.O.R.A. might usefully take up, and insist on the lamp manufacturers turning out a reasonable proportion of low-watt lamps, and not compel people to use 20 watts as a minimum in such places as passages, where that consumption of current is utterly unjustified.—I am, &c.,

Watford, June 25. M. J. E. Tilney.

The I.E.E. Conversazione and Annual Dinner.

After an interval of five years, the Institution of Electrical Engineers resumed their social functions last week, and, for the convenience of country members, the conversazione and annual dinner were arranged for consecutive evenings. The conversazione was held on Wednesday, the 25th ult., and was attended by a large number of members. The guests included the following: Sir Charles Bright, F.R.S.E., Lieut. Sir A. Whitten Brown, K.B.E., Sir Thomas O. Callender, J.P., Col. Sir T. H. Holditch, Sir H. E. Howard, K.T., Rear-Admiral Giuseppe de Lorenzo, Sir Henry Penson, Sir Francis T. Piggott, Sir R. Henry Rew, the Right Hon. Lord Shandon and Lady Shandon, Major-General Sir A. W. Stuart, C.B., and Sir Harry Wilson.

The occasion was marked by an address of welcome to those who had served during the war by the President, Mr. C. H. Wordingham, C.B.E., in the following terms :—

> On this joyful occasion our dominant feeling must be one of thankfulness; primarily to God for having brought this nation through this crisis in its history in triumph shared with its noble Allies, and for the peace which is the immediate consequence of that triumph. Thankfulness also for the bringing back in safety of those who are with us to-night, and whom we are assembled to welcome and to honour.
>
> Secondarily, are our hearts thankful to those whom He has used as His instruments in the persons of those who have fought and many of whom have died to secure that triumph and that peace.
>
> It is no hypocrisy to say that we have not won this war in our own strength. Although we were fully warned we were utterly unprepared. We had but a handful, as armies now go, of trained men, a navy which we are assured on the highest authority was deficient in certain vital respects, we had practically no hospital ships nor ambulance trains, no adequate supply of suitable armament, and we were matched against a nation which had spent forty years in steady preparation, which had sucked the brains of every other nation for ideas and inventions, which stopped at no degradation in the practice of war, using the foulest methods of the vitriol thrower and murderer, and yet we won. We may say it was due to this man or that, to the sailor or the engineer, to our money or to our cleverness, but if we are honest we shall say that we owe it to God's goodness and mercy.
>
> It is true that many of those who stayed at home have been just as indispensable as those who have fought, and they have done their utmost to contribute to the result of the nation's effort, but, after all, nothing can come up to the services of those in the field. They have worked as hard as any, for longer hours than most, and, over and above all, they have faced the foe at close quarters. It was no ordinary foe, but a foe without a spark of honour, chivalry or human feeling, a foe full of bluster when victorious with overwhelming odds on his side, and a craven and snivelling coward when beaten. A foe with whom, though he sign a treaty of peace, we must ever be alert to watch, lest at the last he sting us like an adder.
>
> We as engineers are specially proud of our men, because, while a large proportion entered the ranks, the greater number subsequently earned commissions. We are proud of their merit, but especially proud because the facts show that an engineer's training fits him for administrative work and the command of men.
>
> The Council considered many ways of welcoming back those whom we desired to honour, but we felt that nothing could be better than this conversazione, because it gives all members the opportunity of talking to one another personally. It is five years since the last conversazione; few of us have escaped bitter loss in that time, and the thoughts of many of us will be with those no longer with us. We shall not diminish the heartiness of our welcome to those among us to-night because we do not forget those who have not returned. Let those who are bereaved join heartily with the others in welcoming home the men who have been spared to those who love them. To one and all, whether they come from land or sea or air, I extend the warmest, heartiest, and sincerest welcome from every member of this Institution.

The conversazione, which was held at the Natural History Museum, was in every way a success, being much more varied than on previous occasions. A concert was given in the main hall, and there was also a variety entertainment in the grounds and a programme by the band of the Coldstream Guards.

The I.E.E. Dinner.

For a great many years the dinner has been held at the Hotel Cecil, the main hall of which had become associated with the function. This building, however, is in the hands of the military, and the large hall at the Connaught Rooms was therefore the scene of the dinner on the present occasion. Unfortunately, the attending guests were not sufficiently numerous to fill it after the manner of the Aldwych Club luncheons. Mr. C. H. Wordingham, C.B.E., presided, and amongst the 300 guests were: Sir Charles Bright, F.R.S.E., Col. R. E. B. Crompton, C.B., Rear-Admiral F. L. Field, C.B., Lieut.-Gen. Sir W. T. Furze, K.C.B., D.S.O., Sir Robert Hadfield, Bart., F.R.S., Sir Frank Heath, K.C.B., Mr. H. M. Hobart, Rear-Admiral Giuseppe de Lorenzo, K.C.M.G., Prof. Henry Louis, Mr. C. O. Mailloux, Prof. C. E. Mendenhall, Col. Sir A. M. Ogilvie, K.B.E., and Prof. A. Schuster, F.R.S.

After the loyal toasts had been honoured, the President expressed regret at the absence of Col. Sir Hamar Greenwood, Bart., K.C., M.P. (Parliamentary Under-Secretary to the Home Office), who should have proposed the toast of the evening. Sir Hamar was, however, engaged in the House in connection with the Electricity (Supply) Bill, and Mr. C. O. Mailloux, one of the past-presidents of the American Institute of Electrical Engineers, filled the gap in submitting the toast of the Institution of Electrical Engineers.

Mr. Mailloux remarked that he was one of the founder members of the American Institute of Electrical Engineers, and was also a member of the Institution of Electrical Engineers, and he had followed its growth over a considerable number of years. He paid a special tribute to the great electrical men whom the Institution had specially fostered, from Kelvin onwards, and recalled with pleasure the visit of the International Electrical Engineers to England in 1900. Speaking of the work of Great Britain in the war, he described us as "the great unboasting British who were not certain of themselves, but who, though they made mistakes, always made good." He had followed the work of the Institution during the war, and realised from the casualty lists how many electrical engineers had paid the great price. It was only by visiting this country that Americans were able to realise how great is Great Britain. He was especially pleased to "close a circuit friendship" with British electrical engineers, and hoped that in the future there would be no cross-currents of any kind.

Mr. C. H. Wordingham, in reply, remarked that it was appropriate that the toast of the Institution should be proposed by an American. There was the closest unity in electrical matters between the British Standards Association and American electrical engineers, and efforts were being made through Mr. Comfort Adams to model the American Association standards on the same lines as our own. The Institution represented the profession and industry of electricity, and could now boast of nearly 8,000 members. It was noteworthy that there was the closest co-operation with other institutions in the industry, all of which met together under the ægis of the I.E.E. He mentioned a few of the recent activities of the Institution. The Committee on the Electricity (Supply) Bill, after consulting with all other interests concerned with the Bill, hoped to send forward the considered opinion of the Council as that of all parties interested. He hoped that this opinion would receive the consideration of the Legislature. He hoped that an Electricity Committee would be appointed to consider the questions of overhead conductors, and that this committee would have a research sub-committee to investigate the questions of underground cables. The information obtained from these deliberations would be placed in the proper quarters. On the subject of patents, the Mordey report was of great value, and had been adopted by the Conference considering the question. It was hoped as a result it might be possible to provide for an Empire patent which would be of great benefit to inventors throughout the British Empire. He announced the welcome news that the Institution building would shortly be restored to the members, and he hoped that the sittings would be resumed at the commencement of the next session in September. Commenting on research work, he thought this should proceed on flexible lines. A rigid scheme was a disadvantage, because it did not allow for development. The electrical industry was still in a state of rapid flux, especially in electricity supply. The use of large turbines tended to restrict the choice of site. On the engineering side of the problem there was no finality, and if a similar development to the internal combustion engines were made as marked the introduction of the steam turbine then the position would be again altered. Failing this there might be some method of extracting the potential energy of fuel. His point was that every effort should be made to encourage invention, and on this account Government control should be as light as possible, and the administrators on behalf of the State should be sympathetic to inventors and research. At the conclusion of his remarks, Mr. Wordingham said that it was the feeling of the Council that greetings on this the first meeting and dinner of the members of the Institution of Electrical Engineers since the outbreak of war should be marked by a special message to the corresponding institutions in France, Italy, the United States of America and Japan. The message read as follows: "Fraternal greetings to their brother electrical engineers, allies in war and peace, from members of British Institution of Electrical Engineers assembled at first festival since outbreak of war."

Mr. W. B. Woodhouse, Vice-President (manager and engineer of the Yorkshire Electric Power Company), submitted the toast of the Guests, and referred to the ubiquitous characteristics of electrical engineers. During the war not only had they shown a wonderful capacity for the production of munitions, but they had also done some valuable work in surgery and medicine.

Rear-Admiral F. L. Field, C.B. (Director of Torpedoes and Mining), in replying for the Navy, said that he felt particularly happy in that he was born during the year in which the Institution was founded. During the course of a humorous speech he recalled the early introduction of electricity into the Navy, remarking that the first dynamo was placed in a separate boat and marked with a red flag, as being a dangerous piece of apparatus. So far as the design of electrical machinery for warships was concerned it was, of course, very difficult for the designer to visualise the exact effect upon his plant of an eight-inch shell. He paid a special tribute to the electrical engineers who joined up, and said there were not nearly enough electrical engineers in the Navy. During the war these men had rendered most valuable service, especially on the research side, and he though that the cost of a permanent scientific staff would be well worth while.

Lieut.-Gen. Sir W. T. Furze, K.C.B., D.S.O. (Master-General of the Ordnance), replying for the Army, recalled the words of the poet, which were to the effect "their's not to make reply." He felt that there was too great a tendency in the services to dwell in watertight compartments, and hoped that this policy might be abandoned in the near future. Unquestionably, the skill of electrical engineers had greatly contributed to the conduct of the land forces. A committee was sitting to consider the future of the Royal Engineers, and he hoped that as a result of its report a close liaison would be established between the Army and the civil engineers of the country. In spite of the League of Nations, he felt that it was necessary to prepare for the next war, and it was important that there should be electrical engineers sitting on a research committee to consider the applications of the science to war.

At the conclusion of the dinner members took part in a re-union, which was unfortunately all too short, owing to the length of some of the speeches.

The Shanghai Electricity Works.

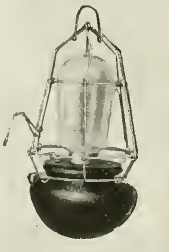
With the accounts of the Shanghai municipal electricity department (abstracted in our last issue) the engineer and manager, Mr. T. H. W. Aldridge, sent us a review of the recent activites of the undertaking. Early in 1916 contracts were placed for a 10,000-kw. turbo-generator and condensing plant with the General Electric Company (New York), for a 10,000-kw. turbo-generator and condensing plant with Messrs. C. A. Parsons & Company (Newcastle-on-Tyne) and for a 5,000-kw. set with Fraser & Chalmers-Vickers. The G.E. machine was put into commission in August 1917. The Fraser & Chalmers machine was put in commission in January last, but the original Parsons machine was commandeered and the new set had not been shipped from England in May. A contract was placed with Babcock & Wilcox for eight marine type water-tube boilers, each having an evaporative capacity of 40,000 lb. to 50,000 lb. of water per hour. Six of these are fitted with B. & W. chain grate stokers, and two with the Taylor stoker. The boiler plant was all delivered in 1917 with the exception of some of the pipework, which was lost at sea. The steel work for the turbine room and boiler house, bunkers, &c., was supplied by the United States Steel Products Corporation, their tender being about £2,000 lower than any British tender. Orders for 22,000 volt switchgear for the main Riverside power station and the Fearon-road sub-station and 6,600 volt switchgear for the Fearon-road station were placed with the British Thomson-Houston Company. Four trunk cables, each 5 miles in length, consisting of 22,000 volt split conductor lead covered and armoured cable laid direct in the ground, was supplied by the British Insulated & Helsby Cables Ltd., and laid during 1917.; and two motor-driven circulating water pumps, each 20,000 gals. per minute, by Mather & Platt, were provided. In 1917 tenders were invited for a 15,000-kw. or 20,000-kw. turbo-generator, and also additional 22,000 volt split conductor cables, pumping plant and 22,000 volt switchgear. Mr. Aldridge went to the United States in the autumn of 1917 and issued specifications in New York for the material required. Tenders were also called for in England for a 15,000-kw. turbo-generator, and at the same time tenders were received from the General Electric Company (New York) and the Westinghouse Export Company. The British tenders were for a 15,000 kw. set and the American tenders for an 18,000 kw. set, this being the nearest size to their standard adapted for 50 cycle operation, the usual frequency in the States being 60 and 25 cycles. The British tenders were lower than the American, but the Ministry of Munitions could not give a guarantee that a licence would be issued to build the machine. The tender of the General Electric Company for an 18,000 kw. machine with its most efficient load at 16,000 kw., and with a capacity of continuous operation at 20,000 kw., with a somewhat higher steam consumption was accepted. The guaranteed steam consumption of this machine with a 29-in. vacuum is as follows: 10·95 lb., 13,500 kw., 10·95 lb., 16,000 kw., 11·1 lb., 18,000 kw., 11·35 lb., 20,000 kw. A contract was also placed with the Worthington Pump & Machinery Corpn. for an electrically-driven vertical centrifugal pump, the motor being constructed for operating at the power house generating pressure of 6,600 volts. For the equipment of a large sub-station handling 25,000 kw. load, the General Electric Company received the contract for 22,000 volt switchgear and a 6,500 k.v.a. synchronous condenser. The bulk of the supply in the district served by this sub-station is to cotton spinning and weaving, flour and oil mills; and supply is also given to a jute mill and an incandescent electric lamp factory owned and operated by the General Electric Company of New York. To connect the Fearon-road sub-station with the above-mentioned sub-station two trunk cables, 5 miles in length, consisting of 22,000 volt split conductor lead-covered and armoured cable, was also placed with the General Electric Company, British manufacturers not being in a position to supply, owing to Government restrictions. For the Fearon-road station, which supplies direct current to the Shanghai Tramway Company, a motor generator-synchronous condenser set has been supplied by the Westinghouse Company. This machine is designed for an output of 600 kw. d.-c. for traction, whilst the synchronous condenser is rated at 3,250 k.v.a.

When Mr. Aldridge returned from the States it was decided, owing to the uncertainty of getting the Parsons machine and the absolute unreliability of the A.E.G. turbo-alternators (two 2,000 kw. and two 5,000 kw.), that a second 18,000-kw. machine should be ordered. Although from a sentimental point of view both the Electricity Committee and Mr. Aldridge himself would have preferred a British machine, the uncertainties were such that it was decided that the best interests of the undertaking would be served by having a duplicate 18,000 kw. General Electric set, as the General Electric Company were in a position to give quick delivery and the foundation work could be carried out from the drawings provided for the first set, saving considerable time. Owing to the serious breakdowns of the German machinery on various occasions the undertaking was seriously handicapped in the winter of 1917. Though the scale of extensions outlined in the report may appear somewhat extravagant, Mr. Aldridge points out that 14,000 kw. of A.E.G. plant is to be scrapped, and the 5,000 kw. steam plant at Fearon-road station will be closed down.

The report by Mr. Aldridge to the Council includes a table showing estimated load increases up to 1924 and the proposed method of dealing with them. It is recommended that after the installation of the second 18,000-kw. machine the A.E.G. turbine plant (14,000 kw.) should be removed and the space utilised for another 18,000 kw. unit, retaining the 1913 boiler plant for supplying it with steam. Then may come the time for erecting a second power station on adjacent property. The estimated demands expected during the period ending 1924 are as follows, the plant capacity required being given in parentheses: In 1919, 29,000 kw. (38,000 kw.); in 1920, 34,000 kw. (79,000 kw.); in 1921, 39,000 kw. (65,000 kw.); in 1922, 45,000 kw. (83,000 kw.); in 1923, 53,000 kw. (83,000 kw.); in 1924, 58,000 kw. (83,000 kw.) or possibly 103,000 kw.). The cost of the 18,000-kw. turbo-alternator and the various other plant and materials, including switchgear, boilers, pipework, transformers, cables, coal-handling plant, &c., which will be required in 1919 and 1920 is estimated at £439,000.

The G.E.C. "Buoy" Handlamp.

The General Electric Company, Ltd., have introduced a hand lamp for industrial purposes for which special advantages are claimed. The new handlamp is known as the G.E.C. "Buoy" handlamp, and is illustrated below.



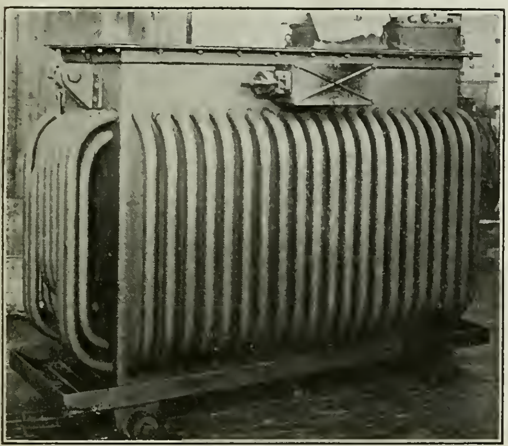
The base is of black insulating material of a robust and indestructible nature, and weighs approximately $1\frac{3}{4}$ lb. The guard is of strong tinned steel wire, and is of small weight compared with the base; thus the latter, owing to its curvature and weight, will keep the lamp upright, however it is first placed. The lamp will stand also on a gently sloping surface, and can be used without any greater care than is commonly accorded material by unskilled labour in heavy industrial work. It is very compact, measuring only $8\frac{1}{2}$ in. long by $4\frac{1}{2}$ in. diameter, is provided with both a side hook and top hook, and has no weak appendages. It is easily grasped, and as it can be hung or stood anywhere *both hands are left free.* It is shock proof, and designed to comply with the Home Office regulations with regard to handlamps for use in factories.

The construction of the Channel Tunnel is claimed by Baron Emile B. d'Erlanger to be one of the most important items in our national policy of reconstruction. It was essential from both the political and economic points of view. In the competition for the markets of the world the question of quick, safe and cheap transportation would be a dominant factor. The speediest, the most reliable and the cheapest access to the markets of Continental Europe would be best assured by the construction of the Channel Tunnel. The Channel Tunnel Company had spent hundreds of thousands of pounds in preliminary work and in keeping the question of the Tunnel constantly before the public eye. The Company was prepared at any time to pronote a Bill in Parliament for the construction of the Tunnel, fully realising that it has to satisfy the House of Commons on certain points.

Transformers in Collieries.

One of the most recent developments of electrical practice in mining is the use of transformers for underground work in collieries. In this connection a new type of colliery transformer for use actually in the pit has been designed by the British Westinghouse Company and recently placed upon the market. The standard type of transformer is not suitable for colliery work, as it cannot be taken down pit roads on account of its height.

The illustration given shows a typical three-phase 50 periods 300 k.v.a. 2,200/500 volts colliery transformer recently installed. The type generally has been developed with a low overall height, making it suitable for passage in the pit. It is mounted on wheels fitted to run on any gauge of track to be encountered in mining work. The underframe is constructed to act as a buffer from either end to protect the cooling tubes from possible damage. This frame is so designed as to permit of couplings being attached at each end.



Mechanical robustness and safety from risk of explosion and fire have been the primary factors in design. The tanks are of boiler iron fitted with external tubes to give the requisite cooling surface, and the cable terminals, &c., are constructed so that no soldering need be done in the pit. Trifurcating or bifurcating boxes for armoured cables are fitted: these comply with the Home Office regulations for fiery mines. So far this type of colliery transformer has been made up to 3,300 volts, 300 k.v.a. at 50 periods three phase.

Connecting cables in mines are subject to very rough usage, particularly if they are of large size, when it becomes very difficult in some cases to find runways for them. This development of the mining transformer avoids the necessity of running large low-tension wires along pit passages, a small high-tension wire sufficing; considerable saving in copper is thereby effected, and it is much easier to find space for them.

Gutta Percha.

The material known by this somewhat curious appellation is the solidified gum of a tree, which is indigenous to the Malayan Islands. The most important use to which gutta percha is put is for the cores of submarine cables, and it was so employed in the construction of the first Channel cable in 1849. Since then it has come into general use for cable cores and insulation and for a number of other less well-known purposes. The India Rubber, Gutta Percha & Telegraph Works Company, Ltd., one of the pioneer firms in the manufacture and laying of submarine cables (they made and laid a cable between Key West and Havana in 1867) have a special department at their works in Silvertown for the refinement of the raw gutta percha, and its reduction to various commercial forms. There is an interesting and a pleasing variety about the Silvertown gutta percha products. These include golf balls (the famous "Silver King"), carboys bottles, test tubes, tubes and valves for breweries, bosses for flax-spinning machinery, pump rings, buckets, seatings, valves, beats, hydrants ball, ram rings, driving belts, washers and moulds for taking impressions of bores of guns. The company also line tanks for acids and acid solutions.

Group of Gutta Percha Articles.

Gutta percha, combined with resin and Stockholm tar, forms the famous Chatterton Compound, which is used for making joints in cables. The Silvertown Company takes the greatest care in the preparation of the raw gutta percha, one of the later processes being to force the previously softened gum through a very fine sieve under a pressure of 100 tons, in order to remove all impurities, after which it is rolled out into sheets. In this form it is stored ready to be manufactured into any of the aforementioned articles. Gutta percha, although it does not play such an important rôle in the commercial scheme as india rubber, to which it is similar in some respects, is absolutely irreplaceable by any other material in certain of its applications.

Electricity (Supply) Bill.

On the 26th ult. the House of Commons, in Committee, passed the resolution authorising the Treasury to spend £20,000,000 in connection with the construction of interim works. In the discussion which arose on an amendment by Col. Gretton, substituting £5,000,000 for £20,000,000 Mr. G. Balfour urged that even the smaller sum was quite unjustifiable, and he desired to limit it to £1,000,000. He contended that the proposal was part of a general scheme of nationalisation which was so upsetting to the whole of the country.

Sir A. Williamson said that the electrical undertakings contemplated were of an enormous kind and their construction would be a matter of considerable time. It would be quite impossible for the Government to enter on a scheme involving between two and three millions without knowing that the sanction of Parliament was behind it. The Government would do well to indicate the total that was required, and to tell the House that it would be spent over a number of years. He understood that a scheme had been in contemplation and had been commenced in the North Midlands in view of legislation. It had been to some extent sanctioned, he believed, by the Ministry of Munitions, and there was some understanding that it should be taken over by the Government. The present provision was only intended to fill the gap until a national system was created. All the evidence taken by the Committee over which he presided was in favour of authority being given to the Government to spend such an amount as would be required until the new authority could take over the electrical undertakings.

Mr. Neal pointed out that schemes were conceivable which might not be financially successful in themselves, but might show a good result in the national balance-sheet by reason of their results; and he thought that the liability to make good any loss during the initial stages of the undertakings should be a charge upon the Treasury. If they were satisfied that it was essential to have cheap electricity, and that they should bring the scheme into effect as soon as possible to find more employment for the people, then the word extravagance was misapplied.

Mr. Wilson Fox approved of the development of electricity on a scale such as they had never seen before in this country, but that was an entirely different thing from giving the Government what was really a blank cheque for spending vast sums of money.

Sir Hamar Greenwood said those sums of money were incorporated in the Bill which had already passed its second reading. Therefore the principle of giving the Government control of those sums had already been accepted by the House. If they were to have a great scheme of electrical supply covering the whole country they could not restrict their plans to one year. He thought the certainty of the return was assured To reduce the amount from 20 millions to five would defeat the purpose of the Bill.

The amendment having been rejected, Sir Hamar Greenwood explained that the Treasury guarantee of interest on stock up to £25,000,000 would only be needed when the market was bad or lenders were unreasonable, and a high rate of interest would be charged. It might be the best economy to guarantee the interest on a given loan in order that a scheme for electrical power might be developed. The guarantee was an important factor in making it possible to borrow money at a cheap rate.

Sir A. Williamson said the main purpose of the 25 millions was to pay for the existing generating stations and transmission lines where they were taken over. It would, he thought, be very much better if the whole business were on one uniform basis. He thought the Committee would appreciate that 25 millions would not cover what was required, but it would be spread over a considerable period. There undoubtedly would be a loss in the taking over of obsolete plant, and probably also in the new stations that would be created, because they must anticipate a demand which did not exist, and they could not possibly expect that the station would pay for a number of years until the demand had grown.

Mr. Wilson-Fox said the majority of the small stations which the hon. member in charge of the Bill prided himself were paying concerns would have to be scrapped, because it was quite impossible to produce electricity as cheaply in them as it was desired to produce it in future. The whole scheme was going to cost hundreds of millions, and the Government ought not to ask for a blank cheque.

Ultimately the motion was agreed to.

The Brazilian Commercial Delegates.

On the 26th ult. the delegates met at the Osram Lamp Works, Hammersmith, where they were received by the Chairman of the General Electric Company, Mr. Hugo Hirst. After explaining the two kinds of manufactures at the works, *i.e.*, lamps and wireless valves, the delegates were shown over the works. Subsequently they proceeded to Claridge's Hotel, where Mr. Hirst entertained them at luncheon.

After proposing the loyal toast, Mr. Hirst said it was a great privilege to be able to entertain the delegates in the dual capacity of a member of the Federation of British Industries and as Chairman of the General Electric Company. Although they manufactured practically only a speciality, the state of the works was a fair reflection of the state of the industry in this country: the stable side of the works, namely, lamp-making, had remained stationary during the five years of war: they had neither labour, skill, nor building to expand, to increase their output, or to make use of the suggestions and inventions of their expert staff. Building work was already progressing: they had lost little time since the armistice, because they realised their task of catching up those fortunate competitors in America and elsewhere who did not suffer through the war. On the other hand, on the wireless valve side they could show them something that owed its existence to the war. With the assistance of the Government, the Company had concentrated their energies on developing wireless valves which had been most instrumental in the winning of the war. The Company were absolutely leading in that new industry. With the assistance of those valves, communication amongst the Allies became possible where all other means failed. With the assistance of those valves, the submarine danger received its death-blow, aeroplanes and ships could be brought safely into their landing places in the midst of fogs and darkness. In the other works of the Company they made turbines, mining machinery and conveying plants, generators and motors (from 20,000 kw. units down to little fan motors), electric carbons, conduits and switchgear, metal fittings, telephones, magnetos, ebonite cables, &c. The Company were taking a prominent part in helping to attain British supremacy in the electrical field in the same manner as it was attained on the battlefield.

Mr. Hirst said that even if he had known something of Brazil, after five years of war which isolated the different countries and which imposed on every land the need of self-preservation and self-development, he was sure Brazil had changed to such an extent that a fresh study would be necessary. He was aware of the boundless store of raw material, of iron ore, of timber, of coffee, cotton, cattle and rare earths in Brazil and he was aware of the need in that country of public utility concerns. "This country has need of your raw materials and is anxious to help you to develop them. It desires a share in the construction of your public utility undertakings and your building-up means of communication, and in the supply of machinery for your industries. We shall continue to be your best customer as we have been in the past. The war has impoverished all nations so that they are short of money; what counts to-day is merchandise or raw material, not money. You will fare better by sending us your raw material in exchange for products which we manufacture, than buying those products, nominally cheaper for money, which is fluctuating in value, from countries which have no need for raw materials. With this in view both we and you must try to develop closest business relations and increase the exchange of commodities between the British Empire and the great Republic of Brazil."

Dr. Souza Bandeira, who replied, thanked the General Electric Company for the kindness with which they had been received at the Osram Works, and he hoped the commercial interchange between Great Britain and Brazil would be largely improved as the result of that visit. The delegation would propose the formation of an Anglo-Brazilian Chamber of Industry and Commerce. Brazil would afford opportunities for exporting British manufactures.

Dr. R. C. Simonsen also replied and said Brazil was the richest country in the world in waterfalls. They had 50 million horse-power, and that should provide the General Electric Company with good opportunities.

Aircraft v. The Telegraph.

Dealing with the general question of aerial transport at the dinner of the London Society last week, Mr. Holt Thomas alluded to the recent long-distance flights, observing that the occupants of the machine which crossed the Atlantic took considerably longer to travel by ordinary means from Dublin to London than it took them to cross this enormous space. He could foresee the time when aircraft would compete much more with cables than with trains. He would go so far as to say that if he started an aeroplane, say, every two hours from London to Paris and vice versa, no more telegrams would be sent, as they could convey words far more cheaply than any cable or telegraphic system and much faster. He did not think anyone would send a telegram to Paris again if a letter could be delivered in 2¼ hours, as no telegram was as efficient as a letter; also in sending a telegram one could not convey, except at enormous expense, the sense of the message. It was impossible to convey photographs, blue prints, deeds, certificates and valuable documents of all kinds. It was, therefore, evident that if the aerial mail could convey, with sufficient regularity, something which the telegraph could not convey, and at a much lower rate, it has a very serious future. London and commerce were entirely dependent on rapidity of communication. It was especially important to have quick means of communication between London and every city of the Empire.

Legal Intelligence.

The Marconi Arbitration.

Mr. Justice A. T. Lawrence resumed on Monday the hearing of the petition of right brought by Marconi's Wireless Telegraph Company against the Crown for the recovery of damages for the repudiation by the Postmaster-General of a contract by the Company with the Government to erect six long distance wireless telegraph stations.

Mr. Godfrey C. Isaacs, managing director of the Marconi Company, who was further cross-examined by the Solicitor-General, said that he did not agree that none of the years during the period from 1904 to 1913 showed a 10 per cent. increase. The 1910 return showed an increase of 10·2 per cent., the 1912 return an increase of 11·9, and the 1913 return an increase of 13·9 per cent. That was the cable traffic increase. He denied that the increased traffic shown by the wireless service was chance traffic due to the strike of Spanish telegraphists. The figures justified him in claiming for the Marconi Company two million words per annum for the Spanish stations. The Company had decided not to push the Spanish service until the Government released the company from Government work, as there was a certain delay in dealing with the messages of the public owing to the transmission of Government messages. The stations of the wireless chain were built to communicate with each other, and experience showed that they could communicate with other stations. There were the first six stations of the chain. His estimate of the traffic was based on the assumption that they would be able to send traffic to the destination by stations to be erected. The Chinese had entered into a contract with the Japanese for the erection of a high-power station, and no doubt others would have been erected. The contract provided that the Singapore station should be able to communicate with Australia. The Marconi system could pick up messages which were sent under any system. He took the view that there would be the same quantity of business now that the war had ceased as there was during the war owing to the great change which would come about in all commercial business in the world. There would be a tremendous impetus. He was aware that a wireless station was erected in 1912 at Honolulu and another at San Francisco. The Pacific was a very easy sphere in which to communicate. Those stations were not wholly independent of the Marconi system. The Marconi receiving patents were used. There was the Fleming valve and its developments. The Fleming valve patent expired in 1918, but the developments of the Fleming valve had not expired. Other stations had been erected by the United States Navy Department for strategic purposes. They had not yet been used for a commercial service. Certain royalties were payable to the American Company. For a station erected by the French Government at Nantes the royalties would be payable to the French Company.

The hearing had not concluded when we went to press.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1919 Specifications.

126,978 Bellino. Devices for coupling circuits in wireless telegraphy and telephony, so as to produce oscillations having a strictly single frequency. (21/2/16.)

126,985 Rey. Projectors or searchlights. (12/4/16.)

127,008 Soc. Francais Radio-Electrique. Wireless telephony. (15/2/16.)

127,012 Crochat. Electrical driving gear, particularly for motor-cars. (15/12/16.) (Patent of addition not granted.)

127,013 Brillouin & Beauvais. Receiving apparatus for wireless telegraphy. (27/3/16.)

Receiving apparatus for wireless telegraphy, having one or more lamps provided with a filament heated by an electric current, and two different electrodes one of which (a plate) is connected to a source of current of given voltage, the other electrode (a grid) being connected through a resistance to a fixed positive voltage point, and oscillating voltage variations transmitted to it through a condenser, whereby the apparatus operates as an amplifier-detector.

127,014 Brillouin & Beauvais. Telephone installations particularly for wireless telegraphy. (7/11/16.)

Consists chiefly in using as an amplifier at the receiver stations of the telephone installations, a certain number of lamps comprising a filament heated by an electric current and two different electrodes, and whilst connecting the second electrode of a lamp to the first electrode of the next lamp and the first electrode of the first lamp to the line, the second electrode of each lamp being moreover connected through a resistance to one of the poles of a source of current in inserting a condenser into each of the connections of the electrodes with each other.

127,030 Compagnie Generale Electrique. Processes of producing metallised brushes for electric machines. (22/5/16.)

127,042 Marks. (Volta Soc. Anon.) Apparatus for the electric driving of ships such as submarines. (24/3/17.)

127,066 Stobie. Electric steel manufacture. (20/2/18.)

127,068 Marks. Interrupters for use with ignition systems and dynamos. (18/3/18.)

127,076 Wheeler. Glands for electric cables, shafting and the like. (20/4/18.)

127,078 MacFadden & Adams. Electrical testing apparatus. (23/4/18.)

127,086 Bastian. Conductors for electric current. (17/5/18.)

127,088 Portable Electric Motors, Ltd., & Fryer. Dynamo electric machines. (17/5/18.)

127,102 Wadkin, Mills & Co., Thatcher & Small. Trolley heads for electric tramways or the like. (23/5/18.)

127,131 White. (Industrial Electric Furnace Co.) Electric furnaces. (20/6/18.)

120,877 Soc. Anon. des Etablissements L. Bleriot. Regulating apparatus for electric supply systems. (23/11/17.)

127,177 B. T.-H. Co. (G. E. Co.) Electro-plating steel articles. (1/10/18.)

127,186 Edison Swan Electric Co. & Shergold. Electric snap switches. (4/11/18.)

127,194 Barbour & Partridge. Electrical swithces, starters, and controllers. (23/11/18)

127,227 Portable Electric Motors, Ltd., & Fryer. Electric motors. (17/4/18.) (Divided Application on 8,334/18.)

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

April 23, 1919.

10,116 Marsh. Electrolytic cells.
10,128 Dawson. Contact breakers for magnetos.
10,130 Teixeira. Electric furnaces.
10,140 Van Loon. Pull socket switches.
10,150 B.T.-H. Co. (G.E. Co.) Controlling chemical reactions.
10,155 Dekker. Process of electrolysis.
10,158 Bardin. Electrical connector for sparking plugs, &c.
10,179 Withers. (National Electro-Products, Ltd.) Apparatus for electrolysing liquids.
10,193 Newland. Carbon holder and feeding mechanism for arc lamps.
10,197 & 10,198 National Carbon Co. Machines for making bobbins for batteries. (10/1/18. U.S.)

April 24, 1919.

10,202 Lenaghan. Automatic telephone system.
10,209 Volk. Automatic time switch for electric lighting, &c.
10,217 Barry. Reducing lag on a.c. systems supplying induction motors, &c.
10,220 Brolt Limited & Holt. Ventilation of dynamos.
10,241 Bilefeld. Incandescent lamps.
10,248 & 10,249 Stratton. Miners' lamps.
10,268 Oldham. Galvanic batteries.
10,273 Borel, Guye & Ramseyer. Electric motor apparatus for winding clocks.

April 25, 1919.

10,314 Bowen & Marino. Electrolytic coating of iron or steel with lead, antimony, &c.
10,336 Runbaken. High-tension magnetos.
10,344 Scintilla. High voltage current distributing apparatus for ignition apparatus of engines. (18/9/18. Switzerland.)
10,357 Campbell, Gifford & Waite & Taylor. Control of power absorbed in electric furnace.

April 26, 1919.

10,378 Canard. Electric contrivance for greeting persons in the dark.
10,390 Railing & Taylor. Electric conduit tubes and fittings.
10,393 Brown. Device for demonstrating difference between true pole and magnetic pole, &c.
10,413 Batten. Electric flash lamps for photographic, &c., purposes.
10,414 Batten. Electrically operated camera shutters.
10,418 B.T.-H. Co. & Whitaker. Protective gear for turbo-alternators.

April 28, 1919.

10,453 Benoa, Houching & Pettinger. Securing terminal nuts on accumulators, magnetos, &c.
10,490 Elecrtolytic Zinc Co. Recovery of zinc by electro-deposition. (27/4/18, Australia.)
10,512 & 10,514 North London Engineering Co. & Godwin. Magnetos.
10,532 Round. Transmitters for wireless telephony.
10,533 Round. Electric generators.

April 29, 1919.

10,579 Hirst & O'Callaghan. Electric light fittings.
10,603 Schneider et Cie. Electric apparatus for indicating and repeating movements at a distance.
10,608 B.T.-H. Co. (G.E.Co.) Protective devices for electrical distribution systems.
10,613 Williams. Electric filament projection lamps.
10,618 White. (Becker Bros.) Electrolytic cell for producing oxides and powders of metals, &c.

April 30, 1919.

10,644 Wheatley. Electrical transmission disengaging lock switch.
10,692 Sharp. Switches for electric bells.
10,698 Emerson. Thief-proof switch.
10,709 & 10,710 Eastern Telegraph Co. & Davies. Telegraphy.
10,716 Olier & Roussillon. Lead-covered electric cables.
10,721 Tavener. Controlling supply of electric currents.
10,722 & 10,723 Commin. Manufacture of insulating, &c. compositions.
10,725 International Electric Co. & Roose. Electromagnets, &c.
10,737 Flory. Means for supporting electric lamp shade.
10,755 Lenoir. Manufacture of manganese, &c., in electric furnaces. (8/1/14. France.)
10,769 B.T.-H. Co. (G.E.Co.) Insulators.

May 1, 1919.

10,855 Quain. Electric radiators.
10,857 Hyde. Electrodes for welding.
10,858 Hyde. Electric welding of iron or steel, &c.
10,877 Opperman. Magneto-electric machines.
10,881 Lithanode, Ltd. & Hazlehurst. Primary batteries.

May 2, 1919

10,910 Gardner. Microphones or electric transmitters for submarine signalling, &c.
10,926 Cable Accessories Co. & Reeves. Electric light, &c., lanterns.
10,932 Brecknell, Munro & Rogers & Willis. Apparatus for lamp signalling in overhead wire systems of traction.
10,942 Shepherd. Electric generators and motors.
10,939 Delille. Electric heaters. (25/9/18. France.)
10,943 Hunt. Vibration galvanometers, oscillographs, &c.
10,975 Dimitrievitch. Arrangement for amplifying electric currents.
10,986 Bibby. Transformation of polyphase currents in furnaces, &c.

May 3, 1919.

11,000 Jones. Apparatus for indicating failure of electric circuit.
11,008 Cowper-Coles. Coating wire, &c., with metals by electro-deposition.
11,030 Cocking & Hean. Automatic cut-outs for electric circuits.
11,032 Turnock. Electrical resistance.
11,038 Williams. Thermo-telephone receivers.
11,086 Ateliers de Construction Oerlikon Wutrich, Fawdry, Dawson & Luder. Locating faults in transmission systems, &c.
11,115 Waghtwick. Electric switches.

May 5, 1919.

11,123 Rickets. Controlling and regulating systems for dynamos or motor starting systems.
11,130 Danks. Machine for starting engines, motors, &c.
11,168 Cowper-Coles. Electro-deposition of copper zinc alloy.
11,192 Tilling-Stevens, Ltd., & Silcock. Electrical resistance controls.
11,201 Round. Receivers for wireless telegraphy.
11,202 Round. Thermionic transmitting devices for wireless telegraphy and telephony.
11,206 Oldham. Galvanic batteries.
11,209 Birk. Continuous-current compressor. (6/5/18. Denmark.)
11,228 Pestridge. Tram rail.

May 6, 1919.

11,234 Potter. Electricity storage coils.
11,240 Cave. Electric cycle wheel attachment.
11,248 Simon. Apparatus for heating liquids by electric resistance or gas.
11,279 Martin. Portable electric piano player.
11,303 Soc. Color. Electrically-heated soldering irons. (6/5/18. France.)
11,304 Vandervell. Lamp fittings.
11,312 Sundberg & Thomasson. Manufacturing electrolytic copper from cement copper.
11,327 Round & Wright. Wireless telegraphy.
11,332 Owen. Electro-plating.

May 7, 1919

11,338 Coxan & Williams. Renewal of metal filaments in lamps.
11,347 and 11,348 Barr. Electrical water-heating elements.
11,387 Thornton. Electric conductors.
11,396 Ogle & Scott. Electric warming and ventilating apparatus.
11,397 Renew Electric Lamp Co. & Harrison. Electric incandescent lamps.
11,427 Electro-agricultur Aktiebolaget. Cables for electrical machines.
11,433 Harris. Electricity motor meters.
11,436 Levin. Electrolytic gas generators. (22/5/17. U.S.)

Commercial Topics.

Import Restrictions.

By an Order in Council the import of chemicals of all descriptions, electrical goods and apparatus, including electrical plant and machinery of all kinds, and insulating materials of all descriptions, scientific, mathematical and optical instruments, tungsten powder and ferro-tungsten is prohibited except under a special licence of the Board of Trade.

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Electrical Illuminations for the Celebration of Peace.

We have received a letter from Mr. J. W. Beauchamp, stating that it is most desirable, if disappointment is to be avoided, that orders for decorative electrical work for the peace celebrations should be placed without delay. This course is rendered necessary by the busy condition of the industry and the shortage of labour in factories and on the staffs of wiring and contracting firms. Also electricity supply works require early intimation of any increase in their load which may be expected and of any special cable work that may be required. The material used on previous occasions should be examined without delay and electric lamps should be ordered as early as possible.

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Agricultural Machinery.

In view of the increasing use of electrical plant and apparatus in agricultural operations electrical engineers and manufacturers will be interested in the decision of the Board of Agriculture and Fisheries to appoint a Departmental Committee of eight members to arrange for the testing, adaptation and improvement of machines likely to prove of value to agriculture, to examine inventions and new devices, and to advise as to the further steps which should be taken to promote the development of agricultural machinery. The chairman of the Committee is Sir Douglas Newton, K.B.E., and the secretary is Mr. V. E. Wilkins, Board of Agriculture, 72, Victoria-street, London, S.W. 1, to whom communications should be addressed.

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The Effect of Strikes on Contracts.

Practically every tramway and electricity undertaking in the country is sadly in need of repairs or extensions in order to meet the peace-time demands for better transport facilities or an increased supply of power for manufacturing. Local authorities and companies have, therefore, been obliged to place contracts for rails, rolling stock, plant, &c., and we regret to notice that many of these have gone abroad. For instance, Birmingham Corporation recently accepted an American tender for steel rails, and we see that Glasgow Corporation has now followed the example and gone to America for its rails. In both cases there were questions of price and delivery to be considered. Mr. Dalrymple, the tramways manager at Glasgow states that the American contract for rails saved his department £1,000, and delivery was guaranteed this month. British firms, owing to strikes, would only promise delivery in September.

* * * *

An Institute of Patentees.

Some manufacturing firms and patent owners are organising an association for the protection of their interests. The association will probably be known as the Imperial Institute of Patentees (Inc.), and the Board of Trade has been asked to grant a licence for its incorporation. A preliminary meeting will take place at the Cannon-street Hotel on the 10th inst. Mr. G. Cheesman, general secretary of the National Union of Manufacturers, is organising secretary to the new association, whose temporary offices are at 6, Holborn Viaduct, London, E.C.4. The reform of the law relating to patents and trade marks is overdue and an amending Bill has been promised by the Government. The subject is one in which electrical engineers and manufacturers are keenly interested and if properly organised the new association should do useful work, not only in the direction of obtaining suitable reforms in the law but in defending the rights and interests of patentees and manufacturers. We think, however, that it should be representative of engineers and patentees as well as of the patent owners and manufacturers.

* * * *

Imperial Mineral Resources.

We are pleased to learn that the Imperial Mineral Resources Bureau, which has been set up on the recommendation of the Imperial War Conference, has begun the work of collecting information regarding the mineral resources and metal requirements of the Empire. The Bureau will act as advisers to the various Governments and others concerned in regard to the development of these resources. In addition to the information to be obtained from the Oversea Governments, certain statistical information from foreign countries will be procured through the Foreign Office. The Governors will issue from time to time statistical and other publications and close co-operation will be arranged with Government departments, scientific institutions and societies. The Governors of the Bureau have been appointed, one by the Home Government (whose representative is the chairman), one by each of the five self-governing Dominions, one each by the Government of India and the Colonial Office, while six representatives of the mineral, mining and metal industries were appointed by the Minister of Reconstruction after consultation with the principal institutes and institutions representing those industries. Committees of the governors are dealing with:—Intelligence and publications, research and development, legal matters, and general purposes and finance. The offices of the Bureau are at 14, Great Smith-street, Westminster, S.W.1.

Electricity Supply.

Batley Corporation has been authorised to borrow £4,118 for extensions of the supply mains.

Weymouth Corporation has applied to the L. G. Board for sanction to a loan of £2,500 for house services for three years.

Thornton Urban Council has asked the Board of Trade to renew the electric lighting order for 12 months.

The residents of Cavan have decided to form a company with a capital of £6,000 or £7,000 in order to establish electricity supply in the district.

Darlington Corporation has applied to the L. G. Board for authority to borrow £25,000 for additional generating plant.

Ealing Corporation has applied to the Board of Trade for an order to enable the price of electric current to be increased from 8d. to 10d. per unit.

Staines & Egham Electricity Company has decided to apply for a provisional order to supply electric current in the parishes of Ashford and Stanwell.

Owing to a fire at Spicer's flour mill, Navan, which destroyed the local electric lighting plant, the supply of electricity has been temporarily suspended.

At Lynn on Tuesday an inquiry was held into the application of the Corporation for sanction to borrow £34,200 for extensions of the electric supply undertaking.

Horwich Urban Council has asked Bolton Corporation and the Lancashire Electric Power Company to state terms for a bulk supply of electricity for lighting and power.

At Keighley, on Wednesday, an inquiry was held into an application of the Corporation for sanction to borrow £72,773 for extensions of the electricity undertaking.

Mr. J. B. Braithwaite, Chairman of the County of London Electric Supply Company, Ltd., has resigned his position and Sir Ernest Hiley has been elected to succeed him.

Eccles Corporation are taking a bulk supply of electricity from the Lancashire Electric Power Company in order to meet the increased demand for current from local manufacturers and others.

The Yorkshire Electric Supply Linking-up Committee has prepared its report on the inter-connection of electricity undertakings and a conference has been called for its consideration.

On Wednesday an inquiry was held at Cheltenham into the application of the Corporation for sanction to borrow £26,000 for the completion of the public lighting of the borough by electricity, and £2,000 for service mains.

Plymouth Electricity Committee has instructed the borough electrical engineer (Mr. E. G. Okell) to prepare a report on the additional plant required at the Prince Rock works to meet the increased demand for current.

Fleetwood Urban Council have increased the charges for electricity as follows: Lighting, 7d. per unit for the first 500 units per quarter, 6½d. per unit for the second 500, and 6d. per unit afterwards; power, 3d. per unit for the first 500 units, and 2½d. per unit afterwards.

Rochdale Electricity Committee has accepted tenders (amounting to £40,000) for the supply of cables, switchgear, &c., for giving a supply of energy to the D.R. Cotton Mills. The agreement for a supply of electricity in bulk from the Lancashire Electric Power Company has been approved.

The Bill to sanction the Dartmoor hydro-electric scheme will not be proceeded with this year. The members of the Devon County Council are friendly but as Dartmoor is the county's chief watershed the matter has been referred to the General Purposes and the Dartmoor Preservation Committees.

In a report to Newry Urban Council, Mr. Arthur E. Porter states that the suggestion to use water-power for the generation of electricity is not practicable, and a supply scheme worked in conjunction with the gas department would be the most economical. The estimated cost of a suitable scheme is £15,026.

For the first time in its career the Grimsby electric supply undertaking shows a deficit on the year's working of £2,642, and this notwithstanding an increase in charges of 30 per cent. for the last quarter of 1917-18. The total cost in 1914-15 represented 1·082d. per unit sold, but for the past year it was 1·999d.

Burnley Electricity Committee has received applications for supplies of electrical energy to premises in different parts of the town, but additional boiler-house plant must be obtained before the applications can be met., and therefore the L.G. Board has been asked to sanction a loan of £7,500 for a new Lancashire boiler at the electricity works and for service cables, &c.

For the past year there was a deficit of over £2,000 in Hove, and a deficit of some hundreds of pounds on the Aldrington undertaking. The maximum charge per unit allowed is being made, but as there are 1,209 consumers of electricity who use less than 20 units per quarter, it is proposed to make an alteration by making the minimum charge 13s. 4d. per quarter to each individual consumer.

As there is a deficit of £3,618 on the past year's working of the electric supply undertaking, Llandudno Council has increased the charge of current to ordinary consumers at 8d. per unit. For large consumers a special rate of 6d. per unit is fixed, and for power the price will be supplied at 3d. a unit. The Council are in negotiation with the North Wales Power & Traction Company for a supply of current in bulk.

A report by Mr. Thos. May, recommending the erection of electricity works in Coleraine at an estimated cost of £46,000, is before the Urban Council. The capital cost of suction gas plant is put at £22,000, of steam-driven plant at £20,500, and of water and suction gas at £24,500. In order to provide a power supply to the mills and factories an additional outlay of £21,500 would be necessary. The report is to be printed and circulated among the members of the Council.

There was a deficit of £2,535 on the past year's working of the Hull electricity works, and the chairman of the Electricity Committee (Ald. J. Pybus) explains that this is due to the higher cost of fuel and the advance in wages. They had made a great number of new connections and the fresh services which would more than recoup them. Many people resident in the Garden Village were anxious to have the electric light, and a large number of people at Hessle also wanted to be connected up. Building operations were proceeding on the Tower Grange estate and on a site in Holderness-road, and they had suggested to the builders and local plumbers that there was a large field for their activities in wiring the new houses. The number of new services applied for during the past month was 68.

The accounts of Leeds electricity department for the year ended March 31, 1919, show that gross capital expenditure £1,788,228 (=£45. 17s. per kilowatt), and the net amount of debt against capital expenditure is £1,009,354 (=£25. 17s. 7d. per kilowatt). Revenue was £327,175 (compared with £271,595 in previous year), and gross profit was £140,476 (£136,111), out of which, in addition to providing for redemption of debt and interest £118,095 (£111,239), contributions to capital were made amounting to £139,827 (£135,833), leaving a surplus profit £648 (£278). Working and general expenses were equal to 0·72d. (0·52d.) per unit sold; total costs of production, including redemption ,interest. &c., 1·24d. (1·01d.). There are 16,825 (15,950) consumers, and total sales of electrical energy were 62,387,433 (62,771,883) units. Power units increased from 46,861,408 to 46,990,861, and motors connected amount to 51,799 (47,900) kw. Maximum load was 23,130 kw. (24,920 kw.).

The receipts of the Ipswich Corporation electric supply department for the year ended March 31 were £55,140 (compared with £55,719 in previous year), inculding £3,447 from the installation department and £847 from the electric vehicle garage. Working expenses were £45,104, the installation department cost £2,992 and the garage £555, war service allowances were £329, income tax required £1,327, interest, &c., £4,608 and repayment of loans £7,832, the net result being a deficit of £7,607. The increase in cost of coal was £3,851, and the receipts were adversely affected by breakdowns due to running overloaded owing to pressure from Government Departments. Total maximum demand was 2,515 kw. (2,811 kw.). Units generated were 7,478,784 (8,496,445) and sold 5,737,961 (6,797,374). In August 1918 a priority certificate was issued enabling the manufacture of the 3,000-kw. turbo-alternator, switchgear, &c., to be proceeded with, and it is hoped to have the plant running by the end of next month.

With the prospect of a big advance on coal manufacturers must look around for other sources of energy. Already experiments have been made in utilising coke-oven gases by Leeds and Middlesbrough Corporations, but the idea was not developed because of the cheapness then of coal. Rotherham Corporation, who obtained authority last year to buy crude gases from all the collieries in their area, have made arrangements with several of the pits and other agreements are being negotiated. Up to the present no attempt has been made to refine the gas and utilise it for pnblic lighting, but should the supply at any time exceed the demand for power the gas could be purified and used for lighting. At Rotherham it is probable that when the full possibilities of the area have been tapped, gas will be available for power at 1s. per 1,000 cubic ft. At Wombwell, the Cortonwood Collieries offered the local Council a supply of gas at 10d., and Wath Council some time ago were offered a supply from the coke-ovens at Manvers Main at 9d. per 1,000 ft. Rotherham Corporation also propose to utilise the waste heat which is available in steel works. The Corporation propose to put down small electric plants at works where waste heat can be bought in suitable quantities. These plants will generate electric current which can be sold to manufacturers.

A Board of Trade inquiry was held last week into the condition of the electric supply undertaking at Walton-on-the-Naze. Mr. W. Young, who appeared for the liquidators and mortgagees for the Coast Development Company, stated that they knew the works were defective; they were prepared to put them in order and to replace the poles where necessary. The company went into voluntary liquidation in 1915 and money could not be found to properly carry out the work.

Mr. Geo. Broadhurst, electrical engineer at Clacton-on-Sea, said he visited the works at Walton-on-Naze and found the generating station in a filthy and dilapidated condition. There was a gas engine being dismantled prior to being sent away for repair, and only one set in commission. The overhead main was in bad condition, most of the poles were unsafe and a source of danger to the public. The declared pressure was 230 volts and the meter registered 190 volts only when he was there.

Mr. F. H. Lewis, electrical engineer at Leyton, stated that the poles were rotten. The overhead system had been grossly neglected. Mechanically and electrically there was much danger to the public, whilst repairs that had been done looked unsightly.

The local witnesses included Mr. C. F. J. Parker, who was chairman of the local Council from 1918 to 1919. He said that one day in November he heard there would be no electric light. He and another found money for a truck of coal (£18) for the electricity works. On another occasion he was without electricity for a week. The supply of electric light had not always been satisfactory at his hotel, and he had to install other light to fall back on.

Mr. Young pleaded that troubles concerning labour and materials had been difficult to overcome. The company had not neglected its duties, and they were doing what the Board of Trade could require.

Mr. W. Tyler, electrical engineer, said the engine was being overhauled. A little engine that he saw worked remarkably well. The battery was in a bad state; half had been re-plated and the other half was to be completed. The switchboard also wanted looking to. As to the overhead construction the trouble was due to lack of help. There was no danger of poles collapsing. It was unfair to compare a little seaside town with Leyton or Clacton. The installation would not run through next winter unless substantial improvements were effected.

Electric Traction.

Dundee Tramways Committee has ordered six new tramcars in addition to the 10 recently ordered.

The Board of Trade has extended by one year from Aug. 15, 1919, the time limited by the Huddersfield Corporation Act, 1913, for the completion of tramways authorised by the Act.

The Edinburgh tramway system passed under the control of the Corporation on Monday. There is no change in the staff except that Mr. Cox retires and is replaced by Mr. R. S. Pilcher. The lines will be gradually converted to electric working on the overhead system.

The Metropolitan Railway Company has prepared plans for the conversion of the line from Harrow to Rickmansworth to electric traction. At present only 36 out of 88 miles of line are worked electrically, but the present scheme will add another 8 miles to the electric system.

Oldham Tramways Committee recommend the Council to increase the salary of Mr. Wm. Chamberlain, general tramways manager, from £450 to £700 per year, rising by annual increments of £50 to £800, on the understanding that he undertakes not to terminate his engagement within a period of five years.

The revenue of Ipswich tramways department for the year ended March 31 was £38,800 (compared with £34,817 in 1917-18), working expenses were £30,279 (£27,071) and net profit, after providing for capital charges, &c., was £2,294 (£1,478). Revenue per car-mile was 19·637d. (13·365d.) and working expenses, including power, were 15·334d. (10·392d.). Passengers carried were 6,224,608 (6,069,777), and car-miles run 473,893 (625,224). Units used per car-mile were 1·151 (1·134).

The House of Commons Select Committee on Metropolitan Transport has continued its sittings, but the witnesses do not appear to have contributed much to the solution of the problem. Mr. Pick, of the Underground Electric Railways of London, thought a Traffic Board was necessary, and he also considered it desirable to secure a "traffic monopoly" for his companies, so that where they run buses now there would be no opportunity of running tramways, and in the main thoroughfares where motor buses now ran they would have a monopoly. It would be entirely in the interests of the public that there should be only one corporate body operating in the streets of London. That would contribute to economical working and efficiency. Railways and tramways had a franchise, and the time had come when the motor buses should have a franchise also. They did not seek to establish a vested interest. For the convenience of the public, the dead ends of the tramways ought to be linked up.

Mr. Herbert E. Blain, operating manager of the London Tube Railways and the London General Omnibus Company gave details of additional trains which are to be placed on the District Railway before the end of August, and 218 additional cars on the Bakerloo, City and South London and Piccadilly Tubes.

Statistics of the L.C.C. Tramways were submitted to the Council on Tuesday and showed that in the year 1917-18 the net surplus transferred to the renewals fund was £95,559, but in 1918-19 it fell to £8,069. The income in 1918-19 was £3.578,256 and the working expenses (including war service allowances) were £2,858,414, leaving a surplus of £719,842, less debt and other charges (£711,773), or a net sarplus transferred to renewals fund of £8,069. The war service allowances absorbed in 1918-19, £162,128, while the total from the outbreak of war to March 31 last was £529,290. For war wages and war bonus to employees the corresponding figures were £832,992 and £1,330,005 respectively. It is estimated that in 1919-20 the total receipts will be £4,475,000 and working expenses £3,531,925, and after meeting debt and other charges (£749,894) there will be an estimated net surplus of £212,567. Passenger receipts and working expenses are expected to average 19·88d. and 15·59d. respectively per car-mile. The growth in working expenses is due mainly to the advances in war wages and the increase in the price of materials. The undertaking will have to bear an additional yearly charge of £360,000 in respect of the 48-hour week, while the wages bill has increased from £1,102,220 in 1913-14, to £2,421,250 for 1919-20. The Highways Committee state that the result of the working of the tramways during the past five years (1914-15 to 1918-19) has been that, taking into account the sums actually expended on renewals, and after providing for redemption of debt and payment of interest on loans, there has been a total deficiency of about £420,000. This sum has been met out of the balances of the general reserve and renewals funds.

On the basis of the revised fares recently introduced by the Council, and on the assumption that sufficient cars will be in service to allow of 53,000,000 car-miles being run during the year, it is estimated that the total amount available for the renewals fund as the result of the working during 1919-20 will be £212,567 to which must be added miscellaneous receipts of £9,102, making a total of £211,669. Against this sum has to be set an estimated expenditure on renewals of £371,480, so that if the estimates are realised it will be necessary to draw on the balance of the renewals fund to the extent of £149,811.

Imperial and Foreign Notes.

The Hydro-Electric Commission of Toronto are taking stops to double their development of water power which now represents 750,000 h.p., and this will, it is anticipated, have the effect of decreasing power costs and increasing manufacturing.

The Burma Oil Company is proceeding with a scheme for drilling and pumping by electric power in the Yenangyoung field. Delay was caused by the war, and that meant an enormous increase on the capital cost. They were confident that not only would there be a considerable direct saving on the present extremely costly and out-of-date method of drilling and pumping by steam power, but that there would also be many indirect savings and advantages through the use of electric power. It would probably be three years before the scheme was completed, but it would begin to come into partial operation with resultant savings and benefits considerably before that.

It is proposed to establish electricity supply in the towns of General Pinto and Amechino (Argentina).

A 25-year concession has been granted for the erection of a generating station for supplying electricity to the Port of Santa Cruz, Argentina.

A co-operative society for the supply of electric current to the township of Udinarrain, Province of Entre Rios (Argentina) is in course of formation.

A petition has been presented to the Municipal Council of Tanlil (Argentina) by residents of the neighbouring township ofMaria Ignacia asking for a 20 years' concession to operate an electric power house.

Of the loan recently authorised for carrying out railway improvements in Chili, $25,000,000 has been assigned for the electrification of the first railway zone, comprising the Valparaiso–Los Andes–Santiago section.

Messrs. Albert C. Nogué and Juan Carrasco have retired from the firm of Eugenio Gross and have started in business at Calle San Martin 333-337, Buenos Aires, as commission agents and manufacturers' representatives in South America.

Educational.

The chair of chemistry at Aberdeen University is vacant owing to the resignation of Prof. Soddy.

Birmingham Education Committee are arranging to provide in the main departments of the Municipal Technical School full-time day courses in metallurgy, engineering and electrical engineering, which will be open to ordinary students and ex-service students, but in the case of the latter the fee will be paid in approved cases by the Board of Education.

With the concurrence of the Society of Merchant Venturers, the Council of the University of Bristol has appointed Major Andrew Robertson, D.Sc., to the vacant Chair of Mechanical Engineering. Prof. Robertson was educated at the University of Manchester: he served his engineering apprenticeship in works at Fleetwood; in 1905 he graduated as B.Sc. with first class honours in engineering; in 1909 he was awarded the M.Sc., and in 1915 the D.Sc. degree. He was a demonstrator in engineering in the University of Manchester and resident tutor of Dalton Hall from 1908 to 1912; Vulcan Research Fellow 1912-15; Lieutenant in the R.N.V.R. 1915, and for some time has been head of the Mechanical Testing Laboratory for the R.A.F., at Farnborough.

The present occupant of the chair, Prof. John Munro, has been granted the title of Emeritus Professor in Mechanical Engineering.

At the University of London on Friday last Dr. S. Russell Wells gave an outline of the scheme for degrees in commerce which has been adopted by the Senate. He pointed out that if we are in the future to maintain ourselves in the great war of commerce we must not enter the struggle unprepared. There was time now to organise on proper lines. Languages would be a special study under the university scheme. The degrees in commerce would be a sound educational training for the mind. The University of London had the machinery and the men and the knowledge to enable them to set up courses, so far as general education was concerned, on lines parallel to those existing in other faculties, but a practical business experience had been lacking; they had, therefore, gone to the foremost business men in London, and from them interest and support were immediately forthcoming. By Oct. 1 a scheme would be in operation which had the approval of commercial experts, the Senate of the university and the support of the Government. After outlining the history of the movement, the activities of the various sub-committees upon whose reports the scheme is based, and the course of study which would lead to the taking of degrees, Dr. Wells made it clear that external courses would be taken as well as full courses within the university. They hoped to establish scholarships, some of which would be tenable abroad. For the scheme it would be necessary to raise £500,000. He was, however, hopeful that the desired amount would be forthcoming. The trustees of Sir Ernest Cassel's fund had promised £150,000 on condition that an equal sum is raised by the end of September. After giving a list of the principal contributors he said the Faculty would be managed, under the control of the Senate, by a Committee composed of the Chancellor and the Vice-Chancellor of the University, the Chairman of Convocation, and thirty others, ten being members of the University and twenty business men.

The scheme of studies seems to be a good and comprehensive one. It is proposed to confer the degree of B.Com. after 3 year's study. The Master's degree will also be conferred, but candidates must have had not less than 2 years' practical commercial experience after having got the B.Com. degree.

Miscellaneous.

"Nature" announces that a Union of Scientifics Federal Employees has been formed in the United States, with Mr. P. J. Agnew, of the Bureau of Standards, Washington, as secretary.

The following companies will be Struck off the Register of Joint Stock Companies unless cause is shown to the contrary before Sept. 27: Alpha Electrical Company, East London Electric Company, G.O. Accumulator, South American Rail-less Traction Company.

British Electro-Chemists, Ltd., is applying for the restoration of patent (No. 28,953/1912) granted to Pascal Marino for "Salicylate electrolytes for use in the electrolytic deposition of metals or metallic alloys," which expired on Dec. 16, 1918.

The Eastern & Associated Telegraph Companies announce that the Tariff for Telegrams between the United Kingdom and Hong Kong, China, Japan and the Philippines will be reduced by 6d. per word as from Sept. 1 next. The present rate to all parts of China (except Macao, which is 3s. 9d.) and the Philippines is 3s. 6d. per word, and half that amount for deferred messages. The rate to Japan is 3s. 11d.

In consequence of the interest displayed by the Federation of British Industries in the question of the flooding of the Tipton and South Staffordshire Coalfields, the Controller of Coal Mines has decided to proceed with the installation of electric pumping machinery, in order to deal with the possibility of the overflow of water from Tipton district to the important adjoining districts of Old Hill, Oldbury and Kingswinsford.

The G. E. C. Travellers' Launch Party of about 55 had a pleasant outing on the 21st ult. and Mr. H. Hirst, chairman, and Mr. M. Railing, managing director of the Company, were present. Starting from Richmond on the 'Richmond Belle' at 10 o'clock, Staines was reached about 3.30. Lunch and tea were served on board. The musical programme was carried on all day and everyone assisted in making the trip a success. A good many interesting photos were taken and the general comment was that everyone had thoroughly enjoyed himself. Richmond was reached at 9.30 p.m. The last similar outing was held on July 28, 1914.

The Assistant Postmaster-General, Mr. H. Pike Pease, has stated that the values at prime cost of the Post Office plant, excluding plant constructed for war purposes, are as follows: Telephone service, £34,838,367; telegraph service, £7,057,266. The accounts show that full allowance is made from revenue for accrued depreciation not covered by the actual expenditure on renewals and maintenance.

Hull Telephone Committee has placed an order with the Western Electric Company for the equipment of an automatic telephone exchange at £19,800. The manager and engineer (Mr. T. Holme) has estimated that the cost of extending the system by an addition of 2,000 instruments would amount to £58,786, exclusive of the building, but including the automatic exchange. Four companies tendered for automatic switching, the tenders being £20,296, £20,224, £19,800 and £13,802 by the Automatic Telephone Mfg. Company, Siemens Bros. & Company, the Western Electric Company and the Relay Automatic Telephone Company respectively.

The Postmaster-General (Mr. A. Illingworth) states that for the year 1917-18 there was a deficit of £556,330 on the Telegraph Service, and a surplus of £355,468 for the telephone service. The accounts for 1918-19 will be less favourable, owing to the increased war bonus paid to the staff, amounting to £1,250,000 for the telegraph service, and to nearly £1,500,000 for the telephone service, and the loss will be about £1,000,000 on telegraphs and £400,000 on telephones. The deficiency will be substantially larger for 1919-20. The war bonus was estimated at over £2,000,000 for the telegraph service, and about £2,500,000 for the telephone service. Owing to the increased cost of materials, &c., the question of increasing the rates is under consideration.

It is desired to permit illuminations on the occasion of the celebration of Peace, and as the use of Gas and Electricity for Illuminating purposes will affect the quantity consumed by persons who are restricted to a definite allowance under the terms of the Household Fuel and Lighting Order, 1918 (or under the new Order when it comes into effect), it is to be understood that no action will be taken in respect of excess consumptions up to 10 per cent. of the allowance for the quarter, where a consumer has used gas or electricity for the purpose of peace illumination. If the concession of 10 per cent. is thought to be inadequate, a consumer must make a special arrangement with the Local Fuel Overseer, who will afford every reasonable facility for illuminations. This concession relates only to illuminations for Peace, and is not to be made use of for taking gas or electricity for illuminated advertisements.

Certain changes have occurred in the staff of the Coal Mines Department. Sir Arthur Lowes Dickinson, Mr. S. W. Runtz and Mr. Follett Holt have, at their own request and with the consent of the Controller of Coal Mines, been relieved of the executive duties which they have hitherto been carrying out in the Finance Branch. Mr. D. W. Coates, C.B.E., F.C.A., Financial Secretary of the Department, will, as from July 1, be in charge of the Finance Branch and will act as Chairman of the Finance Board. Sir Arthur Lowes Dickinson will continue to assist the Controller of Coal Mines in an advisory capacity. Mr. Frank Pick, Head of the Household Fuel and Lighting Branch, is also obliged to relinquish his executive functions, but has consented to advise upon the administration of the Branch. Mr. N. T. Ford, of the Board of Trade, has been appointed to be the executive head of the Household Fuel and Lighting Branch as from July 1.

Appointments Vacant and Filled.

A tramways manager and engineer is required by Southampton Corporation. Applications to the Town Clerk by noon July 7.

Plymouth Corporation require a tramways manager. Salary £700 per annum, rising to £800. Applications to the Town Clerk by noon, July 23.

Applications are invited for the Professorship of Physics in the University College of Wales, Aberystwyth. Salary £600 a year. Applications to the Registrar by July 12.

A telegraph inspector is required for the Uganda Protectorate. Salary £160–£10–£200, with war bonus £70 per annum. Applications to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1.

A consumers' clerk and a correspondence clerk are required for the Hammersmith (London) Borough Council electricity department. Applications to the Borough Electrical Engineer, 85, Fulham Palace-road, by July 10.

The Governing Body of Battersea Polytechnic require a chief assistant lecturer in electrical engineering (salary £240 rising to £400), and an assistant lecturer and demonstrator in electrical engineering (salary £180 to £240, rising to £400). A war bonus of £39 per annum will also be paid.

A principal lecturer in electrical engineering is required at the Goldsmiths' College, University of London. Commencing salary £150 to £240 per annum, rising by £15 increments to £300 and then by £10 to £400. A war bonus of £39 will also be paid. Applications to the Acting Warden by July 17.

Instructors in mechanical and electrical engineering, chemistry, handicraft and manual instruction, technical training, &c., are required for the Hayes and Blackpool Training and Treatment Centres. Applications by July 15 to the Secretary, Ministry of Pensions, Thorney House, Smith-square, Westminster, S.W. 1.

Newcastle-upon-Tyne Education Committee invite applications for the appointment of head of the electrical engineering department of the Rutherford Technical College. Salary £500 per annum. Applications on forms to be obtained from the Director of Education (Mr. Percival Sharp), must be returned by July 15.

The following appointments are vacant at the Northampton Polytechnic Institute: Instructor in mathematics and physics (£250 per annum), demonstrator and assistant lecturer in mechanical engineering (£250), drawing office instructor and assistant lecturer in mechanical engineering (£250), demonstrator in the optical laboratory (£240), demonstrator and assistant lecturer in the technical chemistry department (£240), and an instructor and demonstrator in the electrical and physical laboratories (£200). Applications to the Principal, Dr. R. Mullineux Walmsley, by July 15.

Mr. H. Moore has been appointed Assistant Director of Research by the Council of the British Scientific Instrument Research Association.

Mr. C. T. R. Wilson, M.A., has been appointed reader in electrometeorology at Cambridge University for five years.

Mr. E. S. Rayner, of Doncaster, has been appointed manager of the Hull Corporation tramways at a salary of £800 per annum. Mr. A. Chamberlain, of Oldham, and Mr. H. P. Stokes were also interviewed by the Council.

Tenders Invited.

Tenders are invited for the supply and erection of three electric travelling gantry cranes at Belfast Harbour. Specification from the Harbour Engineer, and tenders to the Secretary by July 30.

Launceston (Tasmania) City Council require tenders by 3 p.m. July 28 for the supply and erection of battery reversible booster, switchgear, &c. Specification, &c., from the City Electrical Engineer.

Darlington Corporation want a Rotary Converter, Cooling Tower, a Water-tube Boiler, Economiser and an induced draught Fan. Specifications from the Borough Electrical Engineer, and tenders by July 11, to the Town Clerk.

Gravesend Corporation want tenders for a 2,000 kw. three-phase Alternator, Condensers with motor-driven air and circulating water pumps. Specifications from the Borough Electrical Engineer, and tenders (by July 12) to the Town Clerk.

Messrs. Fuller, Horsey, Sons & Cassell will sell by tender in lots some surplus machinery and tools, including electric generating sets, suction gas plant, a number of furnaces, &c. Tenders must be delivered at the auctioneers' offices, 11, Billiter-street, E.C., by 4 p.m. July 15.

Redditch Urban District Council invite tenders for high-pressure steam, exhaust and water circulating piping. Specifications, &c., from the consulting engineers (Messrs. Handcock, Dykes & Trotter), 11, Victoria-street, London, S.W.1, and tenders to the clerk to the Council (Mr. G. W. Hobson) by noon July 28.

Bedford Corporation invite tenders for the supply and erection of one 1,500 kw. single-phase turbo-alternator and condensing plant, water-tube boilers, mechanical stokers and induced draught plant, e.h.t. switchgear, water softener, feed pumps, &c. Specifications from the borough electrical engineer (Mr. R. W. L. Phillips), and tenders to the Chairman of the Electricity Committee by noon July 14.

Bedford Corporation also invite tenders for the erection of buildings, and the supply of electric motors, coal conveyor, runaway and chutes, &c. Specifications from Mr. R. W. L. Phillips, and tenders to the Chairman of the Electricity Committee by noon July 21.

Business Items.

Lieut. W. H. Walton, R.N.V.R., A.M.I.E.E., has commenced business as an engineer's agent at 38/44, Bean-street, Liverpool.

The Acme Electric Traction Company has removed its office to Acme Works, Seven Sisters-road, Tottenham, N.15.

Messrs. F. Howarth and W. Howarth, recently demobilised, are shortly recommencing business as electrical engineers at 18a, Market-street, Church, Lancs.

Edward F. Tompkins and Wm. Latta, automobile, electrical and general engineers, Catherine-street, Cardiff, have dissolved partnership. Debts by Mr. Latta.

The British Lighting & Ignition Company, Ltd., has removed from Tottenham Court-road, to Blic Works, Cheston-road, Aston, Birmingham. Telegrams: "Vicksmag Phone, Birmingham." Telephone: East 340.

Tenders are invited for some Electric Lighting Plant at the Kenmore Timber Camps, near Aberfeldy, Perthshire. Offers to the Executive Officer, Timber Supply Department, 1, Queen-street, Edinburgh, by July 12.

The directors of Messrs. D. Hulett & Company, Ltd., manufacturers of electric light fittings, &c., have decided to discontinue business and the stock and goodwill will be sold by auction on the 9th inst. and following days.

The London office of Messrs. Mawdsley's, F. & A. Parkinson, I. Frankenburg & Sons, and the Park Royal Engineering Works, Ltd., is now 34, Broadway, Westminster, S.W.1. Telegrams: Octopede Vic London; telephone: Victoria 3373.

The 18th edition of "Glover's Almanac" is just to hand, and as usual it contains a feast of good things on the subject of cables and things appertaining thereto. The extractions from various electrical publications are of great value to the mains engineer, and I am sure the company will not be able to cope with the demand. The humorous section is still up to the standard of last year.

The A.C. Cutting & Welding Company, Ltd., has engaged Mr. W. H. Flood as chief engineer to its head office, to act as electrical expert and welder in connection with its special system of a.c. welding. Mr. Flood has given up his appointment as chief electrical engineer with Messrs. William Beardmore & Company to join the company, and previously he was chief electrical engineer to the late Thames Iron Works.

Mr. Spencer Hawes has completed his services with the Admiralty as Assistant to the Controller-General of Merchant Shipbuilding and has resumed his practice as Consulting Engineer with his firm of May & Hawes at Westminster. Mr. Hawes has just been the recipient of a handsome silver cigar and cigarette box from Lord Pirrie, the Controller General of Merchant Shipbuilding.

A new list relating to Exide accumulators has been issued by the Chloride Electrical Storage Company, Ltd. The Exide battery has been much used for motor-car work, and the variety now being marketed has proved very successful in the States. A list of American cars on which Exide batteries are habitually used is included and weights, dimensions and capacities of standard types are given.

The British Westinghouse Electric & Mfg. Company have recently issued a group of leaflets dealing with some of their apparatus. Leaflet B.I.L. 86/8-3 gives illustrated particulars of their oil-immersed motor control units for slip-ring type motors; D.L. 333/1-1 is devoted to a description of type B of consumers' oil switch cubicle; and B.I.L. 344/2-3 to type R (moving coil) d.c. ammeters and voltmeters. Leaflets 344/2-1 and 344/3-1 are descriptive of the instruments listed in No. 344/2-3.

Mr. J. Cauthery, late chief boiler engineer of the Vulcan Boiler & General Insurance Company, and previously assistant engineer of the National Boiler & General Insurance Company), has joined the Sutton Oil Company, Manchester, as engineer and general manager. While devoting himself to the development of the company's business in lubricants for all classes of work, Mr. Cauthery's services will be available for consultation in regard to problems in connection with lubrication.

The firm of Payne Gallwey, Brown & Company, which was formed just prior to the outbreak of war, has again been formed on more extensive lines. The directors are J. Payne Gallwey, late Brevet Lieut.-Colonel, R.E., and C. L. Brown, A.M.I.E.E., Lieut. R.E., both of whom have been associated with mechanical, electrical and colliery work on the practical, technical and commercial sides for many years. The firm will act as manufacturers' agents for colliery, factory, shipyard and general engineering supplies, machinery and plant (mechanical and electrical) for home and export. The staff (including the directors) are ex-disabled officers, and the offices are at 49, Queen Victoria-street, London, E.C.4.

The undertaking of the Enfield Electric Cable Mfg. Company has been acquired by a new company, the Enfield Edison Swan Cable Works, Ltd., which has a capital of £200,000 in £1 shares. The control and management remains as heretofore, the chairman of the board being Viscount Grimston, but the board will include Messrs. C. J. Ford and C. E. Hunter, chairman and managing director respectively of the Edison Swan Electric Company, which is subscribing for 50,000 shares in the new company. The works at Brimsdown will be enlarged. Mr. C. F. Plutte is general manager; Mr. John Aspin, managing director of the works; and Mr. A. V. Downton, technical director. The Enfield Company has gone into voluntary liquidation, with Mr. W. L. Smith, secretary of the company, as liquidator.

We are informed that the Enfield Company recently purchased the goodwill, plant, &c., of Messrs, Connolly Brothers, Ltd., of Blackley.

Companies' Reports, &c.

The directors of the Eastern Extension Australasia & China Telegraph Company, Ltd., have declared an interim dividend for the three months ended March 31, 1919, of 3s. per share, payable, tax free, on the 15th inst. The share register will be closed from the 7th to the 14th inst., inclusive.

The transfer books of the Telegraph Construction & Maintenance Company, Ltd., are closed from June 30 to the 10th inst. inclusive, preparatory to payment of interim dividend of 6s. per share, tax free.

The accounts of the Chili Telephone Company for the year ended March 31 show a profit of £82,149. After deducting income tax and excess profits duty and placing £16,964 to general reserve and £15,000 to reserve for renewal of plant, the directors recommend a final dividend of 3s. per share (tax free), leaving £8,510 to be carried forward.

Mr. J. B. Braithwaite has resigned the chairmanship and his seat on the Board of the County of London Electric Supply Company, Ltd., Sir Ernest V. Hiley, K.B.E., has been appointed Chairman and Mr. H. B. Renwick (Managing Director) has been appointed Deputy Chairman of the Company.

Mr. J. B. Braithwaite has resigned the chairmanship and his seat on the Board of the South London Electric Supply Corporation, Ltd., and Mr. H. B. Renwick (Managing Director) has been appointed Chairman of the Company.

During the year 1918 the South Wales Electrical Power Distribution Company sold 36,593,903 units, compared with 36,959,049 in 1917. Particulars of receipts and expenses are contained in the accounts of the Treforest Electrical Consumers Company. After payment of all expenses, the credit balance of the past year's working was £26,144. Deducting interest on the prior lien debenture stock and the original debenture stock and making provision for depreciation of new plant, the balance (£52) is to be carried forward.

The gross profits of the Electric & General Investment Company, Ltd., for the year ended May 31 was £8,117. After deducting general charges, interest on debenture stock, and adding £17,225 from last year, the balance is £23,352, which the directors have carried forward. The directors hope to be in a position to resume the payment of the half-yearly dividend on the preference shares on Jan. 1 next. As it is impracticable to pay off immediately in cash the arrears on these shares, which at June 30, 1919, will amount to 30s. on each £5 share, the directors are considering various methods for dealing with the same. The former secretary (Mr. S. R. Shaw) suffered so severely in health through his service in H.M. Army that he had to resign his appointment, and Mr. R. L. Sare succeeds him as secretary.

The accounts of Crompton & Company, Ltd., for the year ended March 31, 1919, show net profit (after providing for depreciation, interest on debentures, directors' fees, &c., and a reserve estimated to be sufficient to cover Excess Profits Duty for the year) of £38,828. Adding balance from last year (£26,030) and deducting the interim dividend on the preference shares (£4,682) the available balance is £60,176. The directors recommend that £10,000 be placed to general reserve fund, that £16,396 be written off expenses in connection with debenture issue, and that a dividend of 6½ per cent. on the preference shares (making with the interim dividend, 10 per cent. for the year) and a dividend of 10 per cent. on the ordinary shares be paid, leaving £17,409 to be carried forward. The directors have had under consideration the question of the new capital required to meet the growth of the Company's business, and a resolution will be submitted to the shareholders to confirm a provisional agreement with Messrs. Sir W. G. Armstrong, Whitworth & Company to subscribe for 250,000 of the unissued £1 ordinary shares of the Company at par.

Mr. Henry C. Walker, who presided over the meeting of Waygood-Otis, Ltd., said that after the Armistice the company began to reorganise for a return to its normal pre-war line of business and was now almost wholly engaged upon lifts and cranes. The change over was not without difficulties, and it involved expense. There was still delay in securing raw materials and in the delivery to different parts of the country of the company's manufactures due to congestion on the railways. They had re-built a portion of the factory and installed many additional up-to-date machine tools, thus adding appreciably to the capacity of the shops. The company was aiming at further standardisation which would permit of mass production and the carrying of a suitable stock of manufactured apparatus to a greater extent than before the War, and by those means and the improved manufacturing facilities the directors hoped to offset in some measure the higher costs of labour and materials so that prices might encourage prospective buyers to place their contracts with the company without delay. After an analysis of the accounts he said the directors proposed to pay the remainder of the arrears of the preference dividend on July 15, together with the half year's dividend due on that date, and in view of the increased profit made they recommended a dividend of 2½ per cent. for the year on the ordinary shares. The report and balance sheet were then adopted.

Mr. G. M. Booth presided over the meeting of J. G. White & Company, Ltd., and said the task of restoring business conditions to a pre-war basis was going to be long and difficult. He did not see how the trade of this country was to be restored to its proper place unless and until there was borne in upon the minds of all classes an understanding that, the war having left us poorer, we must all work harder. He had searched in vain in the pronouncements of the principal leaders of thought in connection with the great labour organisations of the day for encouragement in that direction. Hours and hours might be spent by

Coal Commissions in discussing whether someone had made more profit than he ought to have made, or received a royalty for which he had rendered no service to the State, but never a practical suggestion was made which would result in more coal being produced more cheaply in England for the general benefit of the home consumer and for the increase of the country's wealth by its capacity to export coal in competition with fuel from other countries. The business of the year had proved not unsatisfactory, and it was remarkable that they had been able to show some increase in net profits. Ordinary engineering construction had been practically suspended and profits in that direction were less than 20 per cent. of the whole profit. The balance had come from interest on the company's investments, from their operating contracts with public utility companies and from special war contracts. They had recently been awarded a small tramway reconstruction contract, but conditions for carrying out any new work were extremely difficult. Their investment account should show better results, and their operating department was also in good shape. An important addition to that section was the operating contract secured with the Chilian Electric Tramway and Light Company. The International Light and Power Company, in which they held a large block of the ordinary and preferred shares, was doing well. A year ago reference was made to the formation of a subsidiary company for trading purposes. That now existed under the name of the J. G. White Commercial Company, Ltd., and although conditions of manufacturing and shipping had been against the progress of such an undertaking, the results so far had been fairly satisfactory.

In the course of his speech to the shareholders of the United River Plate Telephone Company, Ltd., last week, the chairman (Sir F. Green, K.B.E.) stated that the earnings in Argentina and London amounted to £908,870, compared with £793,670 for 1917. Maintenance and other expenses of management in Argentina and London amounted to £616,370, against £528,252 for 1917, an increase of 16 per cent. The working expenses had increased in a greater ratio than the earnings, and the increase in London expenses was due entirely to income tax. It was proposed a final dividend of 5 per cent. on the ordinary shares, to place £60,000 to reserve, and £60,000 to reserve (war contingencies) fund, leaving £36,707 to be carried forward. They had increased their subscribers' stations by some 6,200, mostly during the first six months of the year, as the shortage of plant in the Federal capital had prevented them since then from making much progress, with the result that they had a long waiting list. They had a total of 72,005 throughout the system, against 65,788 last year. Except in the Province of Cordoba, they had not been able to open many new exchanges, but in that particular district, which was isolated from their main system, they had increased the number by nine, to 32. In the Federal capital they had laid down a good deal of underground work in congested areas, but they had not been able to bring into service the new common battery exchange at Belgrano, the equipment for which was ordered in 1916. In the suburbs of Buenos Aires they had been able to carry out some of the much-needed reconstruction work and also to provide a number of additional junction circuits. In March the Buenos Aires employees came out on strike, but with the assistance of some 200 loyal operators and their engineering staff they continued to give a limited service. With the assistance of the President of the Republic the strike was terminated after some 15 days. One of the things the strikers insisted upon was the winding up of the staff provident fund, to which for very many years the company had contributed annually £2,000. The cost of the concessions we had made would probably amount to £100,000 per annum, and to help meet that additional expenditure the Government had promised to give their favourable consideration to a reasonable increase in the rates. The outlook is now better and the prospects of Argentina appeared to be good.

The net profit of the General Electric Company, Ltd., for the year ending March 31 was £480,828; with balance brought forward (£145,286) less payment on account of excess profits duty (£70,000) the total is £556,114. After deducting debenture stock interest (£8,000), normal and special depreciation (£73,653), grants to dependents of men on active service (£16,799), dividend at rate of 6½ per cent. per annum on the preference share capital (£85,292), and transferring to reserve £117,000, the available balance is £255,369. The directors recommend a dividend at the rate of 10 per cent. per annum (tax free) on the ordinary share capital for the year (£113,867), leaving to be carried forward (subject to excess profits duty) £141,502.

The directors state that they are satisfied with the results of the year's trading, more especially as the period under review has witnessed the partial change-over from war to peace work, on which the company has been mainly employed since the cessation of hostilities. The directors appreciate the loyalty and assistance rendered by the company's employees during this strenuous period. Approximately 750 of the company's employees have been demobilised, all of whom have been reinstated. During the year the company acquired the engineering works of Fraser & Chalmers, Ltd., and this concern, as well as the Osram-Robertson Lamp Works, Ltd., has been entirely absorbed into the "G.E.C." organisation. The directors state that the large increase of capital effected early in the year is already justified by results. They have decided upon their post-war programme, a brief outline of which will be presented at the annual meeting. To give effect to this policy will require a further increase in capital, and the directors therefore propose to ask the shareholders for an authority to increase the capital to £6,000,000. Resolutions to give effect to the increase of capital and for splitting the existing £10 preference and ordinary shares into £1 shares will be submitted to an extraordinary general meeting to be held immediately after the annual general meeting. All the works are at present fully employed, and building operations are in progress to provide additional accommodation for works urgently required which, but for the war, would have been long since erected. The Government have vacated the company's building in Kingsway. The contract for the completion of the building has been placed, and it is hoped that it will be ready for occupation in 1920. The allied and subsidiary enterprises of the company have again shown satisfactory results. The £37,500 granted out of the company's reserves at the last meeting for the superannuation, pensioning off and benefit of employees has been invested in ordinary shares of the company. The directors also propose to establish a contributory pension scheme for the benefit of all employees.

New Companies.

T. BEADLE & COMPANY, LTD. (156,275).—Private company. Reg. June 20, capital £20,000 in £1 shares, to take over the business of factors and dealers in electrical supplies, motor car and cycle accessories, &c., carried on at Hull by T. Beadle & Company. Directors: T. Beadle, G. H. Atkinson and R. L. Hought. Reg. office: 3, Castle-street, Hull.

HALWAINS, LTD. (155,794)—Private company. Reg. June 5, capital £5,000 in £1 shares. Electric and steam engineers and contractors, manufacturers of tramway and other apparatus. Directors: T. Halstead and H. G. Wainscott. Reg. office: 44a, Bolton-street, Bury.

R. B. HAND & COMPANY, LTD. (156,193.)—Private company, reg. June 18, capital £1,000 in £1 shares. Electrical and mechanical engineers, agents, merchants, &c. First directors are R. B. Hand and S. Grundy. Reg. office, 63, High Holborn, W.C.

HANDCOCK & COMPANY (ENGINEERS), LTD. (155,734)—Private company. Reg. June 4, capital £3,000 in £1 shares. Engineering in all its branches. Agreement with T. R. Hancock. Directors: T. R. and T. W. Hancock. Reg. office: 224, Upper Thames-street, E.C.4.

VICTOR ENGINEERING COMPANY (CULLINGWORTH), LTD. (155,567). Private company. Reg. May 28, capital £3,000 in £1 shares, to take over the business carried on at Cullingworth, Keighley, as the Victor Engine Company, and to carry on the business of electrical and mechanical engineers, &c. First directors: J. H. Southwell and W. Holden.

V. P. WEBB & COMPANY, LTD. (155,887)—Private company. Reg. June 7, capital £10,000 in £1 shares (1,500 preference). Mechanical and electrical engineers and manufacturers of motors, aeroplanes, &c. Directors: V. P. Webb, C. Somerset and R. D. Dockree. Reg. office: Off Lombard-street, Stourport.

Prices of Metals, Chemicals, &c.

Wednesday, July 2.

Copper—Standard cash	£87	5	0	to	£87	10	0
Three months	88	5	0	to	88	10	0
Electrolytic wire bars pt. c.i.f.	91	0	0	to	95	0	0
Sheets	121	0	0				
Tin—Fine foreign cash	239	10	0	to	240	0	0
Three months	236	10	0	to	237	0	0
Lead—Net	22	5	0	to	22	7	6
English Lead	23	8	0				
Spelter	39	0	0	to	39	7	6

Iron, London, small rounds, squares and flats, £24. 2s. 6d. at producer's works: Middlesbrough, Cleveland pig, No. 1, 164s.; No. 3 G.M.B. and No. 4 foundry, 160s.; No. 4 forge, 158s.; East Coast hematite, 190s.; bars and angles, £20.

Steel, ship plates, £17. 15s.; angles, £17. 5s.; heavy steel rails, £16.

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £21.

" (Roll Brimstone).—Per ton £20.

Sulphate, Copper. Per ton £45.

Boric Acid (Crystals).—Per ton £72.

Bisulphide of Carbon.—Per ton £54.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 8d.

Shellac.—385s. to 390s.; August delivery at 293s. to 395s.

Rubber.—Para fine, 2s. 5d.; plantation grades, 1s. 10d. to 1s. 10¼d.

Gutta Percha.—Fine, 11s.

Thirty-Seven Years Ago.

[From The Electrician, July 1, 1882.]

Working on the Atlantic Cable.—The "Operator" states that the first Gould cable, laid in 1881 by Messrs. Siemens Brothers, has attained a working capacity of about seventeen and a half words per minute.

Electric Light for Hell Gate.—We stated some time since that this dangerous entrance to New York Harbour was to be lighted by the electric light. It has been determined to have two groups of 10 arc lamps of 2,000 c.p. each at either end of the passage.

Proposed Alteration of the Morse Alphabet.—It has been proposed by Mr. W. C. Stevens, in the New York, Pennsylvania & Ohio Railway Company's telegraph service, to alter the present Morse signal for 0 or cipher to two dots and two dashes. It is stated that this alteration is likely to be adopted before long in America.

Boiling Water by Electricity.—When giving evidence before the Select Committee on the Electric Lighting Bill, Dr. John Hopkinson stated his belief that the whole of the electricity generated by 1 h.p. would not do more than boil 1½ gallons of water an hour. This was to show that electricity is not likely to be used in the future for heating purposes.

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Notes.

The Prosperity of Traction Undertakings.

In his Chairman's address to the British Electric Traction Company last week, Mr. Emile Garcke gave a very good idea of the difficulties under which traction undertakings are carried on at the present time. There is a popular notion that any amount of economy can be practised, and that by this means any undertaking can be made to pay. Mr. Garcke pointed out that, although they might economise in every possible way and increase the efficiency of their administration to the utmost extent, the effort so made could only inadequately compensate for the depreciation in the purchasing value of the penny when applied to the payment of wages and the purchase of materials. Since the war the costs of labour and materials have on the average more than doubled, but it has not been possible to make a proportionate increase in the fares. Fares are limited by statute; and, even where alterations are authorised, pressure through public opinion or from local authorities renders it difficult in many cases to make the necessary increase in tariffs. Under the Statutory Charges Act of last year, traction undertakings are not permitted to make such increases as to enable the same return to be obtained on capital as was obtainable before the war; yet local authorities may obtain power to increase fares to an extent sufficient to meet their interest and sinking fund charges. It is, therefore, only natural that the average return on the whole of the capital, amounting to about £160,000,000, is only about 3⅛ per cent., and on the ordinary stock the return is only about 1¾ per cent. Such a position renders it impossible to attract fresh capital, and yet there are many complaints at the present time that fares are too high. After the way in which wages have been increased and hours shortened there is something humorous in the investigation now proceeding before a Select Committee of the House of Commons into the position of traction undertakings of the metropolis. The Chairman and some of the members appear to be quite indignant at times that fares should be so increased, and it would almost look as if they regarded the position as little short of profiteering. It seems to be forgotten that someone must pay for the increased wages and the higher cost of materials, and the idea is prevalent that facilities can be provided almost by the wave of a magic wand. As Mr. Garcke points out, there are physical limitations to the available transport services, and many months must elapse and considerable expenditure be incurred before services can be increased.

The British Scientific Products Exhibition.

The British Scientific Products Exhibition, which was opened at the Central Hall, Westminster, on Thursday last, marks a new stage in the application of science to British industries. While the descriptive catalogue and the exhibits naturally still refer very largely to war developments and inventions, it is recognised that conditions are now very different from those prevailing on the occasion of the first exhibition held a year ago. We were then working more or less in a confined space. We have now to measure ourselves against the rest of the world, and it will demand all our efforts to retain supremacy in quarters already secured, and to make advances in others where we still lag behind. This was pointed out by Mr. Gaster, the Chairman of the Circle of Scientific Technical and Trade Journalists, at the gathering of the Press which assembled at the exhibition in the morning of the opening day. Sir Richard Gregory, in his able address, gave details of some striking achievements. But he, too, pointed out how much remained to be done. We are glad to see, therefore, that the exhibition is becoming an annual feature, not only a transitory record of war developments. It should serve as a centre illustrating future applications of science to industry, and should help to maintain the steady and persistent propaganda which is needed to produce the correct attitude of mind towards Science. We think, indeed, that though our scientific resources at present are insufficient, much more could be done with them if the public attitude towards Science were more enlightened. The creation of this appreciatory atmosphere is one of the most urgent problems of our time, and in this task the technical Press is in a specially favourable position to help. We feel sure their aid will be gladly given. For the rest, the arrangement of the exhibition this year seems to be an improvement in several respects over that of last year, the assembly of the exhibits, in particular, being more compact and convenient. Sir Richard Gregory and his collaborators are also to be congratulated on the useful descriptive catalogue. We wish that, as was suggested at the gathering of journalists, some account could have been included of the valuable work of scientific and technical societies during the war. But there are obvious limits in the space available, and the catalogue, even without this information, has attained considerable size.

Street Lighting Reconstruction Problems.

Mr. Gaster's address to the Illuminating Engineering Society on this subject on June 24th contained some strong but not undeserved criticism of the manner in which the street lighting of London is at present managed. The defects, we believe, are mainly a matter of organisation. Technically, the lighting of many streets in London before the war was by no means bad, in comparison with that of Continental cities. The trouble was, and is, that there is no continuity. Good pieces of lighting end abruptly and bad lighting begins—or at least another form of lighting whose good points are different ones. This chaos is, of course, due to London's complicated municipal system. Logically, one cannot withstand the plea that streets should be lighted according to functions rather than locality. A class of street conveying a great volume of speedy traffic should receive adequate lighting whatever the borough it is in, and along an artery of traffic there should also be a reasonable degree of uniformity. Possibly all these troubles may be solved ultimately by exercise of the authority of the new Ministry of Ways and Communications, to which, it was suggested, street lighting might be relegated. Meantime, we wish Mr. Gaster success in his attempt to bring together those interested on a central advisory council, with a view to obtaining greater uniformity of procedure.

The Illuminating Engineering Society.

The annual meeting of the Illuminating Engineering Society on June 24th was noteworthy as marking the termination of the Society's 10th session, a circumstance to which reference was made at the 10th anniversary dinner last March. The Society has emerged from what must have been in some respects a difficult period, lighting being one of those things which were much upset during the war. The experience, however, has not been without value, and the annual report presented this year shows much variety of work. We notice that the Society proposes to extend its activities by forming several new committees to deal with such subjects as office, railway and stage lighting, in connection with which the assistance of outside experts will be sought. Another step of interest is the addition made to the list of bodies whose presidents become *ipso facto* vice-presidents and members of Council of the Illuminating Engineering Society. This is an enterprising step which should keep the Society well informed of what is going on in other circles, and assist to maintain its policy on broad and wise lines. We observe that the Society has now been added to the list of those represented on the Conjoint Board of Scientific Societies, a step which will doubtless afford yet another useful channel for co-operation.

The Overseas Trade Department.

We think that many commercial men will view with dismay the resignation of Sir Arthur Steel-Maitland, M.P., from the Department of Overseas Trade. So much was expected from this Department, and the present is essentially the time when the Department should be reaching full activity, that such a resignation appears to us to be most unfortunate. Since no details have been published as to why the resignation has been found necessary, we do not wish to say very much upon the subject, but it is sufficiently ominous when Sir Arthur states that his programme was constantly hung up. We fear that it is the old story of inter-departmental jealousies and obstruction by permanent officials. If so, we can only emphasise the general feeling that no such reason should stand in the way of the development of overseas trade at the present time when such trade is essential to the welfare of the country.

Engineering Societies and Public Works.

An example of the enterprise shown by engineering bodies in the United States in dealing with Government departments and public affairs is afforded by the conference which took place recently in Chicago for the purpose of forming an organisation to promote a Bill before Congress for the creation of a federal department of public works. The conference was attended by representatives of 74 engineering societies, with a combined membership of over 100,000. A committee was appointed for the purpose of preparing the draft of the Bill, and special consideration was paid to the relations of engineers to the proposed department. There is good ground for the assertion of Mr. P. N. Moore, who presented the report of the National Service Committee, that engineers should have a larger share in the co-ordination of engineering activities of the Government. There is a general feeling that engineers have not hitherto set their stamp on public affairs, and that scientific and engineering considerations often do not receive sufficient consideration in connection with public works. Especially is this the case with the choice of personnel. Another interesting feature was the offer of Mr. E. J. Mehran, on behalf of the McGraw-Hill Company and others of space in the journals represented for assisting a campaign in favour of the Bill.

The Nobel Prizes.—It is announced that the Swedish Court has agreed that the distribution of the Nobel prizes for 1919 for physics and chemistry, as well as the prizes for some subjects held over from 1918, shall be postponed till June 1, 1920.

Industrial Reconstruction Council.—A series of open air meetings is now being held by the Industrial Reconstruction Council on Tower Hill every Monday at one o'clock, where such subjects as Wages and Output, Bolshevism and Welsh Miners and Workmen in Industry are being discussed. The speakers are announced in advance from time to time. The audience so obtained is certainly of the class it is desirable to reach.

"The Electrician" Tables of Electricity Undertakings.—The annual "Electrician" Tables of British and Foreign Electricity Undertakings have now been published. These follow the same lines as the publication last year, and give particulars of 601 supply undertakings in the United Kingdom, the various power companies, 377 Colonial under takings, 197 foreign electricity supply works, and 50 foreign electric railways, and tramways undertakings. The Tables are in a handy form for reference.

An Illuminating Engineering Society in Japan.—A recent issue of the "Illuminating Engineer" refers to the formation of an Illuminating Engineering Society in Japan, which was originated in 1914, but only actually came into being in the autumn of 1916. The society already has the adherence of over 600 members, publishes transactions, and initiates lectures, discussions, &c. It will be interesting to note the direction in which the art of lighting develops in Japan. Meantime the formation of the society is an instance of the large amount of attention now being given to illumination in different parts of the world.

Natural Science in Education.—A recent pamphlet issued by the Ministry of Reconstruction (No. 26), dealing with "Natural Science in Education" is of considerable interest. It contains a survey of the points dealt with by Sir J. J. Thomson's Committee, the two chief principles emphasised being that all pupils, in the course of their education, should acquire an appreciative knowledge of the principles of Natural Science; and that there should similarly be included the study of the English language and, for pupils doing advanced scientific work, a reading knowledge of French and German. The best methods of giving effect to these recommendations are discussed in detail, sound advice being given on the teaching of science in schools, and its influence in school teaching; science teaching to pupils between 16 and 18, and the application of these principles to elementary schools, adult education and technical institutions and university education.

Speaking Crystals.—We notice in the "Electrical Review and Western Electrician" an account of an interesting demonstration by Mr. A. M. Nicholson before the New York Electrical Society on May 26th. Mr. Nicholson described a method of introducing pure crystals into the telephone circuits instead of dry cell batteries, for the purpose of amplifying sound. Certain crystals can be used as energisers in these circuits by reason of the fact that any distortion of the crystal generates electricity along its edges; conversely, a supply of electricity to the crystal causes it to distort. The most marked distortions are produced by alternating effects, and quite distinct effects can be produced by exposing crystals to the sound of the voice or the vibrations from the sounding board of a piano. Mr. Nicholson succeeded in reproducing in this way the sound of a piano, a gramophone, and the voice of a person in a distant room. The effect is not new. It is stated to have been known 2,000 years ago, re-discovered by East Indian jewellers two centuries back, and studied by Curie 30 years ago. It has also been recently applied to practical measurements in this country, but, so far as we are aware, the applications have only been electrostatic in their nature.

Diesel Engine Users' Association.—At the meeting in June the President (Mr. Napier Prentice) reported that application had been made for a Government grant in connection with the carrying out of research work and tests on liquid fuels for Diesel and semi-Diesel engines, more especially on fuels produced in this country. The application of the household Fuel and Lighting Order, 1918, to electricity supply undertakings using oil as fuel in place of coal was discussed. It was pointed out that the application of the order to such undertakings was placing an unnecessary check on the output of electrical energy in those districts, and that there could be no reason for consumers of electricity for lighting, heating or power to be inconvenienced by restrictions in any area in which the supply of electricity was not derived from the burning of coal in furnaces under boilers. It was suggested that, on the contrary, every encouragement should be given to developing as speedily as possible the greatest use of electric power in such areas of supply, and a resolution to that effect was unanimously passed. Mr. Geo. E. Windeler then read a short Paper on "A Method of Checking the Alignment of Diesel Engine Shafts, and a means of Proving if a Shaft is actually Bedding in its Bearings." He did not claim any novelty for his system, but stated that with the use of a suitable instrument which he had designed (and which was exhibited at the meeting) any engine user could instruct his engine driver in making good practical use of the method described.

Dinner to the Rt. Hon. J. H. Whitley.—Last Wednesday a complimentary dinner was given to the Right Hon. J. H. Whitley, M.P., by members of Joint Industrial Councils. Interim Industrial Reconstruction Committees and the Industrial Reconstruction Council. The chair was taken by Mr. E. J. P. Benn, C.B.E., and there was a large attendance. A message was announced from the Prince of Wales regretting his inability to be present, and expressing his sympathy with the movement.

After the toast of the King had been honoured, Col. C. Lestrange Malone, M.P., and the Right Hon. C. W. Bowerman, M.P., proposed the toast of the guest of the evening.

Mr. Whitley, in replying, remarked that each industry had its own particular problems to be solved by joint endeavour, and that all engaged therein should in future regard their services as something to the common good. The days of trench warfare between employers and employed were now passing, and a new spirit of co-operation had arisen with the war. He felt that unless the country found its way to give a greater contribution of the world's means it must inevitably go down. He begged those who were responsible to inaugurate Works Committees as soon as possible, as they were of the greatest importance.

The toast of Joint Industrial Councils and Interim Industrial Reconstruction Committees was proposed by Sir George Riddell, in a humorous speech.

Sir Robert Horne, Minister of Labour, in replying, said it was much better that employers and employed should settle the hours of labour between them rather than come to his department. Complete knowledge on the part of the workmen was the best antidote to unrest.

Sir Arthur Steel-Maitland, in proposing the toast of the Industrial Reconstruction Council, expressed the view that the nation would come out well from the present position if it used its success advisedly. It was not merely a question of wages and conditions of labour, but what was also required, to a considerable extent, were facilities to extend the mental outlook. The toast was supported by the Right Hon. J. R. Clynes, who emphasised the need for the workmen to participate in the affairs of industry. In his opinion, Mr. Whitley was one of the most effective trade union organisers who had ever arisen, and there was no more beneficent work than that which Mr. Whitley had done.

Mr. Benn responded briefly to the toast, as also did Mr. John Baker.

Metrology in the Industries.—At a meeting of the Physical Society, on March 28th, an interesting discussion on the above subject took place, and is now issued in separate form. Sir R. T. Glazebrook, in opening the discussion, emphasised the use of limit gauges as essential to accurate repetition work on a large scale. At the time of the Boer War the difficulty of getting interchangeable work from different shops was already experienced, and the initial work of a Committee then appointed by the War Office led ultimately to the establishment of the Engineering Standards Committee on Gauges. In the war just terminated the problem came up again on a larger scale. Few firms could make gauges, and, though drawings existed, the real standard was frequently not these dimensions, but a set of gauges in some Government department. Originally rejections of screw gauges submitted to the N.P.L. were as much as 75 to 80 per cent., and after two years' work 70 to 80 per cent. were accepted. Interchangeable accurate work is essential in modern engineering, and it is necessary to maintain standards by local institutions throughout the country for testing and issuing gauges. It is evident from the discussion that in some countries interchangeability was obtained a considerable time ago. Thus, Mr. Wm. Taylor thought that in the Swiss watch industry, where tolerances are of the order of 1/10000 in., it was the practice to interchange parts a century ago. Makers of printing types have achieved a similar order of tolerance. Thus, Sir Henry Stephenson claimed that by the inspection of type with the unaided eye he could detect variations of this order. Dr. P. E. Shaw presented a Paper urging the need for metrology in the universities as an educational asset, and mentioned other cases, notably needles used in Nottingham embroidery and in the textile industries, where small inaccuracies in dimensions are fatal. Mr. F. J. Dykes mentioned that Japan had early welcomed the limit gauge system, no doubt in view of the fact their labour was largely unskilled. He was glad that the E.S.C. were now considering the recommendation of the shaft basis, as compared with the pole basis. The optical projector used at the N.P.L. for gauge work should be developed into a more robust workshop instrument. The published discussion contains further written communications, notably an illustrated contribution from Prof. W. Ripper, descriptive of work at Sheffield University.

Personal.

Mr. J. Beckett, borough treasurer of Accrington, has been appointed general secretary to the Municipal Tramways Association of Great Britain and secretary to the municipal employers at the Industrial Council.

The friends of Mr. Wilson Hartnell electrical engineer and principal of Wilson, Hartnell & Company, Ltd., presented him on the 27th ult. with a silver rose bowl on the celebration of his 80th birthday. The subscribers included three ex-Lord Mayors and a former member of Parliament and other prominent citizens. Sympathetic reference was also made to the fact that Mr. and Mrs. Hartnell's only son was killed in the early days of the war.

Arrangements for the Week.

FRIDAY, July 11th (to-day).

North-East Coast Institution of Engineers and Shipbuilders.

10 a.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Papers to be read: "Ship Repairing during the War," by Mr. M. C. James and Mr. L. E. Smith; and "Transmission of Power," by Mr. G. Constantinesco.

Physical Society.

3 p.m. Visit to the National Physical Laboratory, Teddington, Middlesex. Demonstrations of work in progress in the Laboratory.

British Scientific Products Exhibition.

5.30 p.m. At Central Hall, Westminster, London, S.W. Lecture on "Coal Conservation," by Prof. H. E. Armstrong, F.R.S.

MONDAY, July 14th.

British Scientific Products Exhibition.

5.30 p.m. At Central Hall, Westminster, London, S.W. Lecture on "Progress in Rangefinders," by Prof. A. Barr.

WEDNESDAY, July 16th.

Society of Chemical Industry.

10.30 a.m. and *3 p.m.* At Salter's Hall, St. Swithin's-lane, London, E.C. Conference on "Power Plant in Chemical Works."

The Oscillatory Valve Relay: A Thermionic Trigger Device.*

By Captain L. B. TURNER.

(Concluded from p. 5.)

Summary.—In his introductory remarks the author distinguishes between relays and amplifiers, and explains the triode. Various types of valve relays for acoustic frequencies for high frequency signals and for wireless signals are described, and reference is also made to the use of the relay for steady or slowly varying currents. Finally, an analysis is made of the sensibility and selectivity of the pre-tuned high frequency valve relay, and the general limitations on sensitivity and speed of working are discussed.

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3. A Valve Relay for Acoustic Frequencies.

Fig. 7 shows a valve relay designed for signals of acoustic frequencies, containing its own grid and anode batteries and requiring externally only a 4-volt battery for the filament. It is provided with a small electric lamp as an indicator, together with a change-over switch allowing any external apparatus to be substituted for the lamp. It was designed to replace the ordinary telephones used to read Morse signals from a wireless receiver, or over the wire of an ordinary buzzer field telegraph set. Even without any amplifier it is sufficiently sensitive to respond to signals only strong enough for comfortable commercial work.

The power of the steady incoming signal to operate this instrument is of the order of 10^{-8} watts, whereas an ordinary Post Office telegraph relay controlled by the anode current of the oscillating valve requires an operative power of at least 5×10^{-3} watts for reliable working even at low speeds.

As to robustness, the war has proved the high-vacuum triode to be an instrument adapted for unskilled use in the field of battle. The only adjustment is that of a potentiometer to regulate the potential of the grid to a tenth of a volt or so.

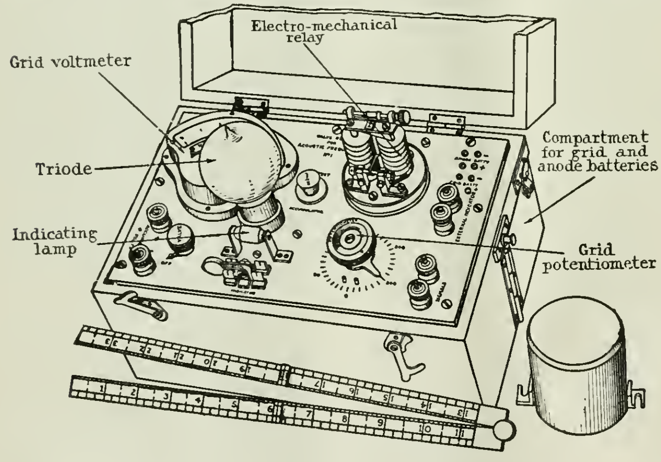

Fig. 7.—A Valve Relay for Acoustic Frequencies.

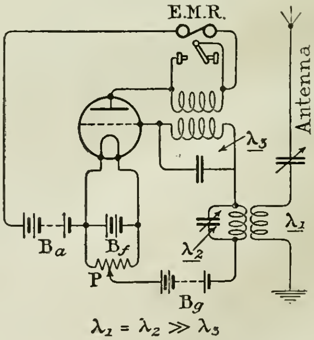

Fig. 8.—Circuits of Valve Relay for High-frequency Signals.

4. Form of Valve Relay for High-frequency Signals.

The relay examined is of aperiodic or non-tuned type, in that the frequency of the signal current bears no relation to the frequency of the oscillation set up. Such a type is well adapted to acoustic frequencies, because it is feasible to build for such frequencies quasi-aperiodic transformers capable of producing on the grid (whose impedance is sensibly infinite at such frequencies) a large rise of potential with an expenditure of only minute power. If the aperiodic iron-cored transformer is replaced by suitable tuned high-frequency circuits, with a frequency still much below that of the oscillation generated in the relay, a relay of like sensitivity, but for high-frequency instead of acoustic frequency signals, can be constructed. Such a relay for wireless signals is sketched in Fig. 8.

But where high-frequency currents such as those of wireless telegraphy are required to operate the relay (particularly undamped or "continuous" waves) an advantage accrues from tuning the oscillation generating circuits of the relay to the frequency of the operative signals. Sensitivity is greatly enhanced, and there is the possibility of an exalted selectivity as between signals of unequal frequencies and between signals of the same frequency but unequal decrement. The λ_2 circuit of Fig. 8 is then conveniently omitted, the λ_1 and λ_3 circuits are coupled together, and λ_3 is made equal to the wave-length λ_1 of the antenna and the incoming signal. To prevent the antenna being set into violent oscillation by the relay (as well as to obtain additional sensitivity), one or more amplifying triodes may be interposed between antenna and relay. The high-frequency valve relay, unlike other wireless receivers, embodies neither heterodyne nor rectifier.

5. A Valve Relay for Wireless Signals.

A valve relay receiver designed for wave-lengths of 1,500-3,000 metres, containing its own grid and anode batteries, and comprising one high-frequency amplifying triode, is shown in Fig. 9.

This valve relay is, by movement of a switch, converted into an ordinary autoheterodyne receiver, and is used as such when tuning up to a continuous-wave signal, the final tuning being to the "silent space"—*i.e.*, to zero beat frequency. On switching over from "phones" to "relay," and adjusting the potentiometer to a potential just below the threshold, we are left with a circuit exactly tuned to the incoming signal and of nearly zero decrement. The discrimination between C.W. and spark signals is very striking. Thus a spark station of nearly the same wave-length as a desired C.W. station, and strong enough to jam the latter hopelessly as an autoheterodyne receiver, can be made innocuous for reception on the valve relay.

6. Valve Relay for Steady or Slowly Varying Currents.

In the two forms of valve relay already described, the signal current was alternating or intermittent, and produced the requisite rise of grid potential by the simple mediation of some form of transformer. For the relaying of slowly changing currents such as those from telegraph cables, the current, and not its rate of change, must be made to affect the relay. This is easily accomplished, with striking sensitivity, by placing an inductance of suitably large time constant in the circuit, accumulating energy therein as long as the conditions permit, and then causing the current to change rapidly, as by breaking the circuit of the inductance, thus producing momentarily a large P.D. across the inductance. This momentary P.D. is applied directly, or through a step-up transformer, to the grid of the valve relay. Experiments on tripping a P.O. polarised relay show that for this relay at least 5×10^{-5} watt-seconds (1 milliampere in over 100 henries) is necessary—*i.e.*, over a million times as much for the valve relay. The valve relay in this form must, it is thought, be adaptable to submarine cable working; but only preliminary trials have so far been made..

7. The Sensitivity and Selectivity of the Tuned High-frequency Valve Relay.

The superiority in the matter of sensitivity and selectivity of the tuned arrangement, referred to in sections 4 and 5, is readily analysed. It is well known that a chief effect of reaction between the grid and anode circuits of a triode is to reduce the resistance of the system. Thus, in Fig. 3, owing to the mutual inductance M between the two coils, the oscillatory resistance is reduced from R_1 to $R_1 - \frac{Mg}{C_1}$. Since the setting of the relay consists precisely in increasing g as far as considerations of constancy and rapid quenching will allow towards the critical value at which the second term in this expression becomes equal to the first, the net resistance is very small indeed. In practice, when using a triode as in Fig. 6, it is found feasible to work with a margin of about 0·05 volt. The sensitivity to accurately syntonised C.W. signals of the tuned arrangement is 50 times greater than that of the aperiodic arrangement of Fig. 8. The selectivity as between C.W. and spark is very marked.

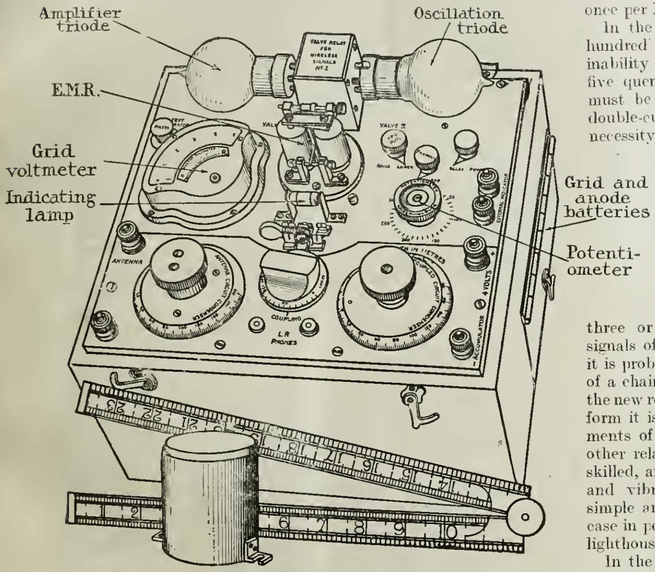

Fig. 9.—A Valve Relay for Wireless Signals.

For equal peak values of signal E.M.F. in the receiving antenna, the peak potential rise on the grid from a C.W. signal may be 500 times what it is from a spark signal. For equal mean powers radiated it is easy to calculate the ratio between spark peak amplitude and C.W. amplitude for any case. Thus, if the wave-length is 3,000 metres, the spark decrement $\delta_1 = 0{\cdot}06$, and the spark frequency 600, the spark amplitude is 10 times the C.W. amplitude. We are thus left with the figure $500 \div 10 = 50$, as giving the preference of the valve relay for C.W. over spark signals of equal power.

8. General Limitations on Sensitivity and Speed of Working.

The valve relay, unlike every form of mechanical relay, requires in theory no expenditure of energy to make it trip; but the sensitivity depends finally on the degree of perfection which it is practicable or convenient or economical to reach in the construction of would-be wattless circuits.

The sensitivity is also inversely proportional to the margin to which the valve relay is adjusted. There is another effect besides inconstancy forbidding the indefinite reduction of the margin. When the relay has been tripped and the oscillation started it has to be re-set by quenching the oscillation and allowing the currents in the anode and grid circuits to die down to their non-oscillatory values (small and zero respectively). This is an asymptotic process never fully completed. The longer the duration of quenching contact the smaller the re-igniting potentials will be; but, whatever they are, they must be provided for by a margin sufficiently wide to make them inadequate to trip the relay afresh.

We are faced, therefore, with a compromise between augmented speed and reduced sensitivity. For high-speed work, the acoustic valve relay of Fig. 7 is unsuitable. The tongue of the mechanical relay must quench several times during a Morse dot, and its speed is here insufficient for signalling at more than about 20 words per minute. The slowness is due to the fact that during oscillation a considerable mean grid current (about 0·2 milliampere) is built up in the secondary of the signal transformer, which is of large inductance (some 50 henries). By using a triode with coarser grid and higher anode potential this grid current can, however, be wholly suppressed. In the high-frequency form of relay (section 5), grid current is harmless, since there is no large inductance in the grid circuit. The anode current in the magnets of the mechanical relay is then the limiting factor. The wireless valve relay of Fig. 9 is satisfactory up to 40 or 50 words per minute. For higher speeds it is preferable to provide for weaker oscillation and use an externally operated quenching switch, the mechanical relay being retained as an indicator only. The mechanical relay has then to move over only once per Morse dot, instead of several times per dot.

In the endeavour to reach really high speeds, such as several hundred words per minute, the limit must ultimately be fixed by inability to quench fast enough. At 100 words per minute, with five quenches per Morse dot, the duration of quenching contact must be less than 1/400 second. An ingenious arrangement for double-current (or two-signal wireless) working, which avoids the necessity of quenching more than once per Morse dot, has been devised by Major Fuller, R.E., and Lieut. Lemon, R.E., of the Signals Experimental Establishment. The principle involves the use of two valve relays, adapted to be tripped by the marking and spacing signals respectively.

9. Conclusion.

The valve relay is an instrument of great sensitivity, yet requiring no delicate handling, adaptable for operation by signal currents of any form. With the multi-triode amplifiers developed during the last three or four years, it is feasible to work commercially with signals of much less power than is required to trip a valve relay; it is probable that this relay will frequently be employed at the end of a chain of amplifying triodes. It is not claimed, therefore, that the new relay is a receiver of unique sensitivity. In its low-frequency form it is surpassed in sensitivity by the electromechanical instruments of Heurtley and Orling. But it is not approached by any other relay capable of being manipulated by operators not highly skilled, and able to withstand ordinary conditions; such as draught and vibration. Situations are common enough where only the simple and robust instrument can give the service demanded. A case in point is that of a wireless call device for the small islands and lighthouses lying a few miles off our coasts.

In the foregoing pages the function of the valve relay has been regarded as solely that of a relay; but it is a relay which responds when the signal reaches, if only for a brief moment, a certain strength, adjustable by the turning of a potentiometer handle, and expressible with precision as the difference between two voltmeter readings of the grid potential. It constitutes, therefore, a simple and convenient instrument for measuring peak values of potential or current, of any frequency and wave-form; and, in one such particular application, may prove an aid to precise wireless experimentation as a ready means of measuring signal strength.

DISCUSSION.

Mr. A. A. Campbell Swinton said the three-electrode type of amplifier was one of the most wonderful discoveries in physics made in modern times. The researches which led up to its invention began with Crookes, and were carried on by experimenters with no object in view except ascertaining phenomena; but the work had been turned to practical effect with most surprising results. Other relays, such as the Heurtley, were in themselves perhaps more sensitive than that described by the author, but great difficulties would result from putting a dozen of them in series, whereas any number of this three-electrode type could be put in cascade, and the effect was obtained of the one multiplied by the other. The National Physical Laboratory used a type which gave an amplification of 18 times, and if six tubes were used that was 18^6 = about 33 millions. The lecturer mentioned 8 or 10 times. With ordinary relays, the distortion in one relay was multiplied, when one used a great many of them, to such an extent that the whole thing became impracticable; but in these tubes one was dealing with matter that had no inertia, and practically no momentum, and consequently there was practically no distortion so far as the tube was concerned. He understood that there was only a single tube in the instrument that had just been shown, which made the results all the more wonderful.

Mr. J. E. Taylor thought the comparison of the energy required to trip an ordinary Post Office relay and Capt. Turner's relay was not altogether appropriate. A more appropriate comparison would be the energy required to trip another form of wireless relay which was also a trigger relay. It took less energy to trip the coherer properly used, than to trip the Post Office relay, though he had no doubt it took much less still to trip Capt. Turner's relay. The coherer was subject to interruption by vibration and in other ways, and the valve relay was not, but the coherer still had some uses as a call device. Its main weakness was that it was affected very much by stray signals. Had Capt. Turner's relay any advantages in that respect ? Being a trigger device, it looked as though it would not have much greater immunity.

Prof. E. W. Marchant said he would like to add the name of Dr. Fleming as one of those who had done a large amount of the experimental work that had led up to the wonderful development that the author had demonstrated. It might not be out of place to give some explanation of the valve as a physical phenomenon. The action of the valve was due to discharges of electrons from the heated filament. The negative electrons to which the filament gave rise moved freely in the surrounding space. If a plate were put above the filament and connected to the positive pole of a battery, the positive charge on that plate would attract those electrons from the filament and cause a current to flow. If, on the other hand, the plate were negatively charged, the potential gradient was in the opposite direction, and drove the electrons back into the filament. If, instead of a plate, one had a grid with holes in it, and put another plate above, one got the three-electrode valve. If that were connected to another battery of high potential, there was a big positive charge, tending to attract those negative electrons. If the grid were made without any charge on it, the flow of electrons would not be sensibly affected ; but if the grid were connected so as to produce a positive potential between the grid and the plate, there was a potential gradient acting on the electrons and tending to move them in the direction of the grid. Some of the electrons would remain on the grid, and the rest would shoot through the holes in the grid and come to the top plate. There was a current amplification depending on the ratio between the grid and the size of the holes, more electrons going to the positive plate than to the grid if the holes were large. One had to come back on the characteristic curve to a negative point before zero was reached—*i.e.*, before the current was stopped. The reason was that if there were a high potential on the grid there was a high potential gradient between that and the filament in the right direction to produce the current. The current could be stopped by neutralising that positive potential gradient due to the anode by a negative potential on the grid, and that negative potential had to be adjusted so as to make the potential gradient equal to zero. Had Capt. Turner ever tried using a leakage condenser connected between the grid and the negative terminal ? The grid potential could easily be controlled in that way, and by altering the resistance of the leak the controlling potential could be varied. He thought perhaps better terms might be used than " margin " and " threshold."

Prof. C. L. Fortescue said all workers with experience of any type of reaction receiver were only too well aware of the action on which the author's relay depended. There was a tendency to oscillate, but Capt. Turner had made use of that tendency in an ingenious way. The invention had two distinct possibilities, from the wireless point of view —acoustical and wireless reception. In the former one would have some detector, and the rectified signals would be passed on to the relay. That was using the device purely as a relay. In the other case the instrument would be used without a detector or heterodyne, and he presumed the telephones would be in series with an electro-mechanical relay. He thought it was as a relay with some other detector that the device was likely to have a future application. If used without a detector to receive spark signals, it would appear that instead of the note of the spark transmitting station being heard on the telephones, merely the note of the make-and-break of the small electromechanical relay would be heard, and the advantage arising from an operator being able to read through the interference by means of a distinctive spark frequency would be lost. If used in that way, the atmospherics would presumably appear on the same note as the signal, which would be a disadvantage. There was little difference between this type and the ordinary reaction receiver. In either case there was a negative resistance in the circuit. In the author's arrangement that negative resistance was an increasing one. As the amplitude of the signals built up in the receiving circuit the tendency to oscillate became more and more marked, instability was quickly reached, and the relay came into operation. In the case of a receiver used with a detector, the tendency was the other way about—as the amplitude built up the tendency to operate became less. Had any other method of quenching the oscillations been tried ? Shortening the coupling might lead to shock of the circuit, which would re-ignite the ignition tubes. It might be useful if one could use a resistance in parallel with the condenser as a damping arrangement.

Mr. B. Binyon remarked that the whole action of the instrument described by the author was in the nature of a coherer, and it could do everything the coherer did, and do it better. It appeared possible that simultaneously with the recording arrangement or valve relay a listening in device could be operated off the same receiver circuit. That was an essential requirement in commercial work. The difficulty might be got over by abandoning the use of the high-frequency valve relay and employing an audion frequency relay at the end of a Mildé valve amplfiier, a special winding being inserted for the telephone circuit. Such an arrangement, however, would be disadvantageous if the valve relay was to be used for speed working. It was essential for the operator to be able to read his signals at high speed, and it was also essential to listen in at the same time, to ensure that there was no fault. An ordinary type of receiver could be used to listen in, but some fault might develop in the valve relay receiver, which might not occur in the duplicate receiver, and the advantages of selectivity which the author described would be to a considerable extent lost. He agreed as to the enormous advantage of aural reception, even when considering high-speed apparatus in conjunction with a dictaphone. The fact that no expenditure of energy was required to trip the relay appeared at first sight a great advantage ; but in high-speed working, where one had oscillation quenching to consider, or anode current quenching in the magnets of the relay, one had energy in inductances which had to be damped out. In the case of the high-frequency relay, one would expect that the electrical quenching in the circuit would be quicker on the shorter wave-lengths than on the longer ones, but it was nearly always the longer wave-lengths which were employed for long-distance communication where high-speed recording was used. Curves of possible speeds for a given signal strength plotted against wave-lengths would be of interest. The inertia of the parts, when one came to the higher speeds, might obscure any differences that arose there. What part did the quenching of the energy in those circuits play when one came to high speeds ? He would think the speed of the relay might be much improved by the employment of an independent mechanical quencher such as a rotating commutator.

Mr. W. E. Twells asked whether the author had made any experiments on really high-speed working—say 200 words a minute ? The United Kingdom was well served with underground cables. The electrical constituents of the pairs were not balanced one against the other, and therefore telegraphy and telephony in one cable for any distance was impracticable. The Post Office had made considerable progress in the direction of working telegraphs and telephones indiscriminately on one pair. The speeds attainable were in the order of 200 words a minute. The problem was not simple. The relay must not be so sensitive that it picked up the telephones, nor must the telephones interfere with the telegraphs ; but it must be capable of ultimately working on single wires. He thought there was a wide field for such relays.

Mr. A. B. Hart said the perfection of the thermionic valve, or triode, had made possible the development of a practical telephone repeater on the telephone trunk lines, and that had revolutionised the design of long-distance lines. Conductors were now specified with one-tenth the weight of copper formerly used. He had in mind the problem of signalling through long lengths of small conductors. The equipment must include apparatus for calling and clearing. The signalling repeaters brought complications into trunk line maintenance, and their presence interfered with the proper functioning of the thermionic valve and its associated apparatus. The outcome of attempts to render unnecessary the signalling repeater had been the thermionic valve for relaying the signalling as well as the speech currents. The essential element of the telephone repeater was that it must respond to signalling currents on the same order of magnitude as the speech current, but must not respond to the speech current frequency.

Mr. G. H. Nash said at the present moment 10 telegraph circuits, each quadruplex, and four telephone circuits, were being carried over a single wire. The triode valve had entirely eliminated distance, and all these things were due to the valve. He had failed to get faithful articulation with the French type of valve, due to mechanical vibrations. If one element of a valve began to oscillate, its natural frequency appeared in the circuit. Had the author experience of that type of valve ?

Mr. B. G. Gosling remarked that valve designers were now faced with a new problem in regard to the curvature of the characteristic. The portion of the characteristic which the author worked upon was one of which the physics were comprehensible, but which was not yet susceptible to exact treatment. It was in the form of an exponential curve, the form of which was clearly shown (in Prof. Richardson's Papers on the distribution of the velocities with which the electrons were omitted from the filament) to be based on certain natural constants. It was, therefore, probable that the valves, as they now had them, gave curvatures much of the same order as was ever likely to appear, always provided someone did not produce some ingenious method of eliminating the effect of the particular natural constants involved. Apart from that, the valve as it stood very conceivably represented something like the high-water mark as regarded the curvature of the characteristic.

Mr. S. G. Brown asked whether the author had done anything in the way of using the higher voltage currents, such as the ordinary current of the electric light mains, to light his lamps, and, if so, had he had difficulty in cutting out the oscillations usually inherent in such mains ? The great difficulty appeared to be keeping the accumulators fully charged, and if the current could be taken from the mains it would be useful.

The Author, replying to the discussion, said the valve relay was to all intents and purposes a coherer, but it only required about one-twentieth volt to trip it, and was more reliable and constant than the ordinary coherer. The power consumption in a coherer was considerable, and a coherer could not be treated as an infinite impedance which would damp the circuit. The negative grid of the valve relay took no power from the circuit which fed it with potential. He agreed that one could not have a recorder in wireless without being able to listen in. He saw no difficulty in having a receiver, such as the C.W., coupled loosely with a pair of telephones, and someone listening. If a rotating commutator were used for quenching, as suggested by Mr. Binyon, it would have to quench several times per signal element, or per Morse dot—say five times. At 100 words a minute it would have to quench in less than $\frac{1}{400}$ second. In the quenching system described in Major Fuller's recent Paper, the relay was relieved of chattering at that speed, and one only had to quench once per Morse dot. The quenching was not brought about until the spacing signal arrived. An oscillating system which was nearly undamped was very selective between one continuous wave and another—an enormous increase of amplitude was built up in the receiving circuit by tuning dead on. The valve relay was a great aid in selecting between different wave-lengths, as well as between C.W. and spark.

The President announced that the author would reply more fully in the " Journal."

Pulsation of the D.C. Terminal Voltage in Rotary Converters.

By J. K. KOSTKO.

The pulsating nature of the direct-current voltage in rotary converters has been discovered almost simultaneously with their first commercial applications. The amplitude of pulsations being small in all but single-phase converters, the phenomenon has not attracted much attention, and the few references to it which can be found in the technical literature contain little more than a simple enumeration of its probable causes. Even where an attempt was made to establish numerical laws of pulsations, the most important causes have apparently escaped the attention of investigators, so that curves of the direct-current voltage calculated by the proposed formulæ do not correspond to the oscillographic records, neither in the wave shape nor in the order of magnitude of pulsations. In large polyphase converters the pulsations are practically negligible; but in small machines, especially of the single-phase type, the amplitude of pulsations may greatly exceed anything that can be expected in a continuous-current apparatus, 25 per cent. of the average voltage being not an uncommon figure; in some applications the effect is so pronounced that corrective means, usually a choke coil, are often used with appreciable advantage; for instance, a telephone battery, while in service, can be charged from a converter of this kind only with a strong choke coil in series; otherwise the noise in the receiver makes the service impossible. If a cinematograph arc lamp is supplied with direct current from a small converter, the quality of light can be improved by the insertion of a choke coil, and the arc made less noisy. When a converter working near its sparking limit supplies current to an apparatus possessing a constant back-E.M.F., such as a storage battery, difficulties of commutation are sometimes caused by pulsations of the current set up by the unbalanced pulsations of the voltage, &c.

Since the total current in an armature conductor can be considered as the algebraic sum of the direct and alternating currents, the instantaneous value of the direct-current voltage of a rotary converter (measured under the direct-current brushes) is the algebraic sum of the following components:—

1. The E.M.F. E_a generated by the motion of the armature in the stationary field set up by the combined action of the exciting current, the triangular wave of the M.M.F. due to the direct current in the armature, and the sine wave of the M.M.F. due to the fundamenatl harmonic of the alternating current in the armature.

2. The ohmic drop caused by the direct current in the armature.

3. The algebraic sum of the ohmic drops caused by the alternating currents in consecutive phases and parts of phases in series between the direct-current brushes.

4. The algebraic sum of the local reactance E.M.F.s due to the alternating currents in consecutive phases and parts of phases in series between the direct-current brushes.

For a phase which, at a given moment, belongs entirely to one direct-current circuit of the armature, the variation of (3) and (4) is due only to the variation of the alternating current in function of time; for a phase which is passing under a direct-current brush this variation is due also to the variation of the number of conductors in the part of this phase which belongs to the direct-current circuit under consideration.

5. In a polyphase converter the M.M.F. due to the combination of the fundamental harmonics (in time) of the impressed currents in all phases can be resolved into a fundamental harmonic (in space), stationary with respect to the field member, as mentioned in (1), and into a series of higher harmonics revolving with various speeds with respect to the field member and the armature, and setting up fields which induce variable E.M.F.s between the direct-current brushes.

6. In a single-phase converter there exists also the "reverse" M.M.F., equal in amplitude to one-half of the fundamental harmonic (in space) of the fundamental harmonic (in time) of the impressed current, and revolving with the synchronous speed with respect to the armature, and with twice the synchronous speed with respect to the field member. The field set up by this revolving M.M.F. induces periodic E.M.F.s between the direct-current brushes.

7. If the impressed currents do not follow the sine law of variation, which may be caused by a distorted wave shape of the applied voltage or by an improper shape of pole-pieces, the higher harmonics of the current set up fields of their own: some of these fields are stationary with respect to the field member, and can be magnetically combined with the field of the exciting winding; the others revolve with respect to the field member and the armature and induce variable E.M.F.s between the direct-current brushes.

Of course, variable components of the voltage react on one another and on the constant components; for instance, any cause of variation of the terminal voltage results in a variation of the direct current in the armature, thus affecting the direct current ohmic drop and the direct-current component of the armature reaction. The variable component of the terminal voltage, applied to the shunt winding, sets up a weak alternating field inducing alternating E.M.F.s between the brushes, &c. The effects of these secondary causes are, usually, very small; some of them depend on the constitution of the external circuit, and cannot be treated in a general way: in what follows only the primary causes will be considered. Of these, (5) and (7) are usually negligible because the amplitude of the M.M.F.s are small and their fields are further reduced by the reaction of eddy currents in pole-pieces and induced currents in various stator windings, especially if the field member is provided with amortisseur windings of the squirrel-cage type. The only really important causes of pulsation are those mentioned in (3), (4) and (6).

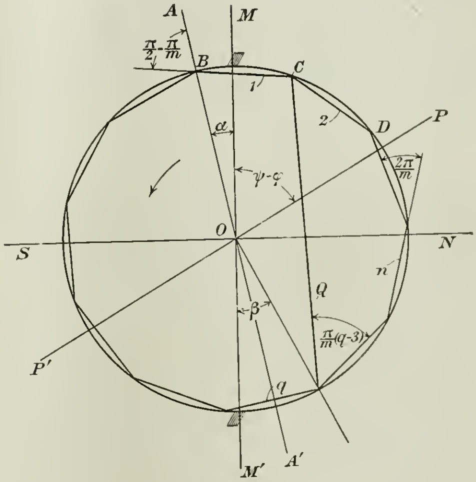

Fig. 1.

In dealing with the local reactance E.M.F. it will be sufficiently accurate to assume that the reactance is distributed along the winding of a phase in a manner similar to the resistance; components (3) and (4) can then be combined in one impedance E.M.F., and this notion applied not only to the entire phase, but to a part of it comprised between a slip-ring and a direct-current brush.

Let circle O (Fig. 1) represent a converter armature connected to slip-rings at points B, C, D, &c., and revolving in a field NS in the direction of the arrow ; MM' is the line of brushes perpendicular to NS; the brushes are assumed to be set on neutral with respect to the exciting winding—*i.e.*, the field NS differs from the total stationary field of the machine only by a small field directed along $M'M$, and due to the slight excess of the watt-alternating current over the direct current in the armature. Let m be the number of phases of the machine, marked $1, 2 \ldots n \ldots q$, as shown. It is clear that if m is even, the pulsations caused by the impedance E.M.F. have for period the interval of time during which a phase passes under a brush. If m is odd, the period is equal to only one-half of this interval, because, while in the part of the armature disposed to the right of MM' a phase passes under a direct-current brush from its tap point to its middle point, in the part of the armature disposed to the left of MM another phase passes from its middle point to its tap point ; and with the assumed sine law of variation of currents the impedance E.M.F.s in the two halves of the armature must balance one another ; analytical formulæ established below lead to the same conclusion. If f is the frequency of the supply, the frequency of pulsations will be $2f$ for single-phase, $4f$ for two-phase, $6f$ for three and six-phase converters, &c.

In a single-phase converter the field set up by the "reverse" M.M.F. mentioned in (6) revolves at double frequency with respect to the brushes, and induces a double frequency E.M.F. between the direct-current brushes—*i.e.*, of the same period as the pulsations due to the impedance E.M.F.

PULSATIONS CAUSED BY THE IMPEDANCE E.M.F.

Let e_n be the instantaneous value of the impedance E.M.F. in the phase n ; the total impedance E.M.F. between the direct-current brushes is the sum,

$$e = \sum_{2}^{q-1} e_n + \frac{\frac{2\pi}{m} - a}{\frac{2\pi}{m}} e_1 + \frac{\beta}{\frac{2\pi}{m}} e_q \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

angles a and β having the meaning shown in the figure, and q being the phase passing under the lower brush. If m is even, phases 1 and q are in opposition, $\beta = a$ and $e_1 = -e_q$; therefore,

$$e = \sum_{2}^{q-1} e_n + \frac{\frac{\pi}{m} - a}{\frac{\pi}{m}} e_1 .$$

If m is odd, then, when a varies from 0 to $\frac{\pi}{m}$, β varies from $\frac{\pi}{m}$ to $\frac{2\pi}{m}$ and is equal to $\frac{\pi}{m} + a$; when a varies from $\frac{\pi}{m}$ to $\frac{2\pi}{m}$, β varies from 0 to $\frac{\pi}{m}$, and is equal to $a - \frac{\pi}{m}$; the term $\sum_{2}^{q-1} e_n$ is also different in these intervals because q is not the same.

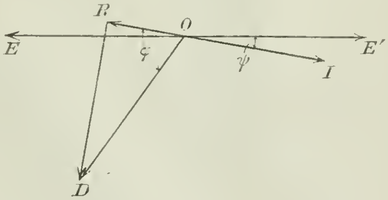

Fig. 2.

The instantaneous value of the E.M.F. E generated in a phase by the rotation in the field NS can be represented by the projection of the chord subtending this phase on the diameter MM' ; therefore, the instantaneous value of the impedance E.M.F. in this phase is proportional to the projection of the chord on a diameter inclined on MM' by the angle equal to the angle of phase displacement between E and this impedance E.M.F. In Fig. 2 let OE be the E.M.F. E, OI the current, OR the alternating current ohmic drop, RD the local reactance E.M.F. OD will then represent the impedance E.M.F. e_n. For the discussion of Fig. 1 it is convenient to use the notion of directed angles by assuming a positive direction of rotation in the plane, for instance, the counter-clockwise direction, and considering an angle, such as angle (OI, OE') between the vectors OI and OE' as represented in value and in sign by the angle, positive or negative, through which the first vector OI must rotate in order to become parallel to the second vector OE' ; since OE' is directly opposite to OE, as shown, the angle $(OI, OE') = \psi$ will be positive for lagging current and negative for leading current, lag and lead referring to the E.M.F.—E or, by approximation, to the alternating current terminal voltage.

Let r and x be the resistance and the local reactance per phase (x corrected for mutual induction in the case of overlapping phases) ; the angle (OR, OD) is then equal to $\tan^{-1}\frac{x}{r}$, and is always positive. Let φ be this angle. In virtue of the well-known relation between directed angles, for any relative position of vectors :—

Angle (OD, OE) = angle (OD, OR) + angle $(OR, OE) = -\varphi + \psi$, *i.e.*, the instantaneous value e_n of the impedance E.M.F. is proportional to the projection of the chord on a diameter $P\,P'$, such that the angle $(OM, OP) = -\varphi + \psi$.

Let I_m be the amplitude of the alternating current in a phase, and $z = \sqrt{r^2 + x^2}$ = the local impedance per phase ; the instantaneous value of e_n is then $I_m z \cos(n, OP)$. For any value of n the angle (n, OP) can be determined as follows :—

Angle $(n, n-1) = \frac{2\pi}{m}$; and angle $(OA, 1) = \frac{\pi}{2} - \frac{\pi}{m}$; therefore, angle (n, OA) = angle $(n, n-1)$ + angle $(n-1, n-2) + \ldots +$ angle $(2, 1)$ + angle $(1, OA) = \frac{2\pi}{m}(n-1) - \frac{\pi}{2} + \frac{\pi}{m} = \frac{\pi}{m}(2n-1) - \frac{\pi}{2}$; and since angle $(OA\ OP)$ = angle (OA, OM) + angle (OM, OP) $= -a + \psi - \varphi$, angle (n, OP) = angle (n, OA) + angle (OA, OP) $= \frac{\pi}{m}(2n-1) - \frac{\pi}{2} + \psi - \varphi - a$; $\cos(n, OP) = \cos\left[\frac{\pi}{m}(2n-1) - \frac{\pi}{2} + \psi - \varphi - a\right] = \sin\left[\frac{\pi}{m}(2n-1) + \psi - \varphi - a\right]$.

In the formula (1) the sum of projections $\sum_{2}^{q-1} e_n$ can be replaced by the projection of their resultant Q as follows :—

Angle $(q-1, Q) = \frac{\pi}{2} - \frac{\pi}{m} - \left[\frac{\pi}{2} - \frac{\pi}{m}(q-2)\right] = \frac{\pi}{m}(q-3)$, angle (Q, OP) = angle $(Q, q-1)$ + angle $(q-1, OP) = -\frac{\pi}{m}(q-3)$ $+ \frac{\pi}{m}(2q-2-1) - \frac{\pi}{2} + \psi - \varphi - a = \frac{\pi q}{m} - \frac{\pi}{2} + \psi - \varphi - a$.

The amplitude of a component vector being $I_m z$, the amplitude of the resultant Q is found to be $I_m z \frac{\sin\frac{\pi}{m}(q-2)}{\sin \pi/m}$, and its projection on OP, $I_m z \frac{\sin\frac{\pi}{m}(q-2)}{\sin \pi/m} \cos(Q, OP) = I_m z \frac{\sin\frac{\pi}{m}(q-2)}{\sin \pi/m}$ $\times \sin\left(\frac{\pi q}{m} + \psi - \varphi - a\right)$.

Substitution of values of Q and $\cos(n, OP)$ in the expressions of $\sum_{2}^{q-1} e_n$, e_1 and e_q in the formula (1) gives final values of the impedance E.M.F. e :—

First case, m is even—*i.e.*, $q = \frac{m}{2} + 1$.

$$e = I_m z\left[\cot\frac{\pi}{m}\cos\left(\frac{\pi}{m} + \psi - \varphi - a\right) + \frac{\pi/m - a}{\pi/m}\sin\left(\frac{\pi}{m} + \psi - \varphi - a\right)\right] \quad (2)$$

Second case, m is odd. When a varies from 0 to $\frac{\pi}{m}$, $q = \frac{m+1}{2}$ and $\beta = \frac{\pi}{m} + a$:

$$e=I_{mz}\left[\frac{\cos 3\pi/2m}{\sin\pi/m}\cos\left(\frac{\pi}{2m}+\psi-\varphi-a\right)+\frac{2\pi/m-a}{2\pi/m}\right.$$
$$\left.\times\sin\left(\frac{\pi}{m}+\psi-\varphi-a\right)-\frac{\pi/m+a}{2\pi/m}\sin(\psi-\varphi-a)\right]. \quad (3)$$

When a varies from $\frac{\pi}{m}$ to $\frac{2\pi}{m}$, $q=\frac{m+3}{2}$ and $\beta=a-\frac{\pi}{m}$,

$$e=I_{mz}\left[\frac{1}{2\sin\pi/2m}\cos\left(\frac{3\pi}{2m}+\psi-\varphi-a\right)+\frac{2\pi/m-a}{2\pi/m}\right.$$
$$\left.\times\sin\left(\frac{\pi}{m}+\psi-\varphi-a\right)-\frac{a-\pi/m}{2\pi/m}\sin\left(\frac{2\pi}{m}+\psi-\varphi-a\right)\right]. \quad (3\text{A})$$

Formula (3*A*) is in appearance different from (3); but if $\frac{\pi}{m}+a$ is substituted in place of a, a few simple operations transform it into an expression identical with (3), thus confirming the statement made in connection with the question of the frequency of the pulsations. Formulæ (2) and (3) cover all possible cases.*

Since the performance of a converter is usually referred to in terms of the direct current and the power factor, it is convenient to introduce these elements in the formulæ; neglecting that portion of the watt-alternating current which gives the torque covering mechanical and magnetic frictions—*i.e.*, assuming that the well-known expression $\frac{2\sqrt{2}}{m\sin\frac{\pi}{m}}$ is the ratio between the total effective watt-alternating current and the direct current in an armature conductor, it is found †

$$I_{mz}=\frac{8RI_d}{m^2\sin\frac{\pi}{m}\cos\psi\cos\varphi},$$

where R is the armature resistance between the direct current brushes, and I_d is the total direct current in the armature (=the line current if the shunt current is negligible). The impedance E.M.F. between the direct-current brushes is then

$m=2$ (single phase): $\left(0<a<\frac{2\pi}{2}\right)$
$$e=\frac{2RI_d}{\cos\psi\cos\varphi}\ \frac{\pi/2-a}{\pi/2}\cos(\psi-\varphi-a)$$

$m=3,\left(0<a<\frac{2\pi}{6}\right)$:
$$e=1{\cdot}026\frac{RI_d}{\cos\psi\cos\varphi}\left[\frac{2\pi/3-a}{2\pi/3}\sin\left(\frac{\pi}{3}+\psi-\varphi-a\right)-\frac{\pi/3+a}{2\pi/3}\sin(\psi-\varphi-a)\right]$$

$m=4$ (two phase): $\left(0<a<\frac{2\pi}{4}\right)$
$$e=0{\cdot}707\frac{RI_d}{\cos\psi\cos\varphi}\left[\frac{\pi/4-a}{\pi/4}\sin\left(\frac{\pi}{4}+\psi-\varphi-a\right)+\cos\left(\frac{\pi}{4}+\psi-\varphi-a\right)\right]$$

$m=6,\left(0<a<\frac{2\pi}{6}\right)$:
$$e=0{\cdot}444\frac{RI_d}{\cos\psi\cos\varphi}\left[\frac{\pi/6-a}{\pi/6}\sin\left(\frac{\pi}{6}+\psi-\varphi-a\right)+1{\cdot}732\cos\left(\frac{\pi}{6}+\psi-\varphi-a\right)\right].$$

It follows from the Fig. 2 that this expression must be added algebraically to the generated direct current E.M.F. E_d.

Since x is always much greater than r, $\cos\varphi$ is very small, and these formulæ show clearly the influence of the local reactance on the amplitude of the pulsations. Moreover, as the local flux is practically undamped, this amplitude may become even greater than expressed by the formulæ, if the impressed current wave is distorted so as to have intervals of abruptly rising current, causing sharp peaks in the local reactance E.M.F. curve.

(*To be continued.*)

Street Lighting Reconstruction Problems.

At the annual meeting of the Illuminating Engineering Society on June 24th a discussion on the above subject was opened by Mr. L. Gaster. Previous to this the annual report of the Council of the Society was presented, its formal adoption being proposed by Mr. J. G. Clark, and seconded by Mr. Geo. Herbert, who, in coupling with the adoption of the report a vote of thanks to the Council and officers, expressed appreciation of the large amount of work carried on in spite of the disturbed conditions during the past year.

The report surveyed the proceedings at meetings during the session. As a result of the latter, new committees dealing with the lighting of offices and railways and with stage-lighting are to be formed. An inquiry is also to be undertaken into various points connected with eyestrain and lighting effects in cinema theatres by a joint committee on which the Illuminating Engineering Society, the Council of British Opthalmologists and other bodies interested will be represented. It is also announced that the Society has been invited to be represented on the Conjoint Board of Scientific Societies. Reference is made to various pieces of work carried out during the war, notably the researches on flares and radioactive luminous materials for the M.O.M., and the participation in an investigation on the lighting of optical test charts. The society has been actively assisting the London "Safety First" Council in connection with lighting matters, and is also represented on the newly formed British Industrial "Safety First" Association.

Mr. Gaster, in opening the discussion on "Street Lighting Reconstruction Problems," alluded to the steps taken by the authorities to regulate the lighting of London during the war. Originally military considerations were the most important, but ultimately considerations of economy were added thereto. Three stages in control were noted, the general diminution in lighting, the adoption of screening devices giving rise to "spotty" effects, and the improved measures of screening giving more diffused and uniform lighting. Mr. Gaster considered that the predominant lessons to be learned from this experience were the desirability of diffusion of light and avoidance of excessive contrast in street lighting and the necessity for uniform procedure throughout the London area. Attention was drawn to the effect of diminished lighting in causing accidents. There is little doubt that the lighting was one contributory cause of this increase, though the way in which returns are presented makes it difficult to trace this with precision. Mr. Gaster stated that a schedule had been drawn up enabling the relation to be traced more exactly on a uniform basis, but owing to the depleted staff and other factors the authorities were unable to give the matter immediate attention. Much valuable information had thus been lost, but it was still hoped that the inquiry would be proceeded with as a measure of reconstruction.

The latter part of the address was directed mainly to showing the need for co-operation in dealing with the lighting of London. There were many different problems that were of common interest not only in London but in provincial cities, such as the relative merits of central suspension and staggered lamp posts, the best form of standard design for street lanterns, the proportion of light to be allotted respectively to the roadway and the faces of buildings, &c. This problem was quite different now from what it was a few years ago, owing to the much greater volume and speed of traffic. A motor car travelling at about 20 miles an hour covered about 15 ft. in one second. The period of time for a driver's decision was therefore very short, and if, during this brief interval, his attention was distracted by a dazzling light or by passing from a relatively weakly lighted area into one of great brilliancy an accident was liable to occur. Mr. Gaster pointed out that the chaotic nature of London's lighting was due very largely to the haphazard manner in which it had been developed according to the caprice of local authorities. He mentioned numerous cases in which there was a sudden change, not only from one system of lighting to another, but also in the order of illumination provided. Whitehall was one example. At the northern end one passed first from high-pressure gas to flame arcs, an then to the variegated and irregular lighting of Trafalgar Square. At the southern end, similarly, the transition from the bright lighting of Whitehall to the relatively subdued lighting in Parliament Square was in the nature of an anti-climax.

These transitions occurred in a very marked manner on some of the chief arterial thoroughfares. To a foreigner the changes as he passed from the Mansion House to Holborn and on through Oxford-street to the Marble Arch and to Bayswater-road were amazing. If such a diversity could not be avoided, it was at least necessary that transitions in illumination should be gradual. Similarly the change in the order of illumination in passing from side streets to main roads should be gradual, an arrangement which had already been made in some boroughs.

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* See Note No. 1.

† See Note No. 2.

Mr. Gaster pointed out that each street should be considered on its merits, and lighted according to its needs, not according to the locality it happened to be in. He suggested as a first step a survey of the streets of London, with a view to classifying them in order of importance according to the grades in the Standard Street Lighting Specification, and providing illumination according to grade. The lighting of London might well be considered by a joint committee, on which the Illuminating Engineering Society, the London "Safety First" Council, and other bodies and authorities concerned should be represented; the committee acting as a centre of information and advising generally on street lighting problems in order that uniformity of action throughout London might be attained. It was also suggested that it would be a great help towards the improvement of lighting in London if some attempt could be made to co-ordinate public and private lighting, so that the latter might be an assistance and not a menace to traffic. In this connection the hope was expressed that those responsible for illuminations in celebration of Peace would endeavour to secure their effects by diffused methods, such as the lighting of appropriate mottoes and emblems rather than by the assembly of masses of bright lamps at a low level, which would prove a distraction to drivers and might lead to accidents, in view of the crowded nature of the streets.

Electric Welding: Its Theory, Practice, Application and Economics.*

By H. S. MARQUAND.

(*Continued from page* 18.)

Summary.—In the present article the author deals with the preparation of welds and then passes on to certain properties of iron and mild steels which have a marked bearing on the methods adopted. The welding of copper and copper alloys has not received very much attention, but electric welding is nevertheless applicable to such work. Finally, examples are given of various types of welding.

APPLICATIONS.

There is no longer any question that large savings in time, labour and money can be secured by electric arc welding; not only when used to repair work, where it is finding an ever-widening field of application, but also as a definite manufacturing process.

Its application is daily extending in carrying out such work as :—

- Varied kinds of ship construction and repair work.
- Repairs to steel castings.
- Repairs to steel and iron forgings.
- Repairs to cast iron and malleable iron castings.
- Manufacture of pipes of all shapes and sizes.
- All kinds of tramway repair and constructional work, both factory and track work.
- Manufacture of tanks, barrels, seamless boats, drums, cylinders, boilers, steel wagons, motor cars, vats for breweries, converter shells, annealing pots, transformer housings, oil refinery equipment, cotton mill machinery, fans and blowers.
- Repairs to rolling mill wobblers and pinions, repair to automobile parts, toothed wheels, building up of worm shafting, and many other phases of engineering construction far too numerous to mention here.

The Steel Barrel Company, of Uxbridge, have extensively applied the Benardos system to the manufacture of steel barrels, tanks and drums of all sizes and for numerous purposes, such as the transport of motor spirit, acetone sulphuric acid, oils, bi-sulphide of carbon, benzol, petroleum and many chemical products.

A longitudinal joint being welded is shown in Fig. 44 by the carbon arc. The sheet steel is rolled into shape, fixed on the anvil with the free edges abutting, and the joint heated with the arc to a fusion temperature, new metal being added to thicken up the joint.

When the desired degree of heat is attained, the welder puts aside his electrode, applies the swage and toughens up the joint. The method of fixing the ends is interesting. The ends are slightly dished, flanged outward (generally), inserted into the ends of the cylindrical body, and a band of like material dropped over the outside and inside of the flange flush with the ends, and the four thicknesses fused and welded together.

To prove the efficiency of this system and the strength of the welds, a drum (Fig. 45) was dropped several times from a height, culminating in 19 ft., on to a solid iron bed. The bung, a wooden shive knocked lightly into a 1½ in. tapered neck, did not move. Fig. 46 shows the drum after being thus dropped seven times. There was not found to be the slightest leakage or fracture.

Recently Mr. T. T. Heaton, of the Steel Barrel Company, carried out drastic tests on electrically welded steel plating. A number of cylinders, about 1 ft. long by 10 in. outside diameter, of open hearth mild steel of 26 tons per square inch tensile strength, ⅜ in. thickness, were welded longitudinally. The cylinders were compressed by means of hydraulic dies to about 4½ in. diameter at one end. The cylinders were reduced

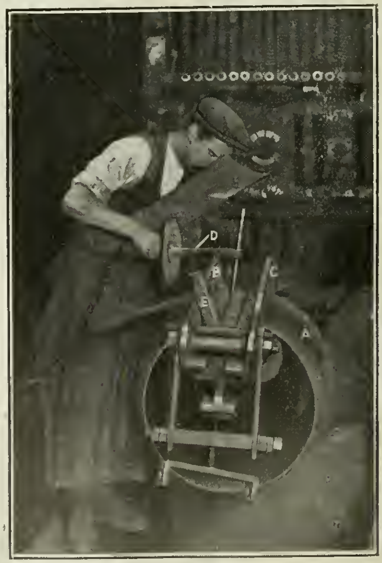

Fig. 44.—Carbon Arc Welding.
(*A*) Drum; (*B*) and (*C*) Clamps; (*D*) Electrode Holder; (*E*) Swage.

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in three stages, the first compression being very severe reducing the diameter by 4 in. All the cylinders (Fig. 47), welded by first class workmen, withstood the operation quite successfully. Mr. Heaton points out that mild steel plating of about 3 mm. to 4 mm. in thickness can be welded, including working the metal, so as to be sound and petroleum-tight at the rate of 2·76 minutes per foot of weld, and other fused welds at the rate of 1·22 minutes per foot of actual welding. Carbon electrodes of 15 mm. diameter are consumed in welding ½ in. thick mild steel at the rate of 8 in. per 50 ft. of welding.

Another important and successful application of the Benardos system is to be found in the attachment of flanges, branches, bends, "T" pieces, &c., to steel and iron tubes or pipes. This process was first adopted at Halisowen, Birmingham, about 1891, and has been in constant use ever since.

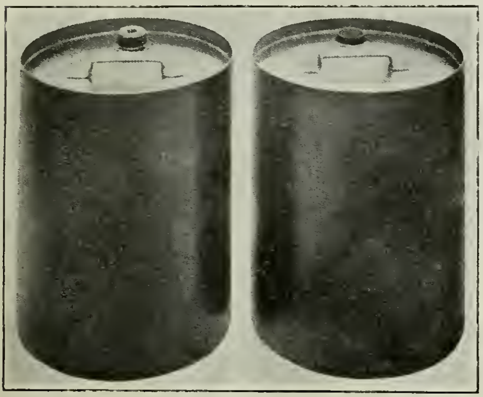

FIG. 45.—DRUM BEFORE TESTING.

The method of welding flanges to steam pipes is shown in Fig. 48. The flange is prepared in such a way that a "V" shaped groove is left on the inside, as shown in diagram 2, extending nearly through the thickness of the metal. The flange is then shrunk on a tube, with flat face outwards, or at the end of the tube, and is carefully let into the required position (diagram 3).

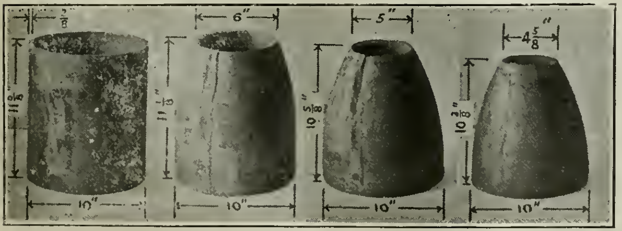

FIG. 47.—BERNARDOS ELECTRICALLY WELDED CYLINDER AND RESULTS OF THE THREE COMPRESSIONS.

Small pieces of steel are laid in the "V" and then welded in by the flame of the arc. The weld should be well hammered between each heat. The welding is carried out right round the back of the flange, and is filled up sufficiently to form a radius of about 1¼ in. 2 in. The flange is thus solidly built to the tube at the back (diagram 4).

The tube is then up-ended (diagram 5) and the outer side of the flange is welded to the tube. In this operation the arc itself is utilised to burn out the metal down to where the first weld commenced: this portion is then filled up and welded as before.

Branches, outlets, "T" pieces, &c., are welded to tubes in very much the same manner as flanges. The branch is cut off to the required length, and a hole is burned into the tube by means of the arc. The branch is then fixed into the hole and welded in the manner already described. All kinds of bends, expansion pipes, tees, &c., can be welded to steel pipes with the most excellent results.

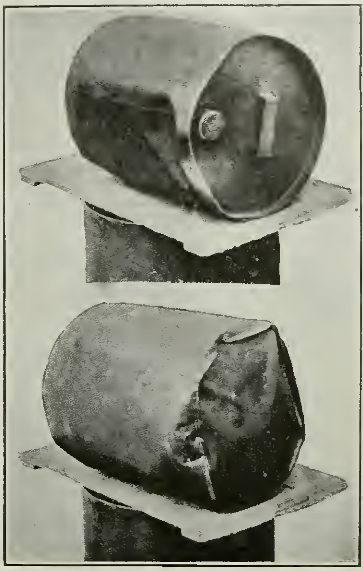

FIG. 46.—DRUM AFTER TEST.

Capacity—5 gallons.
Dimensions—15 in. long by 12 in. diam. by 19 S.W.G.
Weight—Empty, 10 lb.; full of petrol, 49 lb.

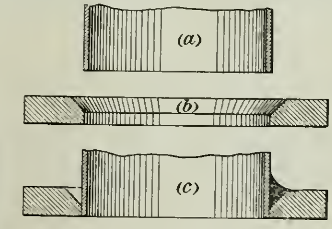

FIG. 48.—FLANGE WELDING.

(*To be continued.*)

Some Special Uses of Electric Fans.*

One of the very first electrical appliances to be introduced after electric lamps came into general use was the portable electric fan. About 1890 the first of these fan motors, as they were called in the early days, was introduced and met with instant popularity as a means of creating a cooling breeze in offices. Electric fans have since been rapidly developed in efficiency, portability, appearance and general utility; the price has been considerably reduced (except during the abnormal period of the war). Throughout these 30 years the electric fan has been primarily used during the relatively short torrid season of midsummer. However, it is still used inefficiently for this purpose in many cases.

Some special instances of the use of electric fans, for assisting ventilation and the distribution of heat will now be given. One of the interesting developments of last year was the placing of large orders for electric fans by various branches of the Government that were most active in the conduct of the war. Thousands of electric fans helped materially in keeping offices, hotels and living quarters fairly comfortable in spite of the crowded conditions prevailing. The same also was true in offices and munition plants, shipyards, mills, &c. In hospitals the electric fan was also found indispensable. At a New York hospital careful experiments were conducted that showed that the vitality of patients in air that was kept in motion by means of electric fans was about 34 per cent. higher than that of the same persons lying in still air, in each case the same temperature prevailing. In the army base hospitals electric fans were constantly used to improve the health, comfort and morale of sick and wounded soldiers, to force all unpleasant odors and smoke from the buildings and to keep a current of pure air in motion throughout the wards. Electric fans were used in many places where food was stored or displayed for sale to keep myriads of germ-laden flies from poisoning the food. The United States Food Administration advocated the use of fans as an aid in drying fruits and vegetables, instead of the customary methods of preserving them by boiling. In this way stocks of sugar that otherwise would have been required were saved for other highly necessary purposes.

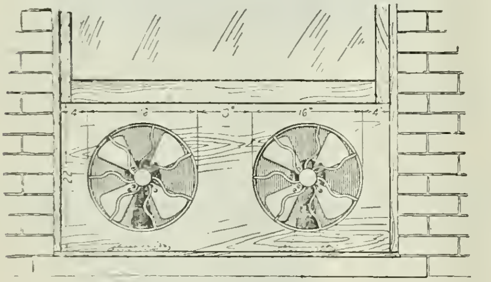

Fig. 1.—Showing Use of Two 16 in. Desk Fans on an Elevated Window Sill to Remove Vitiated Air from a Large Room.

As a special instance of the utility of fans in promoting ventilation the installation of two ordinary desk fans in one of the basement windows of the Chicago Post Office is of interest. The room in which this additional means of ventilation was found necessary is a very large one. It has a fairly high ceiling but the windows are placed so that their sills are approximately 7 ft. above the floor. A mechanical system of ventilation was provided which proved inadequate in winter. The air in the room became close and stuffy and the efficiency of the many clerks employed was lowered. During the summer it was customary to open these windows wide and get considerable natural ventilation. It was found that in order to aid the mechanical system in winter it would be necessary either to provide additional exhaust fans or their equivalent. A considerable number of desk fans are employed in the building in the summer and as a rule these have been stored away during or before October, and again brought out in May. By fitting up a board approximately as shown in the sketch and placing it in the opening when the lower sash was raised it was possible to place these fan directly on the window-sill and turned so as to blow outward, thus very materially increasing the removal of vitiated air. In this room two windows have been fitted up in this way, and excellent results obtained. In other rooms the same scheme is being used. This method is not recommended in place of regular exhaust fans placed in the upper sash of the window. In this case, however, the sills being high and the additional ventilation being needed only during winter when the desk fans were not in use, the plan works out very advantageously.

There are many cases where ordinary desk fans can be utilised as aids to ventilation. Sometimes for blowing fresh air in they may be placed on the sill. Oscillating fans are a material aid to improved air condition, for they may be used to drive the air in the general direction of the exhaust outlets while at the same time stirring it up and keeping it in active circulation. This has been done successfully in many theatres and picture palaces.

An electric fan can also be of such valuable assistance in heating a house by distributing more of the heat and allowing less of it to slip away up the chimney.

Every householder, whether he is using a hot-water, steam or hot-air system, can save money and coal. Let us suppose that a closed room is to be heated with a single radiator which receives its heat supply from a hot-water boiler. The effectiveness of such a radiator depends on two things: First, the rapidity with which heat is supplied to the coils in the boiler; second, the speed with which the heat is carried away from the system into the room. The first object is to get the water as hot as possible in the furnace and send it back from the radiators to the furnace as quickly and as cool as possible. If it could be sent back at room temperature the system would be working at highest efficiency. Consider what happens while the room is heating. First, the air directly around the coils is heated; second, the heated air rises to the ceiling; third, a layer of hot air spreads over the room; fourth, it gives up its heat to the ceilings, walls and surrounding air; fifth, it drops to the floor; and sixth, it flows back to the base of the radiator to begin the cycle all over again. There are only two ways by which the efficiency of a convection system of this sort can be improved, by adding more coils to the radiators, and by increasing the speed of the circulating air, that is, by forcing a current of air past the coils to carry off the heat more rapidly. The first way involves more expense, the latter involves only a small investment in a fan, which can be used both summer and winter for many years. In a steam-heated house, the heating of a room is indicated both by the movement of air and by room temperature taken at the point farthest removed from the radiator. When forced circulation is introduced, the change made in the normal conditions is really surprising.

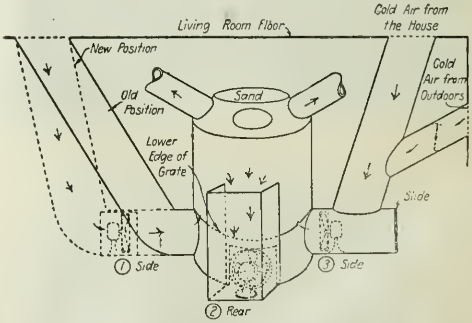

Fig. 2.—Three Different Positions in which an Electric Fan may be Placed to Aid Furnace Heating.

An electric fan may also be used to increase the efficiency of a hot-air furnace. A furnace used to heat a seven-room house had four risers to carry hot air to the various parts of the house. Cold air was taken from the basement. Normally this furnace could not keep more than three risers hot at a time. Much coal was wasted in trying to keep the house warm until the owner hit on the plan of blowing the cold air into the heating jacket with an 8-in. fan. There has not been the slightest difficulty since the new plan was adopted. The United States Fuel Administration for Illinois has prepared the second illustration showing how an electric fan may be placed in any of the three different ways to aid in accelerated circulation of the air through a furnace. If the side return is short and closed, as shown at (1) at the left, it is swung back and a short connecting piece is inserted into which the fan is placed. If the cold-air inlet is open to the basement and placed as at (2) at the rear, the fan is merely placed at the base of this inlet chamber. If a side inlet is provided with a removable slide as at (3) at the right, this slide is merely opened and the fan inserted to the position shown dotted. It may be necessary to place a block under the fan base to give it a firm support when setting it in a round pipe. These arrangements in no way effect the firing except that much of heat generated, which would otherwise go up the chimney, is by this method absorbed by the increased air volume passed through the jacket of the furnace and sent into the living rooms. The cost of current used is negligible compared with the coal saved, which varies from 10 to 25 per cent., and the circulation of heated air throughout the house is much improved.

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* Abstract of an article in the "Electrical Review and Western Electrician."

The British Scientific Products Exhibition.

On the opening day of the British Scientific Products Exhibition, Thursday, July 3rd, a meeting of the technical press, called by the Circle of Scientific, Technical and Trade Journalists, was held at the Central Hall, Westminster, at 11.30 a.m., at the invitation of the Organising Committee, thus repeating the arrangement made on a similar occasion last year.

Mr. Leon Gaster, Chairman of the Circle, who presided, expressed the pleasure of those present at again hearing an address from Sir Richard Gregory, Chairman of the Organising Committee, on the aims and objects of the Exhibition, and took the opportunity to congratulate Sir Richard on his knighthood. The exhibition was opened in circumstances very different from those prevailing last year. Wonderful resource had been shown by British manufacturers and scientists in overcoming the problems set them by the war. In future it would, however, be necessary to determine which of the new industries to develop, which might become permanently successful and which demanded co-operation with other countries. Pre-eminence could only be secured if this country continued to encourage the application of science to industry, and the training of research workers. The excellent exhibition catalogue showed how much had been done, and the survey of research at leading colleges and industrial laboratories was a useful feature. He would like, if possible, to see a similar survey of the work of leading scientific and technical societies in a future edition. After the great wars of the past there had been periods of unrest followed by recuperation. By the aid of the incomparably greater scientific resources of modern times the period of recuperation should be hastened.

Sir Richard Gregory recalled that this was the second exhibition of the kind, organised under the auspices of the British Science Guild, and it again afforded many examples of the supremacy of this country in the field of invention. Additional instances of the part played by science during the war could now be mentioned. Accurate forecasts of conditions in the upper atmosphere had been of great value in aeronautical work, the organisation of the medical service for the prevention of disease had been a veritable triumph, and the universities, whose achievements were referred to in the catalogue, had rendered inestimable service in meeting many new and unforeseen problems. The work done by scientific and technical societies had been equally valuable, and he wished it had been possible to include a summary of this as well. But the work was so vast in scope that it was impossible to do justice to it in a catalogue of reasonable size.

Passing on to specific inventions, Sir Richard pointed out how, again and again, discoveries had been practically applied in ways quite unforeseen by the discoverers. He referred to the discovery of helium fifty years ago by Sir Norman Lockyer and its separation twenty-six years after by Sir William Ramsay. Early in the war the Admiralty Board of inventions had inquired into the production of helium on a practical scale for air-ships, where its lightness and non-inflammable qualities were of great value. This information was subsequently communicated to the United States, where helium was produced in large quantities at a cost of one shilling a cubic foot. If the Germans had been able to produce helium on this scale the history of the Zeppelins would have been very different. Among other inventions Sir Richard referred to the oxygen apparatus developed for the use of aviators at heights of 20,000 ft., which was on view at the Exhibition, and to Langley's original researches on flight. Yet another instance of unforeseen applications was to be seen in wireless telegraphy. Marconi's epoch-making work was based on theoretical researches of Maxwell, Hertz and others, and the oscillatory valves which, more recently, had been so successfully applied to wireless problems were based on many theoretical researches on electrical conductivity in rarefied gases. A feature of the Marconi exhibit was the wireless telephone installation, utilising such valves, with a range of 60, and in favourable circumstances 120 miles. It had frequently been asserted that the German range-finders were better than ours, but this view was erroneous, and the apparatus of this type shown in the Exhibition was of notable interest.

Many other examples of the application of science to industry to be seen at the Exhibition, were mentioned, and in conclusion Sir Richard quoted from the recent evidence of the Hon. W. C. Redfield, Secretary of Commerce to the United States who ascribed Germany's industrial success *first* to the general appreciation of science that underlay each industry, and *second* to the training of the mind as well as the hand of the worker, so that he understood not only *how* to do a thing, but *why* he did it in a particular way. There was a danger, now that the pressure of war was over, that things would be allowed to drift back into the old way; constant effort was needed in order to maintain the ground won, and to apply scientific methods to other industries where they had not yet been used. It was the aim of the British Scientific Products Exhibition to supply an incentive in this direction.

A vote of thanks to Sir Richard was moved by Mr. Davis, seconded by Mr. Percival Marshall, and carried unanimously, and also a vote of thanks to the Organising Committee for their invitation. Lt.-Col. O'Meara, in a brief response, expressed the appreciation of the organisers of the exhibition of the power of the press, which he was glad to think would be strongly exerted in favour of the objects which they had in view.

The visitors then dispersed in order to obtain a preliminary view of the exhibition, which was formally opened at 2.30 p.m. by the Marquess of Crewe, supported by the Rt. Hon. Lord Moulton, Sir Alfred Keogh being unavoidably prevented from taking part. The chair was taken by the Lord Sydenham, President of the Guild.

On this occasion only a brief reference can be made to the exhibits, and fuller descriptions of specific objects of interest will be given in future issues. The arrangements were not quite complete on the opening day, but the general manner in which exhibits are presented appears to be an improvement on last year. The grouping adopted in the Central Hall enables any section to be quickly and easily visited, and the exhibits are less scattered. The Hadfields exhibit adjacent to the entrance is again a prominent feature, and further inside the hall the display of range-finders by Barr and Stroud is conspicuous. Electrical instruments are well represented, for example, in the group representing leading manufacturers, arranged by the British Electrical and Allied Manufacturers' Association. Optical appliances are similarly dealt with in the display of the British Optical Instrument Manufacturers' Association, and the display of optical glass is again impressive. Among electrical exhibits special mention may be made of the Marconi stand where the wireless direction finder, and the short-range wireless telephone set, attracted much interest, while the gyrostats showed by Elliott Bros., Ltd., were examined by many visitors, a feature being the fine workmanship of these small enclosed induction motors, with their air-clearance not exceeding one-hundredth of an inch. Resistances, micanite insulation and Dubilier mica condensers are among the other objects of interest, and there are some good examples of heating apparatus, electrically-heated clothing for airmen, &c.

The catalogue of the exhibition is again a well got up publication of permanent interest. As on the last occasion, the introductory matter is at least as interesting as the actual record of exhibits, a feature being the four introductory sections dealing respectively with war work at the universities and other institutions, works research laboratories, industrial research associations, and the list of selected scientific and technical books. An introduction by Sir Richard Gregory, Chairman of the Organising Committee, is included.

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The Division of the Product of Industry.

It is a common belief that if the incomes of the rich were divided among the remainder of the community everyone (except the expropriated rich) would be comparatively well off. This idea is largely due to the fact that the subject is looked at from only one point of view. When the statement is read that 12,400 persons in 1911-12 had incomes of over £5,000 per annum, aggregating £152,000,000, the natural inference is that this sum would go a very long way towards making other people well off. It is, however, generally forgotten that taxed incomes have to provide a great part of the expenses of the Government and also the savings from which capital is obtained for industrial purposes. Further, it is forgotten that a comparison is drawn between millions of people with a small income and thousands who have a large income. When millions of people are concerned, the addition of a comparatively small amount per annum to their income runs, in the aggregate, into very large figures, and conversely the incomes of the rich, when spread over a multitude of millions, cannot go very far.

Although these elementary statements may be sufficient for many people it is well to have an authoritative discussion of the whole subject, and this has now been provided by Dr. Arthur L. Bowley.* In this small book statistics are given of the aggregate income of the population of the United Kingdom, the national wages bill, and analyses of wages, salaries and profits in the principal industries. A work of this kind is naturally too statistical to be read very widely, but Dr. Bowley, who is Professor of Statistics in the University of London, has done a considerable service in carrying through such an examination, which we hope will be perused by at least those who put forward Socialistic doctrines. The introduction is headed by two statements. The first is by Sydney and Beatrice Webb, to the effect that the manual working class obtain for all their needs only one-third of the produce of each year's work; whereas the second is a statement in the other direction by Sir Hugh Bell to the effect that 75 per cent. of the total sale value of the commodities produced go to pay the persons engaged in producing them. Dr. Bowley comes to the conclusion that neither of these statements is correct. He obtains a figure of 68 per cent. as compared with Sir Hugh Bell's 75 per cent., or 58 per cent. for wages alone.

We suppose that one way which would find favour with certain Socialists would be the reduction of all salaries to a common level. For example, salaries might be reduced to £160 per annum as a mean figure, and everything in excess of this value would be transferred to wages, though presumably wages in many cases would also have to be reduced. As to the effect which would be produced by this reduction in salaries, we need say very little. There is no doubt that the efficiency of industry would suffer enormously, as those who had been accustomed to higher salaries would undoubtedly go to some other more favourable part of the world for their activities.

In dealing with such a subject it is necessary to take the pre-war state of things and to assume output as it then was. For this purpose statistics are available, though not as complete as is desirable, but under definite conditions. When the apparent surplus so obtained is reduced in one way and another (for example, to provide income tax, rates, &c.) a net sum is reached that might be available for distribution. Dr. Bowley finds that the sum so obtained, assuming that all salaries are reduced to £160 per annum, would be little more than sufficient to bring the wages of adult men and women up to the minimum of 35s. 3d. weekly for a man and 20s. for a woman, which Mr. Rowntree in "The Human Needs of Labour" assumes is reasonable. The conclusion must be drawn that the spendable wealth of the nation derived by home industry has been grossly exaggerated by loose reasoning. Whether more will be available in the near future remains to be seen. One thing is at least certain: namely, that increased wealth can only be obtained by increased production. As Dr. Bowley remarks: "The wealth of the country, however divided, was insufficient before the war for a general high standard; there is nothing as yet to show that it will be greater in the future. Hence the most important task—more important immediately than the improvement of the division of the product—incumbent on employers and workmen alike, is to increase the national product, and that without sacrificing leisure and the amenities of life." These are simple facts that must be borne in mind and that cannot be avoided.

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* "The Division of the Product of Industry: An Analysis of National Income before the War," by A. L. Bowley, Sc.D. (Oxford: The Clarendon Press.)

Reviews.

A System of Physical Chemistry. By Prof. W. C. McC. Lewis, 2nd edition. (London: Longmans, Green & Company.) Vol. I. Kinetic Theory, pp. xii.+494, 15s. net; Vol. II., Thermodynamics, pp. vi.+403, 15s. net; Vol. III., Quantum Theory, pp. viii.+209, 7s. 6d. net.

The favourable reception accorded to Prof. Lewis's text-book when first published will be more than confirmed by the second edition, which has just appeared. The book has been considerably extended and brought up to date, and it now has strong claims to be regarded as the best fairly comprehensive account of the subject in any language. Unfortunately the cost—37s. 6d. net—will place it beyond the reach of many students, except as a work of reference in libraries.

The plan of the work is the same as in the first edition, except that the account of the quantum theory has been expanded from a single chapter to a separate volume. Among the new additions to Vol. I. may be mentioned the investigation of crystal structure by means of X-rays, various properties of the colloidal state, the dual theory of homogeneous catalysis, and Langmuir's theory of heterogeneous reaction velocity, catalysis and the mechanism of surface effects generally. The principal change in Vol. II. is the inclusion of a new chapter dealing with osmotic pressure and the modern theory of dilute solutions. The latter volume also includes a brief consideration of entropy, more particularly with the object of leading up to Boltzmann's probability-entropy relation in statistical mechanics.

In the new sections, as in the old, the author has considerably lightened the labour of compilation by his readiness to use long extracts from other writers. Thus, his account of the present position of the subject of solutions of electrolytes is taken almost entirely from the admirable summary by Bates. Fortunately the author shows such good judgment in his borrowing that little disadvantage is thereby involved.

A careful examination of the first two volumes reveals very little that calls for criticism and much that is admirable. The presentation is well-balanced and up to date, and makes easy and interesting reading. Special acknowledgment is due for the clearness and thoroughness with which the thermodynamical sections are set out. It would have been of advantage if the earlier part of Chapter VIII., Vol. II., dealing with the mechanism of osmotic pressure, had been written in a more critical spirit. In Vol. I., p. 53, it should have been mentioned that later workers have failed to confirm the statement of Collie and Patterson that "neon can be detected in hydrogen after the passage of the electric discharge through the latter at low pressure." The statement on p. 548, Vol. I., that "in reactions which are catalysed either by colloidal metals or by enzymes the temperature coefficient for a 10 deg. rise is at least 2," is inaccurate, but the argument is not greatly affected thereby, as the coefficient for the systems mentioned is certainly higher than where solid catalysts are employed.

Vol. III. contains an account of the remarkable theory of quanta, which, first put forward by Planck many years ago to account for radiation phenomena, has since been applied, more particularly by Einstein and by Nernst, to certain other departments of physics, with highly suggestive results. The author gives a clear account of the bearing of the theory on the atomic heat of solids, the molecular heat of gases, the structure of the atom and photo-chemical reactions. The chapters on specific heats and on the structure of the atom are particularly interesting. The discussion shows sufficiently the fundamental importance of the quantum theory but it is also made clear that the latter is far from having attained its final form. Indeed, Planck himself has been led to modify the theory by assuming that whilst the emission of radiant energy takes place in quanta, and therefore discontinuously, absorption can take place continuously.

Vol. III. has three useful appendices, one giveing an account of Krüger's theory of gyroscopic molecules; the two others, by Mr. James Rice, M.A., deal respectively with the principle of the equipartition of energy and with the foundation of the quantum theory.

The author is to be congratulated on the production of a work which is indispensable to everyone who wishes to make himself familiar with the latest developments of a rapidly growing subject. G. Senter.

The Division of the Product of Industry: An Analysis of National Income Before the War. By A. L. Bowley, Sc.D. (Oxford: The Clarendon Press.) Pp. 60. 2s. 6d. net.

We deal with this book in our Leading Article.

Some Features of the Deptford Power Station of the London Electric Supply Corporation.

Our readers are well aware that the electricity undertaking of the London Electric Supply Corporation has had an eventful career. It began with a portable plant behind the Grosvenor Gallery so far back as 1883, though the London Electric Supply Corporation was not formed until 1887, when the Deptford power station was erected. The undertaking has been remarkable as being the first in the world to use high-tension transmission. In fact, it may be looked upon as the forerunner of the popular idea of the present day, namely, the super-power station erected at a favourable waterside site and making use of high-voltage generation and transmission to its areas of supply. Unfortunately, the idea, although sound, was originated by Mr. Ferranti very many years before the engineering world was ready to accept it, and consequently the London Electric Supply Corporation had a somewhat chequered career in the early days. Those times, however, are passed and the undertaking has been for a long time one of the most successful in the London area.

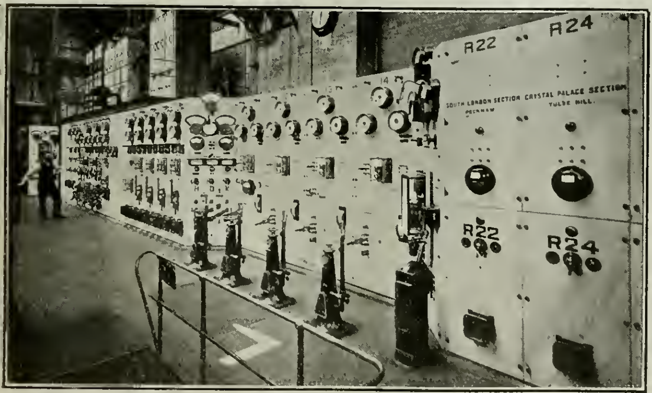

Fig. 1.—View of the Traction and Power Switchboard.

Having tasted misfortune in this way it might be thought that this power station, which has the largest output in London should, in all fairness, have escaped difficulties during the period of war. This, however, was not to be, and in 1916 the station had the misfortune to be struck by a Zeppelin bomb. This was 250 lb. in weight, and consequently of a seriously destructive character. It fell on the operating gallery of the traction and power control switchboard and naturally caused a great deal of havoc. Practically the whole switchboard was wrecked and an attendant near by was killed. One side of the station which is closed in by corrugated iron sheeting, in order to facilitate extensions, was partly blown out, and, of course, practically all the glass in the roof, some 2,500 squares, came down into the engine-room. In Fig. 1 is seen a view of the renewed switchboard. The bomb fell near the spot of sunlight a few feet in front of the head of the stairway on the operating gallery. The effect of this catastrophe which occurred at 1.37 a.m. on August 25, 1916, was to shut down the whole station. Fortunately, it was possible to continue the greater part of the lighting supply within about 10 minutes. The unravelling of the maze of wires and the connecting-up of temporary controls was immediately proceeded with, and the traction generators for the London, Brighton & South Coast Railway and local power supplies were put direct on to the service by this means, the supply to the local power system being resumed within five hours, and the whole supply, including the railway service, in less than 24 hours from the time of the explosion, which must be regarded as something of a record, and reflects much credit on the energies of the engineering staff.

An interesting feature of the explosion, owing to the bomb not hitting the engine room level, was the smallness of the area severely affected. An interesting phenomenon occurred in the assistant engineer's office, which is a wooden structure high up on one side of the station. A sheaf of loose papers was hanging on a nail inside this office and after the explosion it was noticed that this sheaf, instead of being inside, was outside the office. Examination showed that the woodwork had been split and momentarily had opened sufficiently to allow the papers to be blown through. These are now protected by a glass case as a monument to the work of the Hun.

Through the courtesy of Mr. G. W. Partridge, chief engineer of the Company, we had an opportunity of inspecting some of the more recent features of the station last week.

The plant at Deptford, worked under the able supervision of Mr. M. Feetham, the Company's chief superintendent engineer, was described at some length in THE ELECTRICIAN of August 9 and 30, 1912, so that we need not refer to it at any great length. We may mention, however, that the turbo-generator plant has been increased. A 3,000 kw. Oerlikon set, running at 2,500 revs. per min., was put down in 1916. Two larger sets, having a normal rating of 7,500 kw., are running at 750 revs. per min. These are Brown-Boveri generators driven by Parsons impulse reaction turbines, and were installed in 1912

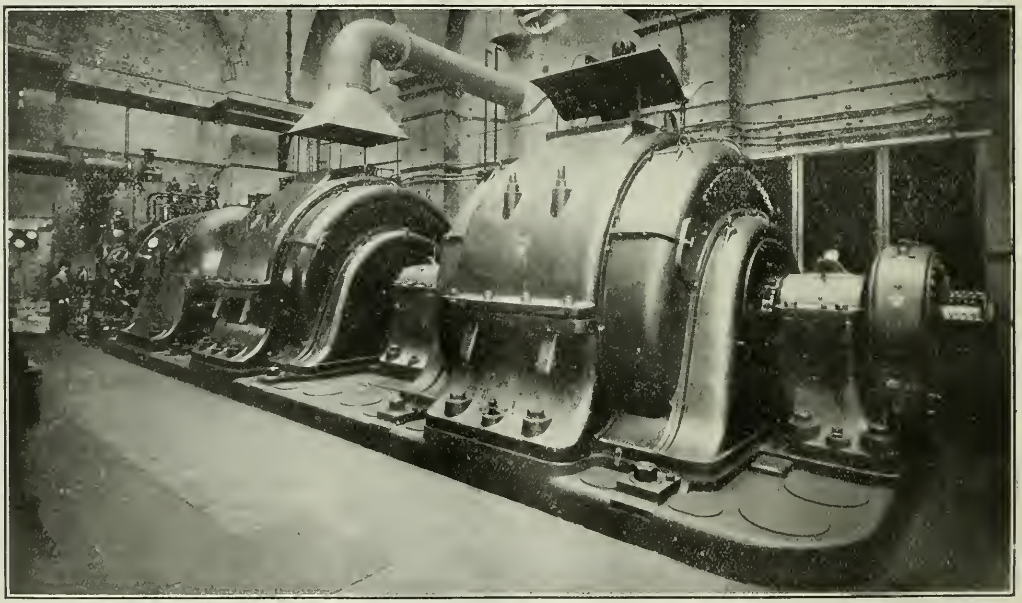

FIG. 2.—VIEW OF THE 15,000 KW. TURBO TANDEM SET.

The latest and somewhat belated addition is a large set, which is shown in Fig. 2, comprising a 15,000 kw. impulse reaction turbine, by Richardsons, Westgarth, and two alternators in tandem, by Brown-Boveri. One of these is of 7,500 k.v.a., and the other of 12,000 k.v.a. The former is single-phase, and the latter may be run either as single-phase or three-phase. Both give a pressure of 6,600 volts at a frequency of 25. By means of this plant the whole of the single-phase traction and three-phase power can be generated by one turbine, except at peak loads. It will be noticed that above one of these machines there is a duct for carrying off a certain amount of the heated air. This is used in connection with a water-spray air washer. It has been found that if a filter of this kind is placed near the machine the insulation is affected owing to deposition of moisture. This objection can be avoided by placing the filter at a suitable distance, so that any moisture is deposited before the air reaches the machine. On the other hand, if it is placed outside the building it is liable to become frozen up in the cold weather. In order to avoid this objection a certain amount of the warmed filtered air is carried back to the filter from the duct here seen and thus maintains the temperature at such a figure that no difficulty is experienced from freezing. This supply of warmed air intermingling with the cold air passing through the water screen has also been found to play a very important part in preventing condensation in the coils of the machine, which otherwise has been found to take place under certain atmospheric conditions and at periods of light load, causing the insulation resistance to fall away. The amount of air so used is readily varied by means of a damper in the discharge pipe.

Among the switchgear we noticed an interesting automatic earthing switch in connection with the supply for traction purposes. The cable for this supply, which is single-phase at a pressure of 6,600 volts, is earthed at the railway end only, there being no permanent earth at the power station. Consequently, if a serious short-circuit occurs the drop in the outer conductor of the concentric cable may cause the power station end to reach a pressure above earth which might be serious for the insulation. Consequently, the device in question is inserted as a protection, as shown in Fig. 3. If the voltage on the outer at the station end exceeds a certain pre-determined value of, say, 750 volts, a small current is forced to earth through the high resistance shown in the diagram. This current, operating through a relay, automatically closes the earthing switch, putting the outer straight to earth, and at the same time rings a bell which calls the attention of the switchboard attendant, who, as soon as normal conditions again prevail, opens the switch by hand. Thus a potential of 750 volts between the outer conductor and earth cannot be exceeded.

During the war the Deptford station, like many others, has found it necessary to put up with most inferior fuel. Not only has the ash content varied between 25 and 30 per cent., but the class and nature of fuel has also differed widely and this has rendered it very difficult to obtain efficient results. Uneven distribution of the coal on the grate is particularly liable to occur when using slack coals, owing to the coal burning more rapidly in some parts than in other parts, and the inequalities in the burning fuel bed are found to vary considerably with the size, nature and quality of the coal which differs according to locality. This difficulty has been overcome by a special furnace door, designed by Mr. Fox, one of the Company's engineers at the station. This consists in making the door of the Babcock grate in a number of sections; for example, eight sections instead of the single door, which is usual. The ordinary method is to raise or lower the door and vary the thickness of the fuel bed as a whole. By means of the present device any section of the door can be varied so as to vary that part of the coal bed to which it corresponds, thus allowing of local irregularities of the fire thickness being corrected as occasion demands, and at the same time the door as a whole can be raised or lowered if desired. The wasteful condition which results from an uneven fire fringe is indicated in Fig. 4, and the advantage of a device which avoids this fruitful source of loss will be obvious. In the present arrangement each section of the door is lined with firebrick and is fitted with renewable shoes, so that the replacement of burnt parts is not a serious matter and can be quickly carried out. The overheating and resulting distortion so frequent with the continuous type door commonly in use is very considerably avoided by this sectional form with its heavy shoe brick, as will be noted from the illustrations, an advantage which engineers will readily appreciate. Fig. 5 shows a complete door and Fig. 8 a section.

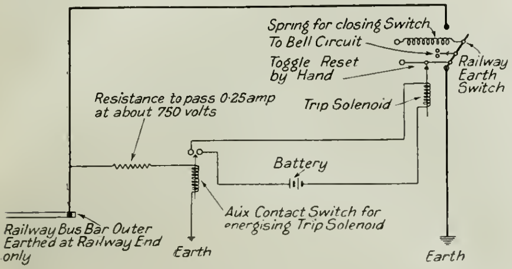
Spring for closing Switch
To Bell Circuit
Toggle Reset by Hand
Railway Earth Switch
Resistance to pass 0·25 amp at about 750 volts
Trip Solenoid
Battery
Aux Contact Switch for energising Trip Solenoid
Railway Bus Bar Outer Earthed at Railway End only
Earth
Earth

Fig. 3.—Diagram of Connections of Railway Earthing Switch.

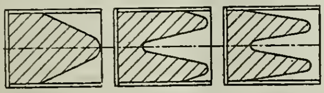

Fig. 4.—Plan Diagrams of Grate, showing Uneven Distribution of Coal. (Furnace Door to the Left.)

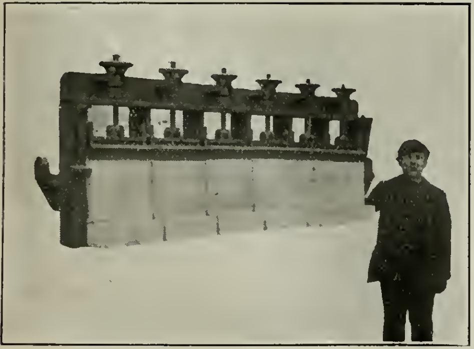

Fig. 5.—Furnace Door in Sections.

Another interesting and novel device is an adjustable dumping bar fitted at the rear end of the grate. It has been found that some coals tend to "spread" or assume a very open formation on the grate when being burnt, and in order to prevent excessive air leakage it is essential that the fuel bed should be held together or compressed by a dumping bar or dam of a form such as is indicated in Fig. 6(a), a type of fixed bar which is commonly in use. Unfortunately, however, while this bar has the advantage of holding the fuel bed together, it prevents the evacuation of the ash and clinker, which, in the case of the inferior coals referred to, soon spread over the grate and choke it up. On the other hand, if the low type of fixed bar, as shown in Fig. 6(b), is used, the grate may be kept free from clinker, but there is nothing to hold the burning fuel together, with the result that it breaks through into blowholes, excessive air leakage takes place, with cascading of partly burnt fuel over the back end. The adjustable bar referred to above and indicated in Fig. 7 has been very successful in overcoming this difficulty. As seen in Fig. 7(a) the bar is set in the high position, forming a substantial dam for the fuel to compress against. From time to time, as the clinkers form, the bar is lowered into the position shown in Fig. 7(b), allowing the clinker and ashes to pass over, when the bar is again raised to the position which has been found most suitable for the particular fuel being burnt. The movement of the bars can be readily obtained, either by hand operation through worm gear, or a simple form of hydraulic gear served from the boiler feed mains. This device has been found to make a very material difference in the efficiency obtainable

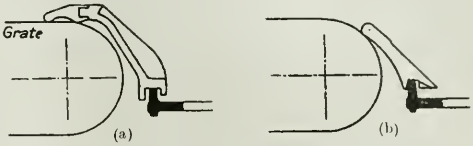

Fig. 6.—Fixed Clinker Dams.

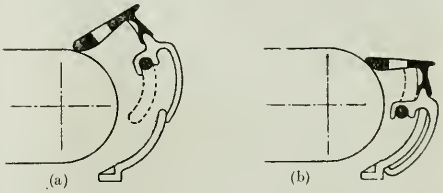

Fig. 7.—Adjustable Gate for Insuring Uniform Fuel Bed.

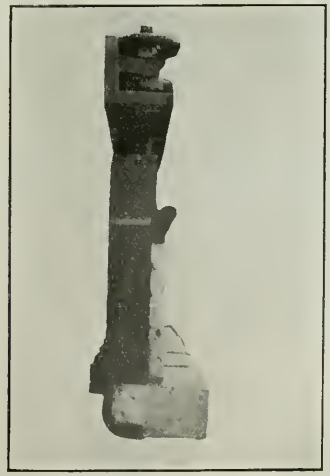

Fig. 8.—View of a Section.

with the various qualities of coal that have necessarily been used during the war.

We were interested to see the adequate arrangement made for testing coal, flue gas, water, oil and any other materials, a special laboratory being arranged for the purpose. Apart from the usual apparatus, there is a most useful device for testing lubricating oil. The object in view is to obtain a fair idea of the character of the oil to be used for the steam turbines beyond the information disclosed by the usual laboratory tests and without waiting to see the effect of, say, a six months' run in actual operation. If the oil is unsuitable considerable damage may be done in a very short time. The method adopted is to mix the oil with water to the extent of two parts of oil to one of water. This is then placed in a vessel fitted with two stirrers working in opposite directions and motor driven. The oil is heated to about 200°C. At the same time as agitation is going on, air is forced through the oil under a pressure of 1 in. or 2 in. of water, and there is also a reduced pressure above the oil to the extent of, say, 3 in. of water. Consequently, the more volatile constituents of the oil go off fairly readily, and these are condensed and sent back with the water into the main body of oil. The apparatus is run for a week continuously; at the end of this time, tests are taken of viscosity, deposits, gum, acidity, &c., from which a very good idea may be obtained of the behaviour of the oil in actual practice.

Correspondence.

ECONOMY IN LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In the current number of The Electrician Mr. M. J. E. Tilney calls attention to the waste of electrical energy due to low-watt lamps being unobtainable.

May I use your columns to point out what seems to me an even more flagrant case of waste of energy? I refer to the fact that the street lamps are lighted at about 8.30 p.m., while there are still at least 1½ hours of serviceable daylight. We are urged to economise energy, but apparently D.O.R.A. is ignorant of Joule's law, and possibly holds the lay opinion, that as "the electricity is always *on*," it costs no more to have the lamps alight—a belief which should receive its death-blow when the coal-bill comes in!—I am, &c.,

London, July 5. T. H. Solomon.

[We regret that it has been necessary to hold over some correspondence.—Ed. *E.*].

Illuminations for Peace Celebrations.

We have before us several catalogues illustrating illumination devices for use in the coming Peace celebrations. The special catalogue on this subject issued by the General Electric Company, Ltd., shows enterprise, typical devices being shown in colour on the right-hand pages and others of generally similar form in black and white on the left. The decorative designs shown can be fixed in position without the need of scaffolding. Most are made of "Pytram" composition, which is non-inflammable, the design being wired to a D.P. asbestos-lined cut-out, which can be readily connected to any existing installation. The wiring is protected from the weather. Among the coloured designs shown are Union Jack with Rose, Shamrock and Thistle; wreath, crown and shield with purple drapery; Britannia, floral festoons, &c., and metal rosettes in various varnished colours are also listed. Somewhat more elaborate is the figure of Victory, intended as a central decoration. In general, the devices are wired for a single Osram Atmos lamp; but in others, such as the Star of India, a considerable number of Osram lamps are worked into the design. Particulars of various accessories, "Pixielite" strip, colouring lacquer for lamps, &c., are also given.

We understand that the Sun Electric Company, Ltd., are supplying "Suncolite" strip, with insulated case holders to take the ordinary carbon filament lamps in lengths of 6 in., 12 in., 18 in., 24 in. and 36 in. Other specialities include Tudor and other metal rosettes from 4¾ in. to 8 in. in diameter, and finished in various colours, wood crowns and letters wired ready for use.

Messrs. Baxendale & Company, Ltd., of Manchester, illustrate various designs and mottoes made to order for either gas or electricity; while the catalogue of lanterns and reflectors, of the Wardle Engineering Company, Ltd., contains various standard types of units, such as the angle type for gas-filled lamps, which could no doubt be used with good effect for concealed lighting of mottoes and pictures.

Electricity (Supply) Bill.

Standing Committee B of the House of Commons, presided over by Sir Samuel Roberts, commenced consideration of this Bill on Wednesday.

Mr. J. C. Swan moved an amendment to insert words in clause 1 to add "providing" the supply of electricity amongst the powers of the Electricity Commissioners, on the ground that as the Electricity Boards were to have that power, the governing body should have it also. The amendment was rejected.

The Home Secretary (Mr. E. Shortt) suggested, in regard to a proposal by Mr. Trevelyan Thomson to insert a provision that the Commissioners should be "whole time officers, having no interests whatever than the special duties which it is proposed to confer upon them under this Act," that it should be limited to three whole time officers. It was proposed that three should be engineers, one of whom would be an engineer with experience of working a municipal supply, one an engineer with experience in a power company's supply. There would be three engineers, one financier and one gentleman skilled in law and administration (a trained civil servant). He suggested that three instead of five should be whole time officers, because it might be desirable to put on a man later who could not be a whole time officer. Mr. Thomson's proposal that the Commissioners should have no other interests was too stringent.

Mr. Thomson's amendment was rejected by 27 votes to 12.

Viscount Duncannon moved an amendment to leave out "in the case of two of" in clause 1 (2), the effect of the amendment being that the whole of the Commissioners would have their term of office fixed by the Board of Trade.

Sir Kingsley Wood said the Commissioners should be independent. He did not like the provision that they should be under the direction of the Board of Trade nor have a fixed term of office.

Mr. N. Chamberlain said if the Commissioners were permanently appointed it would not be an inducement to keep in touch with the progress of the science. They would only have to keep quiet and draw their salaries. There should be power to review their fitness from time to time.

The Home Secretary said some of the Commissioners ought to be trained permanent men.

Viscount Duncannon withdrew his amendment, on the understanding that it would not prejudice his subsequent amendment. He then moved an addition to clause 1 (2) that "three of the Commissioners shall be selected for practical commercial and scientific knowledge and wide business experience, including that of electrical supply." It was agreed to alter "and" in both cases to "or," and the amendment was adopted, as altered, by 22 votes to 15.

An amendment proposed by Mr. R. F. W. Nelson to the effect that the Commissioners should devote their whole time to the performance of their duties under this Act was altered by agreement with the Home Secretary to read "Three of the Commissioners," &c., and passed.

An amendment proposed by Mr. John Taylor to leave out "subject to the approval of the Board of Trade" in regard to the Commissioners' powers, granted by clause 3 (3), to conduct experiments or trials for the improvement of the methods of electric supply, was agreed to.

Mr. Geo. Balfour proposed, as an amendment to the same clause, to leave out the words in italic: "The Commissioners may, either by themselves or through *any district electricity board established under this Act, or* any authorised undertakers, conduct experiments or trials for the improvement of the methods of electric supply, and incur such expenditure as may be necessary for the purpose."

The Home Secretary said that was an important part of the Bill, and he suggested that the Committee should not deal with it that day, but consider the matter until they met again on Tuesday, and this was agreed to.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1917 Specifications.

127,313 Bagnolo, Johnson & Goldstone. Variable inductances. (13/4/17.)

127,315 Jones. Electrodes for electric arc soldering. (13/4/17.)

127,316 Barnes. Searchlight and other mirrors. (14/4/17.)

127,319 Soc. anon. de Magnetos & Appareils Electrique Sama. Magneto or dynamo electric machine. (17/5/16.)

127,325 B.T.-H. Co. (G.E. Co.) Wireless signalling systems. (19/4/17.)

Comprises an electron discharge device having grid and plate circuits containing inductances, an antenna connected to the grid and plate circuits in such a way that the capacity of the antenna serves to couple the two circuits, the grid and plate circuits being so organised that radio frequency oscillations are produced in the antenna.

127,335 B.T.-H. Co. (G.E. Co.) Wireless signalling systems. (24/4/17.)

Relates to a method of neutralising the effect in a receiving antenna system of electrical waves radiated from a separate transmitting antenna in proximity thereto, which method consists in applying directly to the receiving system from the transmitting antenna an E.M.F. substantially equal in value and opposite in direction to the E.M.F. induced upon the receiving antenna from the transmitting antenna.

127,616 Atherton. Electric ignition apparatus for internal-combustion engines. (30/4/17.)

127,634 Marconi's Wireless Telegraph Co. & Shoenberg. Thermionic devices particularly for use in wireless telegraphy. (5/5/17.)

Relates to the combination with a thermionic device of means for passing a distorted alternating current through the filament.

127,651 Marconi's Wireless Telegraph Co. & Wright. Employment of thermionic devices for magnification purposes. (12/5/17)

Relates to the combination of a thermionic relay, a resistance connected to the anode thereof, and to a battery connected to the filament, and a second thermionic relay, the grid of which is connected to the anode of the first while its filament is connected to a point in the battery.

127,661 Watson & Co., Greaves & Etchells. Means for sealing the openings in the roofs and walls of an electric furnace through which the electrodes are introduced. (16/5/17.)

127,669 Brown. Telephone and like receivers or relays. (19/5/17.)

127,675 B.T.-H. Co. (G.E. Co.) Wireless telegraphic apparatus. (23/5/17.)

Relates to means for receiving wireless signals, comprising a coil of a large number of turns in a plane parallel to the direction of the signals to be received and connected in a circuit of high impedance for undesirable impulses, and a plurality of circuits of low impedance located within the field of said coil and in planes at right angles to the direction of the signals to be received.

1918 Specifications.

124,206 Lineprauch. Dynamo-electric machines. (6/3/18.)

124,733 Collet. Brush holders for dynamo-electric machines. (16/3/18.)

127,366 Graham & Ricketts. Telephonic systems. (25/4/18.)

127,367 Creed & Co., Polley & Creed. Apparatus for reproducing in ordinary characters messages or intelligence received as electric impulses or in the form of perforations in a tape. (26/4/18.)

127,368 Gray. (Warren Clock Co.) Apparatus for performing work of short duration at pre-determined times, such as automatically operating electric switches, gas and water valves, and the like. (26/4/18.)

127,375 Thomson & James. Telephone and like apparatus. (7/12/18.)

127,376 Oldham & Oldham. Galvanic batteries. (15/5/18.)

116,286 Gossweiler. Dynamo-electric couplings. (29/5/17.)

127,417 Fuller Accumulator Co. & Welsh. Electric safety lamps. (8/6/18.)

127,426 Igranic Electric Co. (Barnum & Date.) Electric lockout switches. (17/6/18. Patent of addition not granted.)

127,434 Binyon. Electromagnetic wave transmission. (24/6/18.)

127,438 Gamble. Devices for placing trolleys on to the overhead conductors of electric tramway systems. (28/6/18.)

127,441 Mossay & Mossay & Co. Electrically-propelled trucks and like vehicles. (2/7/18.)

119,444 Bosch Magneto Co. Trip or accelerating mechanism for magnetos and for other purposes. (21/9/17.)

127,458 Rondelli. Electric furnaces. (10/8/18.)

127,483 Rushen. (General Motors Corpn.) Ignition systems for internal combustion engines. (25/9/18.)

127,487 Davis. Attachment of telegraph wires to the insulators of telegraph poles and like supports of aerial wires. (22/10/18. Addition to 3,478/18.)

27,488 Young. Machine for the generation of electric currents, also applicable as a motor. (2/10/18. Divided application on 14,538/17.)

127,495 Parmenter. Attaching-means for electric fixtures. (13/11/18.)

127,496 Nobbs & Nobes. Electrical heating and cooking apparatus. (18/11/18. Addition to 12,318/15.)

127,510 Bushnell Magneto Co. & Bushnell. Armature cores. (17/12/18.)

127,514 Monard. Apparatus for electrically controlling railway signals. (28/5/18. Addition to 21,298/18.)

1918 Specifications.

127,682 Revell. Electric lamp brackets. (22/7/18.)

127,694 Lovesey. Carbon holders for arc lamps. (3/5/18.)

127,707 Watson & M.L. Magneto Syndicate. Electric spark-gaps. (31/5/18.)

127,724 Edmundson, Munro & B.T.-H. Co. Vacuum electric discharge devices. (6/6/18.)

127,732 Beaver, Stratton & Claremont. Lapping machines for covering electric conductors. (12/6/18.)

117,082 Lund & Lawerentz Aktieselskab. Automatic electric switches. (23/6/17.)

127,750 B.T.-H. Co. (G.E. Co.) Electric time limit devices for electromagnetic switches. (24/6/18.)

127,756 Ninon Denki Kogyo Kabushiki Kaisha & Yanai. Leading-in conductors for electric lamp bulbs and the like. (12/7/18.)

127,758 Parry. Telephone receivers. (15/7/18.)

127,759 B.T.-H. Co. (G.E. Co.) Electric switches for use in governing fluid pressure. (16/7/18.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

May 8, 1919.

11,460 Taylor. Obtaining single-pole alternating currents from three-phase systems.

11,466 Imbery. Electric muffle furnaces.

11,480 Chawner & Wain. Magneto-electric machine.

11,492 Bell & Brearley. Water-cooler and electrode economiser for electric furnaces.

11,507 Colquhoun & Niblett. Electrolytic treatment of substances.

11,514 amd 11,515 Lewis. Selective indication, &c., systems for operation by alternating or pulsating currents.

11,536 Burke. Incandescent lamps.

11,538 Chassin. Dynamo-electric machines. (8/5/18, France.)

11,540 Perrie. Electric resistances.

11,544 Evershed & Vignoles. Magneto-electric machines.

11,551 Lemaire. Electric lamps for miners.

11,554 Cross. (Hulfish.) Automatic telephone line-finder systems.

11,570 Johnson & Phillips & Pearson. Projector arc lamps.

May 9, 1919.

11,648 Benard. Electric signal lights for marine or aerial navigation.

11,660 B.T.-H. Co. & Wedmore. Electric switches.

11,661 B.T.-H. Co. (G.E. Co.) Systems of radio communication.

11,666 British Westinghouse Electric & Mfg. Co. & Ansingh. Electric switches.

11,679 Creed. Electrical receiving apparatus.

11,682 Ireland. Electric traction motors, &c.

11,687 Harrison. Incandescent lamps.

11,694 Lemaire. Accumulators.

May 10, 1919.

11,742 Macrory. Service joint box for paper-insulated lead-covered, &c., cables.

11,759 B.E. Co. & Harrison. Electric lamp holders, &c.

11,762 Mason & Newbury. Ray filter for cutting out heat ray of arc lamps, &c.

11,767 Forrester. (Burgess.) Electric heating apparatus.

11,789 Burden, Hawes & Rivers-Moore. Electric fuses.

11,800 Harrison. Incandescent lamps.

May 12, 1919.

11,873 Fleming. Thermionic detectors of electric oscillations.

11,888 Spencer. Electric battery cells.

11,909 Perl. Electric switches.

11,912 Carey-Gavey Synd. Alternating-current motors, &c.

11,916 Warburton. Controlling series of electric motors.

11,919 Soc. Anon. des Etablissements L. Bleriot. Electro-magnetic relays for control of electrical installations. (26/8/18, France.)

11,920 Soc. Anon. des Etablissements L. Bleriot. Electric contact devices (27/8/18 France.)

11,921 Soc. Anon. des Etablissements L. Bleriot. Electro-magnetic controlling devices. (28/8/18, France.)

May 13, 1919.

11,935 Harrison. Manufacture of incandescent electric lamps.

11,940 Metcalfe. Double combination magneto-earthing switch.

11,953 Tucker. Assembling electric switches and accessories.

11,960 Britton. Double combination magneto earthing switch.

11,967 Knowles. Dynamo-electric machines.

11,978 Greenhill, Watson & Pollard. Electric liquid heaters.

12,004 Round. Receiving systems for wireless telegraphy and telephony.

12,005 Round. Thermionic receiving devices for wireless telegraphy and telephony.

Commercial Topics.

Patents in Enemy Countries.

The Board of Trade have issued a general licence authorising the payment of fees in respect of the grant and renewal of patents and of the registration and renewal of the registration of trade marks and designs in enemy countries or on behalf of enemies.

* * * *

Non-Ferrous Materials.

The following particulars are published of the stocks (exclusive of old metal and scrap) in the possession of the Minister of Munitions on July 1: Copper, 44,298 tons; spelter, g.o.b., 26,059 tons; spelter refined, 13,356 tons; aluminium, 10,662 tons; soft pig-lead, 121,135 tons; nickel, 2,452 tons: and antimony regulus, 4,368 tons.

* * * *

Wireless Telegraphy on Ships.

In the House of Commons last week the Merchant Shipping (Wireless Telegraphy) Bill was read a second time. The object of the Bill is to extend the statutory requirements as to wireless telegraph installations on merchant ships. Every passenger steamer and every cargo vessel of 1,600 tons gross and upwards must have a wireless telegraph installation.

The coming into operation of the Merchant Shipping (Convention) Act, 1914, has again been postponed until Jan. 1, 1920.

* * * *

The Shipping, Engineering and Machinery Exhibition.

We are glad to learn that it has been decided to revive the annual shipping, engineering and machinery exhibition, which will be held at Olympia in September and October next. It was proposed to hold the exhibition in the autumn of 1914, but it had to be postponed on account of the war. The organising manager of the exhibition, which will be open for three weeks from Sept. 25, is Mr. F. W. Bridges.

* * * *

Belgian Business Methods.

The British Vice-Consul desires to emphasise the advantages of utilising travellers rather than catalogues in order to secure orders from Belgian retail traders. Catalogues are a practical medium only in the case of goods which are too heavy or bulky to move about. And in such cases the Germans often organised in pre-war days at Brussels an exhibition in a room hired at a hotel which they invited customers to attend, frequently repaying the railway fare. If manufacturers wish to resort to catalogues, the catalogue must be printed in French, with prices in francs, metric measurements and a nomenclature approaching as nearly as possible that current in Belgium.

* * * *

The Gattie Goods Handling Scheme.

It is satisfactory to learn that a Committee has been appointed "to investigate Mr. A. W. Gattie's proposals for improving the methods of handling goods and traffic, and to consider the practicability of the introduction of any of the suggested improvements into the existing transport system." The chairman of the Committee is Sir Fortescue Flannery, M.P., and the other members are Sir John Aspinall, Mr. F. T. Hopkinson, General Sir Philip Nash, and a representative of labour. The chairman is an engineer and chairman of Callender's Cable & Construction Company, and Sir John Aspinall is a director of the Lancashire & Yorkshire Railway Company. It is to be hoped that the Committee will make a full and impartial investigation of the merits of Mr. Gattie's scheme which has been before the public for many years and has been described in the columns of this journal.

* * * *

German Trade Competition.

In the course of an address to the Association of Chambers of Commerce last week, Mr. H. B. Ferguson, principal adviser on economics to the British military authorities in Cologne, said Germany's business largely depended upon the continuance of her capital and pooling of her knowledge. That was opposed to the British system of secrecy in regard to new processes. That must cease if we were to compete on favourable terms with Germany. There was very little to fear except in the handling of raw materials, in which the Germans used every possible labour-saving device. The Germans were also superior in regard to industries utilising large quantities of motive power. The present rate of exchange was enabling Germany to dump goods more cheaply than any other nation. According to Mr. Ferguson British traders must not sell goods to Germany and take pounds sterling in exchange; they must take goods in return.

* * * *

An Importers' and Traders' Association.

We learn that the Electrical Importers' and Traders' Association was recently formed, and that several leading firms have already applied for membership. The object of the association is to combine importers and traders in opposition to the action of British manufacturers for the total prohibition of imports of certain classes of goods in the electrical and allied industries. The association will oppose any such unreasonable restriction of trade, and will contend by every possible means to secure reasonable facilities for importing and distributing such goods as are required by the public and are not manufactured in this country either in sufficient quantities or of suitable quality. The secretary (Mr. Frank W. Challis) states that the association is in full sympathy with every legitimate means of fostering home industries and encouraging the handling of British goods, but it considers that established importing interests should be fairly treated, and it is not prepared to see the trade given over to a group of manufacturers to the detriment of consumers. The address of the association is 97, Cannon-street, London, E.C. 4.

Electricity Supply.

Croydon Corporation has obtained sanction to borrow £9,500 for extensions of the electric supply mains.

Sanction to a loan of £20,540 for extensions of the electricity undertaking has been received by Watford Council.

Salford Electricity Committee propose to increase the price of electricity from Sept. 30th as follows: from 30 to 50 per cent. for lighting; and from 50 to 75 per cent. for power and heating, including both supplies.

For the year ended March 31 there was a profit of £9,609 on the working of the Halifax Electricity Works, a drop of £2,674, compared with 1917-18.

Wolverhampton Electricity Committee has decided to carry out extensions of mains in various districts of the borough and in Buckbury, at an estimated cost of £6,379.

Burton Gas and Electricity Committee has decided that, having regard to the present and prospective scarcity of coal, no illuminations are to take place in connection with the Peace celebrations.

The new Fuel Order, modifying the scope of the scheme for the rationing of coal, gas and electricity as from July 1 has been published in the "London Gazette." We gave a summary of its provisions in a recent issue.

Tunbridge Wells Council has resolved, on the recommendation of the electrical engineer (Mr. R. N. Torpy) to purchase additional plant and lay down new mains at £17,025 and £12,975 respectively, and to apply to the L.G. Board for sanction to borrow £30,000.

Swansea Electricity Committee recommend the Council to pay the Borough electrical engineer (Mr. J. W. Burr) a salary in accordance with the scale adopted by the Associated Municipal Electrical Engineers of Great Britain and Ireland. At present Mr. Burr gets £700 a year, but the scale salary will be £1,050. The Electricity Committee has decided to extend the supply main to Manselton.

The South Wales Electrical Power Company having withdrawn their opposition on the insertion of an acceptable clause, the preamble of Bedwellty Council's Bill for the acquisition of the Rhymney Valley General Electric Power Company, and for power to supply electricity and gas and other powers, has been passed by a Select Committee of the House of Commons.

According to the Association of British Chambers of Commerce, "the time has not arrived for framing a complete scheme such as the Electricity (Supply) Bill attempts to put forward, but the powers of the proposed Commission should for the present be confined to investigation and report with a view to the settlement of a scheme after full inquiry and consideration."

Sunderland Electricity Committee now recommend that the resignation of Mr. J. M. Donkin, chief clerk in the electricity department, be accepted, and that he be thanked for his past services and paid three months' salary in recognition thereof. The Committee is of opinion that the whole of the changes in the staff have been fully justified, and the Committee has every confidence in Mr. Blackman for the efficient management of the department.

The following Loans have been granted by the Government to Electric Supply Companies since August, 1914: Cleveland & Durham County Electric Power Company, £85,000; Clyde Valley Electric Power Company, £100,000; Newcastle-on-Tyne Electric Supply Company, £47,726: North Metropolitan Electric Power Company, £80,000; Shropshire & Worcestershire Electrical Power Company, £270,000; and Yorkshire Electric Power Company, £182,000.

An inquiry was held at Keighley last week into the Corporation's application for sanction to borrow £72,773 for electricity purposes. Of that sum £39,773 had already been expended on mains, services, machinery and extensions of buildings, and £33,000 was needed for new expenditure. Details of the expenditure having been given, the Inspector called attention to a letter from the L.G. Board written in 1915 directing that if the Council decided to raise a loan they should make application in the usual way. In October, 1916, the Council asked for a loan of £2,000, but they appeared to have then spent more than they were asking for. As to sinking fund, no provision seemed to have been made. Interest was now higher than it was four years ago. He also referred to an arrangement with the contractors for the payment for a turbo-alternator by instalments. But now it was shown to have been paid, not by instalments, but by overdraft—a spending of money without notice. The inquiry was, therefore, adjourned until some time in August for the production of adequate particulars as to £46,000 of the amount applied for.

At a conference of representatives of local authorities, large power users and steel and iron works in the Furness and South Cumberland area it was decided to form a committee to deal with the subject of electricity supply, and to prepare a scheme under the Electricity (Supply) Bill.

Mr. H. R. Burnett (borough electrical engineer, Barrow) explained at some length a number of the clauses in the Bill and their probable effect upon the supply of electricity in the district. He also referred to the utilisation of water-power, waste heat and waste gases. On his suggestion, a Provisional Supply Committee, composed of one representative of each of the following, was appointed: Barrow Corporation, Ulverston, Dalton, Millom and Grange Urban Councils, and Ulverston and Bootle Rural Councils; the Windermere & District Electricity Supply Company; Messrs. Vickers, Barrow Hematite Steel Company and the Furness Railway Company (as large power users); the Millom & Askam Hematite Iron Company, North Lonsdale Iron & Steel Company and Kennedy Bors., with one representative of labour

Electric Traction.

East Ham Corporation has received sanction to borrow £10,230 for six tramcars.

Accrington Tramways Committee proposes to purchase two double-deck and two single-deck bogie tramcars.

Redditch Urban Council has applied for sanction to a loan of £1,250 for an electric vehicle for refuse collection.

Salford Tramways Committee has decided to convert the majority of their uncovered deck cars into the closed-in type.

Edmonton Urban Council has asked the L. G. Board to authorise a loan of £10,000 for the purchase of electric dust carts.

York Corporation will adopt the trackless trolley system of traction in the Heworth district, where extensive building developments are projected.

Paisley Council is opposing the Paisley & District Tramway Company's application to the Board of Trade for powers to increase their fares.

The Board of Trade has extended for one year from Aug. 18, 1919, the period limited by the Northampton Corporation Act, 1911, for construction of tramways and acquisition of lands.

The Board of Trade has also extended for one year from Aug. 17, 1919, the time limited by their Order dated May 15, 1918, for purchases of lands authorised by the Metropolitan District Railway Act, 1912.

In the next Swansea Corporation Bill power will be sought to construct a tramway from the Cross, Morriston, to Skewen, to run motor omnibuses within and without the borough, &c.

On the past year's working of the Kirkcaldy municipal tramways there was a surplus of £2,329, but a deficit of £875 on the electric supply dept. The traffic revenue increased by £6,697 over 1917-18.

A Select Committee of the House of Lords, presided over by the Duke of Northumberland, has passed the Birmingham Corporation Tramways Bill, and adjusted the clause with regard to the variation of the route of the Selly Oak-Northfield tramway through Sir John Middlemore's estate.

Mr. W. Chamberlain, general manager, Oldham Corporation tramways, was one of the selected applicants for the post of manager of the Hull tramways, but on condition of his withdrawal, the Special Salaries' Committee recommend the Council to increase his salary from £450 to £700, rising in two years to £800.

In reply to a question in the House of Commons, Sir A. Geddes states that he has no power to compel London railway companies to consider the question of the electrification of those lines which serve suburban areas. The question of the extension of electric traction on railways will no doubt be a matter for the early consideration of the Ministry of Ways and Communications.

Halifax Corporation celebrated the 21st anniversary of the introduction of electric tramways on the 30th ult. At present there are 37½ route miles of line, of which nearly 14 miles are outside the borough. The power to run trackless trolley cars to Stainland and Wainstalls will be exercised in the near future. The total capital expenditure is £423,532, and the outstanding debt is £246,358.

Rochdale's application for permission to borrow £5,500 for expenditure on the electricity mains and services has been sanctioned by the L.G. Board. The Board also agreed to the borrowing of other sums of £35,000 for mains, £27,000 for transformers and £800 for buildings, on condition that the Board of Trade's consent for the overhead wires is obtained.

The extension of the tramway system of the town is to be the subject of a special meeting of the Burnley Council. The original proposals would have included an expenditure on new track, cables, cars, &c., and street widenings, of nearly a quarter of a million, but the Tramways Committee has now decided in favour of motor-buses. The proposed new routes would have meant the addition of five miles of track.

On the occasion of the celebration of the silver jubilee of the Glasgow tramways last week, the Tramways Committee arranged for an inspection of the department's works at Coplawhill. During the visit reference was made by the general manager (Mr. James Dalrymple) to the recent order for 5,000 tons of American rails. He said the British rail-makers at Middlesbrough had been on strike for five weeks, and though the department had saved nearly £10,000 by giving the contract to America, it was not altogether a question of price. British makers could not begin delivery till October, so that if they had accepted British rails they could not have done any more renewals at present. The Americans promised delivery in July, and the department wanted to go on with the work of renewal. On returning to the city, the company were entertained to luncheon in the Banqueting Hall of the Municipal Buildings. Councillor Kelly, convener of the committee, presided, and in reply to the toast of "The Tramways Department," said the history of the tramways during the last 25 years was a magnificent record. They had given the public the finest tramway service in Great Britain, and they had carried them at the lowest possible fares. No increase in fares had been made during the war, but he regretted even with the increased revenue that they had enjoyed since the beginning of the financial year they were not paying working expenses—due to the increased cost of materials and higher wages. The committee had many schemes in hand; they had power to construct new sections and they had other sections mapped out.

Miscellaneous.

The cable ship "Stephan," which formerly belonged to the Deutsch Atlantische Telegraphen Gesellschaft, and now at Devonport, is to be taken over from the United States by the Eastern Telegraph Company.

The men employed by the Southend electricity works and tramways have struck for the London rates of wages. The electrical engineer (Mr. R. Birkett) maintained until Wednesday a supply of electricity with the aid of a few loyal men and some outside assistance.

In connection with the epoch-making flight of the R.34 naval airship from Britain to America—the first airship to cross the Atlantic—it is interesting to note that the Sunbeam engines were equipped with B.T.-H. magnetos, all-British in design and construction.

The annual Sports of the General Electric Company took place on the 28th ult. at Herne Hill, and the programme of 37 events was successfully carried out. The inter-branch ¾-mile relay race for the Hugo Hirst Challenge Cup was won by the London office team, with Witton works a good second. The head office won the Fletcher Challenge Cup for the London inter-departmental relay race and the Railing Challenge Cup for the London office tug-of-war; and the Osram-Robertson works won the Byng Challenge Cup in the tug-of-war. The prizes were distributed by Mrs. Hugo Hirst. A military band performed in the afternoon and concert artistes in the evening. Over 800 spectators were present.

The Annual Sports of the Sterling Athletic and Social Club (Sterling Telephone & Electric Company, Ltd.) took place on the 28th ult. at Dagenham. In the event for associated companies there was a big contingent of athletes from the Chelmsford Works of Messrs. Marconi's, and the employees of several more or less neighbouring firms, including Messrs. Fuller & Company, Fraser & Company, Union Cable Company, Roneo and Williams & Company also had invitations to compete in several of the principal events, the number of entries from them exceeding 500. The prizes were presented by Mrs. Guy Burney, wife of the club's president. ; and Mrs. Burney also distributed the medals presented by the Sterling Telephone & Electric Company, Ltd., to the famous and all-victorious Sterling Ladies' Football Team amidst great enthusiasm. There was a large number of spectators.

A soiree was held in Manchester College of Technology on the 4th inst., when there was an interesting exhibit of the work done in the various departments of the College. About 800 persons attended, representing Manchester City Council, the University and local commercial and industrial firms. In order to have a permanent and complete record of work done in the Manchester district arrangements are being made for making a collection of examples of all the war products of the district. With the co-operation of the Manchester and District Armaments Output Committee and through the generosity of a large number of firms a good deal of progress has already been made. A large number of valuable exhibits have been received and are exhibited in the corridors of the College and in the Council Chamber. The Exhibition will be permanently kept in the Sculpture Hall when the hall will be available.

With the passing of "Dora" and the removal of the censorship, light is gradually being thrown upon the work of the various branches of H.M. Army during the war. The Tank Corps formed that part of the Army which made victory over the Germans possible. Since the Battle of the Somme almost everyone has known something more or less accurate about the Tanks—how they are driven, built, &c.—but it is only now that details of the internal economy are permitted to be spoken of. The latest type of tank weighs approximately 35 tons, and is driven by a powerful petrol motor operating endless "caterpillar" tracks, the course of the tank being directed by the relative speed of the tracks To govern the speed of the tracks use was made of a friction band attached to differential gears driving the tracks. From the first, Ferodo friction linings were employed as the fabric friction surface for the brakes and clutches of the tanks used by the British and Allied armies, and it has earned the high approval and confidence of those who know its full value by continual experience. Messrs. Herbert Frood & Company have received from tank officers testimonials to the excellence of Ferodo lining.

Business Items.

Mr. Edward Ingram Hill, advertising expert, has removed from Wimbledon to 29, Ludgate-hill, London, E.C.4.

John Cuthbert Lee and Thos. Raffles Walker, electrical engineers, Ormskirk and Liverpool, have dissolved partnership. Debts by Mr. Walker, who continues the business as Lee & Walker.

Tenders are invited by July 18 for the purchase of a quantity of Magnetos. Detailed list from the Director of Publicity, Ministry of Munitions, Whitehall-place, S.W.1.

Messrs. Fuller, Horsey, Sons & Cassell will sell by tender in lots some surplus machinery and tools, including electric generating sets, suction gas plant, a number of furnaces, &c. Tenders must be delivered at the auctioneers' offices, 11, Billiter-street, E.C., by 4 p.m. July 15.

Lieut. B. Sleath (O.C. 4th and 16th E.M.R.U.'s), who has been mentioned in General Allenby's latest despatch for services in connection with the operations in Palestine last September, was one of the representatives of Chamberlain & Hookham, Ltd., before the war, and his many friends will be glad to learn that he hopes to resume his duties very shortly.

Messrs. John Birch & Company, Ltd., export engineers, of London, have undertaken the overseas agency of William Beardmore & Company. The Beardmore workshops are rapidly being converted from war to peace production of metals and machinery for distribution throughout the world, and the extensive Birch organisation is being further developed to meet these new requirements.

Appointments Vacant.

A charge engineer is required at the Torquay electricity works. Applications to the town clerk, Mr. Fredk. S. Hex, by 19th inst.

An assistant electrical engineer is required for the Welsh Metropolitan War Hospital, Whitchurch, near Cardiff.

Plymouth Corporation require a tramways manager. Salary £700 per annum, rising to £800. Applications to the Town Clerk by July 23.

A works electrician is required for the maintenance of rotary converter plant, d.-c. motors, &c. Applications to the Manager, Sewage Disposal Works, Huddersfield.

The Ministry of Pensions require instructors in electrical and mechanical engineering for the Hayes and Blackpool Training and Treatment Centres. Salaries from £350 to £450. Applications by July 15 to the Secretary, Ministry of Pensions (Treatment Training Branch), Thorney House, Smith-square, Westminster, S.W.1.

A principal lecturer in electrical engineering is required at the Goldsmiths' College, University of London. Commencing salary £150 to £240 per annum, rising by £15 increments to £300 and then by £10 to £400. A war bonus of £39 will also be paid. Applications to the Acting Warden by July 17.

Dublin Technical Education Committee require a head teacher of physics, electrical engineering and wireless telegraphy (£500, plus war bonus £60 and £150 as headmaster of Kevin-street Technical Institute), £350 (plus war bonus £60), rising to £450. Applications to the Secretary by July 18.

Newcastle-upon-Tyne Education Committee invite applications for the appointment of head of the electrical engineering department of the Rutherford Technical College. Salary £500 per annum. Applications on forms to be obtained from the Director of Education (Mr. Percival Sharp), must be returned by July 15.

The following appointments are vacant at the Northampton Polytechnic Institute: Instructor in mathematics and physics (£250 per annum), demonstrator and assistant lecturer in mechanical engineering (£250), drawing office instructor and assistant lecturer in mechanical engineering (£250), demonstrator in the optical laboratory (£240), demonstrator and assistant lecturer in the technical chemistry department (£240), and an instructor and demonstrator in the electrical and physical laboratories (£200). Applications to the Principal, Dr. R. Mullineux Walmsley, by July 15.

Tenders Invited and Accepted.

Nuneaton Corporation require tenders by July 15 for 1,350 yds. 0·6 by 0·1 by 0·6 three core paper-insulated feeder cable, &c.

Grimsby Corporation require tenders by first post July 14 for supply of water softening plant, feed tank, and electrically or steam driven boiler feed pump. Specifications from the Borough Electrical Engineer.

Tenders are invited for the supply and erection of three electric travelling gantry cranes at Belfast Harbour. Specification from the Harbour Engineer, and tenders to the Secretary by July 30.

Birkenhead Guardians require tenders by noon July 28 for the installation of internal telephones at their institutions. Specifications from the Clerk, Conway-street, Birkenhead.

Launceston (Tasmania) City Council require tenders by 3 p.m. July 28 for the supply and erection of battery reversible booster, switchgear, &c. Specification, &c., from the City Electrical Engineer.

Bedford Corporation invite tenders for the erection of buildings, and the supply of electric motors, coal conveyor, runaway and chutes, &c. Specifications from Mr. R. W. L. Phillips, and tenders to the Chairman of the Electricity Committee by noon July 21.

Redditch Urban District Council invite tenders for high-pressure steam, exhaust and water circulating piping. Specifications, &c., from the consulting engineers (Messrs. Handcock, Dykes & Trotter), 11, Victoria-street, London, S.W.1, and tenders to the clerk to the Council (Mr. G. W. Hobson) by noon July 28.

Durban (Natal) Corporation require tenders for the supply and delivery, c.i.f., of a quantity of Telephone Underground Cables. Specifications from Messrs. Webster, Steel & Company, 5, East India-avenue, Leadenhall-street, London, E.C. 3, to whom tenders are to be sent by Aug. 1.

Birkenhead Corporation has placed an order with W. T. Henley's Telegraph Works Company, at £864.

Glasgow Tramways Committee has placed an order with the United States Steel Company for the supply of 5,000 tons of tramway rails at £17. 9s. per ton. The lowest British tender was £19. 13s. per ton.

Watford Urban Council has accepted the tender of the Brush Electrical Engineering Company for a Ljungstrom turbo-alternator at £13,420, and with F. & A. Parkinson for motors at £300.

Bankruptcies and Liquidations.

An order for the winding-up of Connolly Brothers, Ltd., was made in the High Court of Justice on July 1.

The Oulton Broad Electricity Company, Ltd., is being wound up voluntarily. The Company has entered into an agreement for the transfer of certain of its assets and powers to Lowestoft Corporation. Claims against the Company must be sent to the liquidator, Mr. A. Garratt, at Suffolk-chambers, Lowestoft.

Companies' Reports, &c.

The directors of the Brazilian Traction, Light & Power Company have declared a quarterly dividend of 1½ per cent. on the preference shares.

Mr. L. A. Waldron has been appointed chairman of the Board of the Dublin United Tramway Company, Ltd., and Capt. W. L. Murphy has been elected to a seat on the Board.

The directors of the Anglo-American Telegraph Company have decided to declare an interim dividend for the quarter ended June of 15s per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock.

The directors of Veritys Limited have declared a dividend of 7 per cent. per annum (7s. per share) on the preferred ordinary shares for the half-year, making 7 per cent. for the year. A sum of £1,000 has been placed to reserve against debts and £2,769 for depreciation.

Extraordinary general meetings of the shareholders of the Adelaide Electric Supply Company were held on the 1st. when a resolution was passed providing for the increase of capital to £1,000,000 by the creation of 250,000 "A" cumulative preference shares of £1 each.

The accounts of the North Metropolitan Electrical Power Distribution Company, Ltd., for 1918 show a net revenue (after providing for debenture interest, &c., and £1,000 for renewals) of £1,712, and including £157 brought forward, the available sum is £1,869, out of which £1,000 has been placed to reserve, making £9,962, leaving £869 to be carried forward.

The profit of the Arbroath Electric Light & Power Company for 1918 was £2,977, to which had to be added £291 brought forward. After paying interest and preference dividend the balance is £2,415. The directors propose to place £1,000 to reserve and renewals, and to pay a dividend of 5 per cent. on the ordinary shares, leaving to be carried forward £612.

It was announced at the recent meeting of the Northern Exploration Company that important deposits of asbestos, molybdenum, zinc, iron and other metals had been discovered in the company's properties at Spitzbergen. The chairman (Mr. F. L. Davis) said that, given electric coal cutters, conveyors and other appliances, their output of coal could be greatly increased. The Marconi Company was erecting a wireless station at King's Bay, Recherche Bay and Lowe Sound.

The total revenue of the Woking Electric Supply Company, Ltd., for 1918 was £28,183, and after payment of expenses, debenture interest, preference dividend, &c., the balance is £1,826, of which £1,000 has been placed to renewals fund, and £540 carried forward. There are 2,227 consumers, compared with 1,901 in 1913, and the equivalent connections 143,490 8 c.p. against 88,143.

The gross income of the Anglo-Portuguese Telephone Company, Ltd., for 1918 was £103,957, against £99,507 in 1917, and the gross profit £27,071, against £25,617. After payment of tax, interest, &c., and adding £10,000 to renewals fund, the amount available (including £7,092 brought forward) was £17,207, against £16,092. The directors recommend a further dividend of 3 per cent., making 6 per cent. for the year, carrying forward £8,207. The actual loss on remittances amounted approximately to £17,354, against £22,000 for 1917.

At extraordinary and separate meetings of the preference shareholders of the Barnsley & District Electric Traction Company yesterday (Thursday), resolutions were passed to change the name of the company to the Barnsley & District Traction Company, Ltd., to divide each of the existing ordinary and preference shares of £5 each into five shares of £1 each, to alter the rights of the six per cent. cumulative preference shares to a non-cumulative dividend of 7 per cent., and to increase the capital to £100,000 by the creation of 25,000 new preference and 25,000 new ordinary shares of £1 each.

At the meeting of the Imperial Tramways Company last week the chairman (Mr. S. White) said that in regard to the Middlesbrough, Stockton and Thornaby Electric Tramways, which the company owned and managed, the three Corporations interested had decided to purchase the portions of the lines in their several townships. The next stage would be to secure an agreement as to the valuation, and the price to be paid for the undertaking. The valuation would be based upon what it would cost to establish it at the present time, with allowance only for depreciation. The report was adopted and a dividend of 4 per cent. was declared.

The gross receipts of the Anglo-Argentine Tramways Company, Ltd., for the year 1918 were £3,012,821, and the working expenses £2,375,564. Adding interests on investments and deposits, &c., and balance from 1917 (£67,990), and deducting annuity to City of Buenos Ayres Tramways Company, interest and sinking funds on debenture stocks, &c., the balance is £83,043, which it is proposed to carry forward. Having regard to the abnormal cost of fuel and the uncertainty of the outlook, the directors regret they are not yet justified in recommending the payment of any dividend on the preference shares. The traffic receipts for the year amounted to £2,909,376, an increase of £209,132 over 1917, the number of passengers carried being 349,286,338 against 324,231,620. The abnormal cost of fuel is responsible for an additional expenditure of £245,959 for electric energy compared with 1917. Mr. William Morris, of Messrs. Ashurst Morris, Crisp & Co., has been elected to a seat on the board.

The Rangoon Electric Tramways & Supply Company states that a revised agreement with Rangoon Municipal Committee for public lighting has been signed. The gross profits for 1918 were £77,661, and with transfer fees and interest (£2,912) the total is £80,573. Deducting debenture interest (£12,457), provision for redemption of 4½ per cent. debenture stock (£7,320), depreciation (£1,753), renewals account (£12,500 and special reserve for cables, &c. (£12,500), net profit is £24,039, which, with £4,258 brought forward, makes £28,297. The year's preference dividend absorbed £15,000, and a dividend of 5 per cent. on the ordinary has been declared, and £4,447 carried forward.

At the recent meeting last week the chairman (Sir F. W. R. Fryer) said the improvement in the returns from the tramway service continued to show healthy expansion. During the past year the cars travelled 63,112 miles and carried 34·75 more passengers than they did in 1917, resulting in an increase in gross receipts of Rs. 1,67,427. The time had arrived when, in view of the expansion of the city of Rangoon, it became the duty of the board to extend the tramway system. Arrangements were in hand for considerable extensions of the tramway system as the necessary materials became available. The returns from the supply of energy for lighting and power continued to show a healthy increase, which had only been limited by the want of additional machinery; this was now ready for dispatch to Burma.

At the annual meeting of Crompton & Company, Ltd., on Friday last, Mr. A. A. Campbell Swinton (chairman), who presided, said that when the accounts were made up to March, 1918, the liability of the company for excess profits duty was not settled, and £61,549 was carried forward subject to war taxation for three years. They had been able finally to settle with the authorities for a sum of £35,520. After providing for this and other items, they had an available profit of £38,828, an increase of over £11,000 compared with 1917. During the second half of the year the profits had been favourably affected by the reduction in special war work, with a consequent increase in output of their standard machines; in fact, they were making better profits since the war ceased than they did during the war. The demand for the company's manufactures was still increasing. New extensions to the works were in hand, and would, he hoped, be ready in the latter part of the year. At the meeting in February last it was resolved to increase the capital from £221,007 to £500,000, £24,000 to be new preference shares reserved for the employees, and the balance of £254,993 to be £1 ordinary shares. Messrs. Sir W. G. Armstrong, Whitworth & Company had offered to subscribe for 250,000 of those ordinary shares at par, on the condition that two of their directors should be elected on the board of the company. The new directors were Mr. Saxton Noble and Sir Glynn Hamilton West. The report and accounts were adopted, and resolutions were passed increasing the number of directors from eight to nine, and approving the acceptance of the offer of Messrs. Sir W. G. Armstrong, Whitworth & Company.

In the course of his analysis of the accounts of the United Electric Tramways of Monte Video, Ltd., last week, the chairman, Sir Geo. Touche, said the gross receipts rose to £380,000, which constituted a record, being £20,467 more than in the previous year, and £6,774 more than the highest pre-war figure reached in the last full peace year. The progress was the more gratifying when account was taken of the fact that during August and September, 1918, there was a general strike in Montevideo, in which the company's employees were involved. During the year 47,928,606 passengers were carried (increase of 3,045,086), although the car-mileage showed a decrease of 473,456 miles. Expenses, which had reached £263,189 a year ago, advanced to £294,945, an increase of £31,756, of which more than 86 per cent. was accounted for by the cost of fuel. The price of the fuel consumed averaged 146s. per ton, compared with 104s. 7d. in the previous year. On a consumption of 13,179 tons the increase was equal to £27,399. The increase in the cost of all materials used in connection with the maintenance of the company's plant, as well as a considerable increase in wages (operative during the last two months of the year), practically accounted for the balance of the increase in expenses. The net receipts of the Uruguayan company were £85,355, compared with £96,644, a decrease of £11,289. There was a good case for an increase in fares, but the authorities had in no way assisted the company to meet the increasing burden of expenses and improve the lot of its employees. The net profit of the London company was £35,584, an increase of £8,211, and with the amount brought forward there was a total of £48,880. The directors recommended payment of a dividend on the cumulative preference shares in satisfaction of the arrears for the half-year to Sept. 30, 1917, and with improving conditions it was hoped to make increasing payments on account of arrears and ultimately to resume the regular payment of current dividends. The directors entered into negotiations some time ago for the sale of the tramway undertaking to the Government: terms were provisionally agreed, but no binding contract had been entered into. Public opinion seemed to be moving in opposition to the nationalisation of industries.

The twenty-third ordinary general meeting of Callender's Cable & Construction Company, Ltd., was held on the 3rd inst. Sir J. Fortescue Flannery, M.P. (Chairman), presided, and after a reference to the great loss the company had sustained by the death of Mr. James Callender, and also by the death of Mr. Wm. Roberts, the company's agent and business manager in Bombay, went on to describe the change in the company's works since the signing of the Armistice. They had made the most extraordinary strides in adapting their works for peace occupation. The foresight of the management had enabled them to make surprising progress in returning to their peace manufactures and in renewing their relations with their ordinary customers. During the war their works in Lancashire and Erith were extended very considerably. To meet war requirements, new plant to a very large sum had been installed. Much of it was unsuitable for peace requirements, and they had to get rid of it, but other parts were capable of adaptation. In addition, they actually built new works at Erith, which they called the Picardy Works and which were erected at the urgent request of the Government. Those works had been occupied upon producing field telephone cables. The scientific branch of their organisation had been very busy. During the war many problems arose which had to be solved by experiment and research, with the result that valuable discoveries were made. One of the most important was a cable of an extremely high voltage—what he thought Sir Thomas Callender called super-voltage—which would be an economy, as they believed, to those who used it, and which would, if it were as successful as they had confidence it would be, make a very great change in the use of electricity throughout the world and very much increase the demand for electrical appliances for most commercial purposes. The obvious advantage of that high-tension or super-voltage cable was so clear that the company already had more demand for it than they could meet. They had booked orders of a very satisfactory and hopeful character which they believed would be very profitable in the future. They were faced with many difficulties in the matter of transport, prices of material, and particularly with regard to labour. The continuous use of machinery in shifts, and a desire upon the part of the workers to give some return for the increased remuneration they were receiving, would be the salvation of the country as a manufacturing country. The Chairman then dealt briefly with the figures in the report (which was abstracted in our issue of June 27) and concluded by moving the adoption of the report and accounts

Sir T. O. Callender, managing director, seconded the resolution and endorsed what the Chairman had said in regard to the loss they had sustained in the loss of his brother James, who had been his chief assistant in most of the departments. He was pleased to say they were getting clear of the control which the Government had exercised over the supply of many materials. Of all the difficulties they had had, one of the greatest had been the heavy hand of the Government upon them, and though they recognised that it was necessary during war, they were now anxious to get entirely clear of Government control, because they were convinced that no commercial business could be efficiently carried on when it was under direct Government management or subject to Government interference. After the Armistice there was a period of great slackness. The change from the anxieties of war necessarily brought about difficulties, unrest, dissatisfaction and curious views on the part of their employees. The result was that in the last half of November and in December, 1918, they did very little real and effective work; it was mostly clearing up their old business, and therefore the results placed before them were really not those of a full year's work. Since then, however, the horizon had cleared to a large extent. Those who had hesitated to place orders or to make contracts could now see that they could go ahead, and the difficulty now was to make satisfactory arrangements for the execution of the orders. There was a large amount of work in hand, and a still larger amount in front of them; in fact, there would be great difficulty in doing all that would be required of them. They were extending their plant ready for the super-tension work which was going to make a considerable difference in the country, and they were finding now that the heavy expense which for many years they had lavished on their research department was now bringing forth some useful results and would probably repay its cost over and over again. With regard to labour, the cable bands were now settling down and working satisfactorily, but in the engineering department things were not so satisfactory. There was there a greatly diminished output,.

The report and accounts were adopted and the dividends approved. Mr. C. H. McEuen was re-elected a director.

The directors of the Great Northern Telegraph Company, Ltd., state that the two Franco-Danish cables and one of its Anglo-Danish cables, as well as the cables connecting Denmark with Russia, remained interrupted during the whole of 1918. The repairs of the first three cables will not be possible until the seas have been cleared of mines, but there is little prospect of mine-sweeping being completed at an early date. The two cables between Denmark and Libau were repaired at the beginning of the year, but it has not yet been possible to repair the cable connecting the latter place with Petrograd. As regards the remaining cables of the Company, seven breaks occurred in five cables in Europe, whilst 33 breaks occurred in eight of the cables in the Far East. The cable steamer in Europe, "H. C. Orsted," was occupied for 39 days, 11 of which were for the account of other administrations. In the Far East, the "Store Nordiske" and the "Pacific," were engaged for 203 days, inculding 101 days for other administrations or companies. The Wladiwostock and Kiachat routes were still able to take a small share in the transmission of correspondence between Europe and the Far East in the early part of the year. Both routes were, however, completely closed in April 1918 when all telegraphic communication between Western Europe and Russia over the company's cables was suspended. All telegraphic connection, except by wireless, between Central Russia and the outside world has been interrupted since April last year. In July last year permission was obtained for the Danish staff to resume the working of the cables at Petrograd. Many circumstances made it impossible at the time to re-establish any telegraphic connection with Petrograd, and since then conditions there have developed in such a manner as to necessitate the repatriation of the Danish staff, with the exception of a few volunteers. In May 1918 the Company was able to conclude an agreement with the Finnish Government and to open its own telegraph office at Helsingfors. The traffic, at first very small, has, however, developed satisfactorily. Last November the Company was able to re-open communication with Esthonia via Helsingfors, whilst in January last through the repair of the two cables between Denmark and Libau, telegraphic intercourse was re-established between Latvija and the outer world. At the same time the cable office at Libau was re-opened. Whilst connection with the Wladiwostock station was maintained through the Far Eastern cables during the whole of the year, Irkutsk station was temporarily closed for about a month. These two stations are at present dealing with a rather considerable traffic. The political situation in China has, during the past year, been anything but peaceful, but the telegraphic correspondence has continued to develop satisfactorily. On June 1 the Company attained the 50th anniversary of its foundation, and a gratuity was paid to the whole of the staff. Remembering also that its existence is primarily due to the ingenious invention of H. C. Orsted, the Company has placed at the disposal of the Polytechnic Section of the Copenhagen University about £13,900, the interest on which is to be applied preferably to research work and further development of electro-technical problems.

The financial results of the year were satisfactory, owing to the profit of about £148,270 realised by the considerable increase of value in the foreign currencies in which the Company receives the major part of its traffic receipts. That extra profit enabled the Board to propose the distribution of the same total dividend as last year, viz. 22 per cent., without unwisely reducing the amounts placed to reserve. Salaries and wages show an increase of approximately £29,000. Expenditure in connection with the ordinary supervision and maintenance, &c., and the maintenance of buildings was lower by £6,400 and £750 respectively. It is proposed to reserve £55,555 for the renewal fund for cable steamers. The obligations of the Staff Pension Fund necessitate an increase of £2,778. The balance carried forward is £15,370 less than last year.

The directors state that the revenue account and balance sheet show the financial position to be as strong as ever, whilst the fact of the commercial intercourse between the various countries having become less difficult since the Armistice has caused the traffic over the Company's cables to increase satisfactorily, notwithstanding the continued absence of the former large Russian traffic. But permission to use telegraphic codes, which may not be so far off, will shorten the telegrams and diminish the Company's receipts. It is also well to remember that several of the countries served by the Company's cables have built, or are contemplating the building of, powerful wireless stations, the activity of which may possibly tend to lessen the receipts. Finally it should be taken into account that the conveyance of postal matters by aeroplane is likely to supplant, to a certain extent, short-distance telegraphy.

The annual general meeting of the British Electric Traction Company took place at the temporary offices of the company on the 3rd inst., Mr. Emile Garcke (chairman) presiding.

The Chairman congratulated the shareholders upon the extent to which the company had emerged from the troubles and anxieties caused by the war. From an operating point of view the problems they had to deal with during 1918 were probably more difficult and anxious than any other set of problems previously experienced in the whole history of their industry. The demands made on the services rendered by the various companies exceeded in most cases all previous records. In 1918 the problem was how to handle the increased volume of business in excess of their ordinary facilities. The efforts made by the staffs to cope with those difficulties were deserving of the highest praise. Mr. Howley, who for some years acted as joint manager, in conjunction with Mr. Dade, had decided to practice as a consulting engineer, and had therefore resigned his position as joint manager, but they had been able to make an arrangement by which he would devote part of his time to the company's affairs. The chairman then dealt briefly with the figures in the report and accounts, of which an abstract was given in our issue of June 27, and added that the apparent simplicity of the position was due to the fact that the company was now only a holding company, holding stocks and shares in various allied companies which did the work of the various departments, of whose aggregate captal of about £15,000,000 the British Electric Traction Company held about one-third. The average yield on the whole of their investments for the past year was 5·08 per cent., compared with 4·93 per cent. for 1917. The prospects for the current year were good in some respects, but uncertain in other directions. Negotiations were pending for the sale of the undertaking in Auckland, New Zealand, and an option had been given to the city to purchase the undertaking. The local authorities had given notice to purchase the Oldham, Ashton and Hyde undertaking, but the arbitration had not yet been fixed. Negotiations were begun some time ago for extensions of the tenure of the Potteries Company's concession, and the company had been approached by Stoke-on-Trent Corporation with a view to the purchase of the company's lines. Their interest in the Sheerness motor omnibus service had been sold, and the Sheerness Company had now the electricity supply business only, which was developing. The Southport tramway undertaking had been sold to the Corporation, but the balance of purchase price was not payable until 1922. The Wellingborough electricity undertaking had been amalgamated with the Electricity Supply Company of Northampton.

Mr. Garcke said their operations comprised (1) operation of tramways and light railways, (2) working of motor omnibuses, (3) supply of electricity, (4) manufacture of electrical machinery, rolling stock, aeroplanes, &c., and (5) finance business and general enterprise. The first three had, with one or two exceptions, done a great volume of work, and for the most part made increased profits. The manufacturing department, represented by the Brush Electrical Engineering Company, made distributions on its ordinary stock of 12 per cent. last year and 18 per cent. this year. The business of finance and general enterprise had necessarily been restricted during the war, but that department possessed potentialities which they might have to put to a greater test in the near future. The gross receipts on the tramways and light railways (omitting the London companies) were £1,500,000, an increase of £200,000, or 15·4 per cent. In the electricity supply department gross receipts were £368,000, an increase of £80,000. Units sold showed an increase of about 10 per cent., and the average price charged was 16 per cent. higher than that of the preceding year. Taking the traction, motor omnibus and electric supply departments together, the gross receipts were £2,400,000, an increase of £400,000., and the gross profit was £793,000. an increase of 16 per cent.

The London undertakings were grouped in the London & Suburban Traction Company, which was associated with the Underground Railway Companies of London. The results of the year's working of the London Companies had again been disappointing, for they had no dividend for the past year on their shares (not even on the cumulative preference shares) in the London & Surburban Traction Company. If the London figures were included in the general statistics of results he had given, they would only strengthen the good case they could make that the fares and electricity charges were inadequate. In the case of the North Metropolitan Electric Power Supply Company, no dividend could be paid on the ordinary shares for 1918, compared with 10 per cent. in 1917. The Metropolitan Electric Tramways Company had been able to increase some of the fares, and the London United Tramways Company had been permitted to increase fares up to 1d. per mile Under the Statutory Charges Act of last year, instead of getting permission to carry on the business on the same commercial lines as all other businesses, they were not permitted to increase the rates and charges to the extent necessary to maintain even the small return on the capital which they were able to earn before the war; but local authorities might obtain power to increase fares to an extent sufficient to meet their interest and sinking fund charges. It did not seem to be sufficiently recognised that there were physical limitations to the available transport services, and that many months must elapse, and considerable expenditure be incurred, before they could be augmented. The provision of increased travelling facilities in order to avoid overcrowding entailed large expenditure on new works, rolling stock, &c. At present the capital invested in public service undertakings was not adequately remunerated. The average return on the whole of the capital of about £160,000,000 invested in electric traction companies was only $3\frac{1}{3}$ per cent., and on the ordinary stock only about $1\frac{3}{4}$ per cent.

Reports made by Departmental Committees on the existing legislation affecting electrical enterprises were unanimous in condemning the past legislation, and in a pamphlet issued by the Ministry of Reconstruction it was stated that those responsible for the Electric Lighting Act of 1882 ignored the necessity of security and a reasonable profit if capital was to be attracted to the development of any new industry. The Ways and Communications Bill contained some very desirable provisions in regard to the co-ordination of Government control. Instead of tramways, light railways and omnibus undertakings being under the control, as at present, of several separate Government departments, all matters affecting those industries would, if the Bill became law, be under the authority of one Ministry. That was an improvement in Government organisation which they had reasons to appreciate highly. But the new Ministry also acquired additional powers of a wholly unprecedented character. The Bill gave autocratic powers to the Ministry for two years, at least, to control and manage tramways and other road traffic (among other services) and to establish new services. The only certainty about the situation was the uncertainty of the results of the proposed legislation. One noteworthy provision of the Bill was the exclusion of municipal tramways from the operations of the Bill. The main features of the Electricity (Supply) Bill were the appointment of Commissioners for the purpose of co-ordinating control, and the constitution of District Boards for the purpose of amalgamating generating stations. In regard to transport facilities, the Minister in charge of the Bill had stated that he had no policy except to investigate and consider. No immediate purchase of the undertakings was contemplated. But in regard to the electricity undertakings, the problems of which were much more difficult than those relating to railways, tramways and omnibuses, he had a cut-and-dried scheme of dividing the country up into electrical districts, arranging for District Boards to purchase the generating stations, including the main transmission lines, and leaving the distribution systems in the hands of the present undertakers for some time longer. Many engineers who had practical knowledge of the working of these undertakings were confident that the developments could not follow the lines of policy indicated by this proposed legislation. The Bill provided that the price to be paid for the generating stations should be the cost of construction less depreciation. In most cases that would not be as favourable as the terms under which the companies at present held their rights, and in the case of electric power supply companies, the terms suggested were altogether inadmissible. The Bill gave no compensation whatever for past losses, nor for disturbance, nor for the sacrifice of future gains. The District Boards will be empowered to take the heart out of an undertaking; and with regard to the remaining distribution system, present owners would be left in an unsatisfactory position, because, not having control of their own heart, they would not be able to regulate their activities. Therefore the District Boards should not be empowered to buy part of their undertaking without buying the whole, and the purchase price should not be less favourable than that to which they are entitled under their present rights, and they should receive reasonable compensation for anticipating the date of purchase. The private enterprise interests in the industry were practically unanimous in advising the Government to limit legislation to the appointment of Commissioners qualified to examine the facts of each particular case and advise parties concerned and Parliament as to the steps to be taken. The Board would not relax their efforts to obtain amendments in the Bill. If, however, they failed to obtain reasonable amendments, while they would be bitterly disappointed, they would not be discouraged, for the resources of enterprise would not be exhausted. They would find fresh fields and pastures new.

The motion for the adoption of the report was carried unanimously, the dividends as set out in the report were declared, and Sir E. C. K. Ollivant, K.C.I.E., and Mr. C. G. Tegetmeier were re-elected directors.

New Companies.

ABBOTT, TURNER & COMPANY, LTD. (156,401).—Private company. Reg. June 25. Capital £500 in £1 shares. To into enter an agreement with Turner & Company, of Birmingham, electrical engineers, and to carry on the business of electrical, sanitary and mechanical engineers, &c. Reg. office: 6, Temple Row, Birmingham.

CHALLENGE MANUFACTURING COMPANY, LTD. (156,249).—Private company. Reg. June 20, capital £5,000 in £1 shares, manufacturers of and dealers in sparking plugs and cycle and motor components and accessories, electricians, &c. First directors: F. A. Johnson, F. A. L. Johnson and C. E. Johnson.

ELLESCO, LTD. (156,339).—Private company. Reg. June 23, capital £2,000 in £1 shares, to carry on the business of electrical, mechanical, aeronautical engineers, &c., and to adopt an agreement with J. Lee, of the Albion Engineering Works. First directors are J. Lee and W. Ellerd-Styles. Reg. office: 81, Rosebery-avenue, E.C.

ENFIELD EDISWAN CABLE WORKS, LTD.—Reg. as a private company, with a nominal capital of £200,000 in £1 shares. Objects are: To enter into an agreement between the Enfield Electric Cable Mfg. Company, Ltd. (and its liquidator), and others for the acquisition of the undertaking of the said Enfield Company, and a further agreement with the Edison Swan Electric Company to carry on the business of manufacturers and general merchants, engineers, patentees and agents, and in particular the business of manufacturers of and dealers in wires, cables and all other articles and accessories for the electrical and allied trades, to manufacture and deal in mechanical, scientific and other goods, &c. Particulars of the directors, &c., were given in our last issue. Reg. office: Central House, Finsbury-square, E.C.2.

IMPERVIOUS FITTINGS, LTD. (156,308).—Private company. Reg. June 21, capital £2,000 in £1 shares, to carry on the business of manufacturers of electric fittings and apparatus, other than cables, &c. Permanent directors: G. H. Scholes and E. A. Claremont.

W. E. JACKSON & COMPANY, LTD. (155,860)—Private company. Reg. June 6, capital £10,000 in 9,000 10 per cent. preference shares of £1 each and 20,000 deferred shares of 1s. Electrical and mechanica engineers, &c. Directors: H. H. Oxley, W. E. Jackson, W. R. Taylor, G. C. Lawrence. Reg. office: 60-1, Blackfriars-road, S.E.1.

NEWINGTON MOTOR & ENGINEERING COMPANY, LTD. (155,882)—Private company. Reg. June 7, capital £3,000 in £1 shares, to acquire from L. L. Stuart certain freehold premises and stock in trade, and to carry on the business of motor, electrical, and mechanical engineers. First directors: L. L. Stuart and W. H. Maggs. Reg. office: 53, Walton-street, Hull.

Prices of Metals, Chemicals, &c.

Wednesday, July 9.

Copper—Standard cash	£95	0	0	to	£95	5	0
Three months	96	0	0	to	96	5	0
Electrolytic wire bars pt. c.i.f.	97	0	0	to	102	0	0
Sheets	127	0	0				
Tin—Fine foreign cash	247	0	0	to	247	10	0
Three months	244	10	0	to	244	15	0
Lead—Net	23	0	0	to	23	2	6
English Lead	24	0	0				
Spelter	40	2	6	to	40	12	6

Iron, London, small rounds, squares and flats, £24. 2s. 6d.; Middlesbrough, Cleveland pig, No. 1, 164s.; No. 3 G.M.B. and No. 4 foundry, 160s.; No. 4 forge, 157s.; East Coast hematite, 190s.

Steel, ship plates, £17. 15s.; angles, £17. 5s.; heavy steel rails, £16.

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £22.

„ (Roll Brimstone).—Per ton £21.

Copper Sulphate.—Per ton £45–£46

Boric Acid (Crystals).—Per ton £72–£73.

Carbon Bisulphide.—Per ton £53 10s

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 8d.

Shellac.—385s. to 391s.; August delivery at 385s. to 388s.

Rubber.—Para fine, 2s. 5d.; plantation grades, 1s. $9\frac{1}{4}$d. to 1s. $10\frac{1}{2}$d.

Sulphuric Acid (92–93%).—Per ton, £7 10s. to £8.

Thirty-Seven Years Ago.

[From The Electrician, July 8, 1882.]

Electric Light in Kendal.—Messrs. G. Gilkes & Company, iron-founders, of Kendal, Westmoreland, recently lit up part of their works with Swan lamps, in order to exhibit its qualities to the Town Council and other residents of the locality.

The Electric Light Bill.—The "Daily News" says: "Though the Electric Light Bill was not mentioned in Mr. Gladstone's category of measures intended to pass this Session, such intention is held, and will probably be carried into effect."

War Preparations.—A telegraph train is being got ready at Woolwich, in anticipation of hostilities in Egypt. It consists of four telegraph offices, ten wire wagons, carrying thirty miles of wire, four air line wagons, and four Royal Engineer general service wagons.

New Ship.—On Thursday week Messrs. John Elder & Company, of Glasgow, launched the steel paddle ship "Normandy," which they have built for the London, Brighton & South Coast and the Western of France Railway Companies. Her gross tonnage is 600 tons. She is handsomely fitted up, and is supplied with electric lights.

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Notes.

The Price of Coal.

DURING the past week the nation has received a severe shock through the announcement that the price of coal is to be advanced by another 6s. per ton. The policy of increased wages and shorter hours is now becoming so general that few people pause to inquire from whence the increased wages are to come. The theory that shorter hours are more efficient, particularly in piece work, is based on the fact that a higher rate of production can be obtained owing to the shortening of hours. This has been proved, and, provided that it holds good, then no harm results from a shortening of hours; on the contrary, it is all to the good. But if the rate of output is not increased, and if the output as a whole falls, then there must inevitably be an increase in the cost of the product. The policy of increasing wages and decreasing hours of work was followed in the Sankey report, and considerable increases in wages were awarded. The owners at once voiced their misgivings and these are now beginning to be realised. As was pointed out by Sir AUCKLAND GEDDES last Monday, the effect of this increase in the cost of coal is to make everything dearer, and, what is still more important, to make the costs higher than those of materials which may be imported. Thus rails in this country will be £17. 10s. a ton, as compared with £10 per ton in the United States, and Cleveland pig iron £9, as compared with £6 at Pittsburg. At the moment it must be borne in mind that the 6s. increase is not wholly due to fall in production by the miner. There are other causes to be taken into account. Every industry is more or less affected by what takes place in other industries. The effect of higher wages and shorter hours in engineering has, for example, rendered it more difficult to obtain the necessary supplies for mining. Consequently, there is a check over which the miners have no control. Further, it is stated that some of the mines cannot be worked to their full output owing to lack of railway facilities. The whole question is, therefore, very complicated, and it appears to us that there has been a lack of investigation into the full causes of the reduction of output. Although for the moment the imposition of the 6s. is postponed, it is to be hoped that the seriousness of the proposed step will be realised. There is no getting away from the fact that lower production coupled with higher wages form the direct route to industrial suicide.

The Effect on Electricity Supply.

IT will be noticed that the proposal to increase the cost of coal by 6s. has the effect of raising by this amount the cost of all grades of coal; consequently, the percentage increase is much greater on the low grades than on the high grades. Now, in electricity works the lower grades are usually employed, and consequently the increase becomes a serious charge. The same effect is seen in the cost of carriage. For example, if before the war coal cost 8s. per ton at the pit and the charge for carriage was another 8s. per ton, then 50 per cent. was spent on transport. Since that time, however, there have been a number of advances, so that at present about 33 per cent. may be regarded as expended on the coal and 67 per cent. on transport, and advances of one kind and another. If now a further increase of 6s. is made, only 28 per cent. may be regarded as expended on the coal and 72 per cent. on transport and advances. Consequently, the natural tendency is to use higher quality of coal as far as possible. This is harmful in that the market for the lower grades becomes reduced. It would therefore be an advantage if coals could be graded to a larger extent and the increased charges allocated so as to be greater on the higher value coals. This would relieve the industrial position to some extent. Taking, however, the position as it stands, we may say that we hope the electricity undertakings will avoid, as far as possible, the raising of prices further. By so doing they will undoubtedly gain, because it will appear that they are less subject to fluctuations than competitive forms of heat and light. The inefficiency of private steam-raising plant will become still more apparent, and thus the station engineer will have a greater opportunity of improving his load factor and increasing his output.

Electric Power Generation in Ontario.

THE Paper by Mr. A. H. HULL, which appears in this issue gives a comprehensive account of the hydro-electric developments in the province of Ontario, in Canada, one of the most populous and highly industrialised provinces in the Dominion. As Ontario has no coal deposits, and few resources in the shape of other forms of fuel, the development of water power is of great importance and has expanded rapidly within recent years. The transmission voltage in the various districts varies from 22,000 to 110,000 volts, and in many cases the plant has features of interest. The Queenstown Development, mentioned in the latter part of the Paper, is worth attention as an example of the tendency towards the use of big units. Thus the development under construction provides for

200,000 H.P. in four units, and ultimately the use of 100,000 H.P. units is proposed. It is interesting to note that the 45,000 k.v.a., 12,000 volt, generators under construction involve a turbine speed of 187·5 revs. per min., and special importance is attached to the ventilation, each unit requiring 125,000 cubic ft. of air per minute.

Electric Cooking.

ALTHOUGH there is considerable activity by manufacturers of electric heating and cooking apparatus at the present moment, it may be questioned whether the lines that are now being followed are not rather too standardised. The tendency at present is to employ what may be described as high temperature methods exclusively. The average housewife has been accustomed to these methods alone, and is not likely to take kindly to a different policy. It may be doubted, however, whether high temperatures are really the best to employ, and whether an extension of the familiar idea of the hay-box should not be developed. Such methods if they can be worked in with the ordinary requirements of the household have the great advantage that the power requirements are small; consequently, from the point of view of the generating station, such methods are eminently desirable. They might be extended so as to include heating, water being used as the medium for the distribution of such heat. More than one water heater on this principle is already available, but the idea might be extended to the heating of rooms. There are many engineers who are in a position to experiment along these lines, and we commend to them the investigations of such problems to see whether something useful cannot be evolved.

The General Electric Company.

AT the annual general meeting of the General Electric Company last week MR. HUGO HIRST, the chairman, gave a very interesting account of various innovations which should serve to bring the management, the staff and workers into more cordial relationship. For example, a superannuation scheme is being adopted on a contributory basis, to which the employees will contribute at the rate of 4 per cent. and the Company to an equal extent, so that at the age of 60 years a pension will be available for workers who retire, or at an earlier age in the event of incapacity. A considerable sum is also being spent on welfare work, and a scheme of education is being carried through. Thus a director of education has been employed in Birmingham, and some 300 or 400 boys are being encouraged to take up lines of study in the Company's time. A similar scheme is being provided in London, and commercial apprentices are being encouraged to benefit by these facilities. Further, a "rush course" has been organised for demobilised officers. The industrial programme is one of very considerable magnitude, necessitating the increase of the capital to £6,000,000. This expansion will enable the Company to absorb a large number of demobilised men without displacing any temporary labour. Along with all other large employers, MR. HIRST is hoping that the State will avoid stepping in to the control of industry, and undoubtedly it will be generally agreed that the less the State interferes in such matters the better.

The Imperial Institute of Patentees.

AS will be seen by reference to another column a meeting was held last week to approve the formation of the Imperial Institute of Patentees. The chair was taken by SIR JOSEPH LAWRENCE, who is to be the first president, and the vice-presidents consist of a number of men of standing. Among the various objects which the new body have in view may be mentioned the extension of patents owing to the war, the institution of an imperial patent, the rendering of advice and assistance to inventors, the establishment of laboratories for the use of inventors, and the holding of exhibitions. Although the programme may seem rather ambitious, there is no doubt ample room for a body of this kind to carry on useful work. The patentee at present does not receive the consideration he should, and in connection with the war he will receive scant consideration unless he looks after himself. The meeting was well attended, and we hope that the proposed Institute will go forward and do useful work.

◆

Aluminium Conductors for Overhead Power Transmission Lines.—*Erratum.*—We regret to find that a printer's error occurs in the table on page 743 of Mr. Jacob's article in our issue of June 27th. The figures for annealed copper should read: Ohms (mil. foot), 10·371; microhms, cm. cube, 1·7241.

British Scientific Products Exhibition.—This Exhibition will be closed on Saturday, July 19, and will re-open on Monday, July 21. We are glad to find that the Exhibition is attracting a great deal of public attention. A unique feature is the display of kinematograph films of scientific and technical interest which takes place on Tuesday, Thursday and Saturday afternoons. These films illustrate: (1) Aircraft construction and utilisation; (2) the making of a big gun; (3) the water powers of Canada, and their industrial utilisation; (4) wireless telegraphy and telephony; (5) magneto construction.

Potash from Bracken.—We notice in the "Proceedings" of the Cambridge Philosophical Society are more additions to the many possible sources of potash suggested during recent years. Mr. J. E. Purvis describes experiments conducted by various workers on the extraction of potash from bracken. It appears that results depend much on the nature of the soil in which the bracken grows. Thus, the bracken grown in the sandy Cambridge soil yielded less potash than that grown in the peatty Welsh soil. The yields recorded vary from 0·82 up to 3·22 per cent. K_2O, but the industrial possibilities of the process are problematical.

Aluminium and Its Light Alloys.—A useful communication on the above subject (Circular No. 76) has been issued by the Bureau of Standards, Washington. A very full account is first given of the chief properties of aluminium (optical, mechanical, thermal, chemical and electric), and some useful notes are given on casting and working, soldering and various miscellaneous processes such as finish, granulating, use in the form of powder and application by the Schoop process. In the second section data are given on a variety of alloys, with copper, nickel, zinc, silicon, &c., and typical specifications are presented. The circular is concluded by a bibliography and is well worth study by all interested in the subject. Copies can be obtained on application to the Bureau.

Bulletin of the Federation of British Industries—Recent issues of this bulletin have provided interesting reading. No. 20 refers to various matters of industrial importance, such as the visit of the Brazilian commercial delegates, the insurance of trade with Russia, and trade developments in Greece, Belgium and elsewhere; while the subsequent number deals with British industry and the Spanish market. Another matter of considerable interest is the London University Scheme for Graduates in Commerce, dealt with by Mr. T. C. Elder. We notice that in the former issue an account is given of the Paper dealing with Commercial and Technical Education, recently read by Mr. A. P. M. Fleming before the Imperial Education Conference in London last month, in which stress was laid on the value of a knowledge of industrial economics amongst workers and artizans—a matter which, it will be agreed, is of special importance at the present moment.

An Automatic Regulator for Low-Temperature Electric Furnaces.—In "La Nature" an account is given of an automatic regulator for low-temperature electric furnaces, the invention of which is ascribed to Mr. Lequeux, whereby the temperature is accurately controlled. The device consists of a glass tube inclined at 30 deg., and connected at its upper end with a vessel containing a fluid which undergoes considerable dilatation under the action of heat. The lower end of the tube connects with a vertical cylinder containing mercury in which is an adjustable piston. In the sloping tube, where the mercury enters up to a certain height, are spaced platinum contacts connected with points on the coil of a rheostat. The device is placed in the furnace, and when the latter is cold the platinum points are short-circuited by the mercury. The furnace, therefore, receives the full current. With a rise in temperature the liquid in the upper vessel expands and forces down the mercury, thus putting into circuit in succession the various sections of the rheostat connected to the platinum points and diminishing the current. The device is intended primarily for laboratory furnaces heated by electricity (we presume of the resistance type), but the same principle may be applied to other forms of apparatus so heated.

Interior Lighting of Cinema Theatres.—Some interesting points in the lighting of cinema theatres are discussed in a recent issue of the "Electric World." The modern tendency is toward the provision of a weak general illumination in the theatre, so as to relieve contrast with the screen, and assist supervision. One must, however, keep all lights out of the range of vision, and ensure that this illumination is not prejudicial to the appearance of the picture on the screen. In the installation here described the illumination is provided by artificial windows in the ceiling. Above these windows are long boxes approximately 18 in. (45 cm.) in height, painted white inside. These boxes act as diffusers, throwing the light through the windows into the auditorium. The type of glass used gives very good diffusion and efficiency. The lamps are arranged on three separate circuits, allowing for the use of full intensity, a secondary intensity or a very low intensity for photoplay work. The lamps on the circuit which give the lowest intensity have been so graded in size as to furnish a very low value of illumination near the front of the theatre and a higher value of illumination near the rear. This type of lighting directs the greater percentage of light to the seats and aisles, where it is needed.

Regenerative Braking With Single-Phase Commutator Motors.—The Oerlikon method of regenerative braking was described in The Electrician of December 20, 1918. Our readers will be interested to know that this method was tested under working conditions on June 27th. Preliminary tests on the Loetschberg Railway had already shown that the method would be successful. The present tests were carried out with the second of the four trial locomotives ordered by the Swiss Federal Railways for the Gotthard Railway. This locomotive, as the first one, was built by the Ateliers de Construction Oerlikon in conjunction with the Locomotive Works, Winterthur, and it has been in regular service on the newly electrified section, Berne-Thun, since the beginning of May. Trials were first made with the locomotive alone on the steep gradient between Kandersteg and Frutigen—this corresponds with the conditions of the Swiss Federal Railways for braking tests—and thereafter with a train of a total weight of 310 tons, travelling at different speeds up to approximately 70 kilometres per hour down hill without the use of mechanical brakes or brake resistances. We are informed that the very great simplicity of the equipment and its operation, and also the reliability of the regulation at all speeds, was most noticeable From the invention of the Ateliers de Construction Oerlikon one may expect, therefore, for the future a considerable progress in the efficiency and economy of electric traction.

Electrical Equipment of an Army Base.—The "Electrical World" quotes the Army Supply Depot at Boston as a good instance of rapid equipment in which electricity has played a conspicuous part. The base, which is directly on the water front, has a working area of somewhat more than 40 acres and pier facilities for accommodating simultaneously 10 of the standard vessels of the Emergency Fleet Corporation. The main storehouse alone, of reinforced concrete, occupies 35 acres. It was determined to equip the whole terminal electrically for freight handling and general use. The buildings are fitted with 46 electric freight elevators, 6 automatic passengers elevator, 24 electric winches and 4 cranes. There are also 40 small storage-battery tractors and 600 trailers. Two hundred carloads can be unloaded in 10 hours, while the wharf shed cranes can load an 8,000-ton vessel in less than 60 hours' working time. The freight elevator equipment consists of four 5-ton units in each of the six independent sections into which the storehouse is divided. The plant is operated by a substation initially of 4,500 k.v.a. rating fed by duplicate 13,800-volt cables from the Edison station. Distribution is at 2,300 volts stepped down to 110 or 220 for the motor and lighting service. During the building of the plant an 800-k.v.a. temporary substation was installed to furnish power during the construction period. This station was put up complete in less than 30 days from the start, together with about 14 miles (23 km.) of line wire and all accessories for interior wiring of temporary structures, &c.

Sound Under Water and Its Applications.—Last week, at the British Scientific Products Exhibition, Prof. W. H. Bragg, F.R.S., gave one of a series of lectures, his subject being "Sound under Water and Its Applications."

Prof. Bragg explained that in the case of sound in air the energy was comparatively small though the motion was large, whereas under water the energy might be considerable though the motion was small. Consequently, massive devices, such as large bells, were used under water as sources of sound in order to get the necessary energy into the water. For receiving sound a plate could be used with a microphone upon it, transmitting to a telephone or to a phonograph. A device could take the form of a hollow vessel and a diaphragm. There was great difficulty in eliminating the noise of the vessel on which the device was fitted. This noise was largely due to the propeller and to the cavitation thus caused. Some of the noise was also due to the engines. If a boat was going slowly it was practically noiseless. With regard to vibrating plates, such a plate could not transmit in its own plant, and similarly it would not receive in its own plane. When such a plate was used for obtaining direction the result was ambiguous, because the sound would vanish in two opposite directions. If, however, on one side of the plates a box was fitted so as to provide a baffle with an air cavity within it the diaphragm became deaf upon that side. This was something new in physics. It was necessary for the plates so used to be non-resonant. The diaphragm itself was usually resonant, and thus magnified certain sounds, and impressed this frequency upon the sounds that were received. This had advantages and disadvantages. The idea was prevalent that direction was detected by the human ear through the shadow cast by the head. This, however, was not the case, as the direction was determined by the ears discerning which ear received the sound first. Prof. Bragg showed a number of experiments and slides, and in conclusion described the use of hydrophones spaced at certain distances apart for the determination of distances under water, the source of sound being an explosion in the water. Very accurate results were so obtained, and the method would probably be put to practical use.

Obituary.

We regret to record the death of Mr. Albert Vickers, managing director, and until recently, also chairman of Messrs. Vickers, Ltd. Deceased, who was 80 years old when he retired from the chairmanship of the company last year, had been associated with the firm for 64 years. Mr. Vickers was also chairman of the Harvey United Steel Company, and was on the board of the Alby United Carbide Factories, William Beardmore & Company and other engineering and industrial companies.

Personal.

Mr. John Newlands, C.B.E., C.I.E., late Controller of the Central Telegraph Office, London, has been presented with a silver tea and coffee service on his retirement after about 50 years service.

Owing to ill-health, Mr. J. Wilkinson, who has been for the past 20 years tramways electrical engineer to Hull Corporation, has tendered his resignation.

Col. Sir Hamar Greenwood, Bart., M.P., has been appointed additional Under Secretary of State for Foreign Affairs and additional Parliamentary Secretary of the Board of Trade, in succession to Sir A. Steel-Maitland, M.P.

Arrangements for the Week.

FRIDAY, July 18th (to-day).

British Scientific Products Exhibition.

5.30 p.m. At Central Hall, Westminster, London, S.W. Lecture on "Explosives," by Mr. J. Young.

Electric Power Generation on the Ontario Systems of the Hydroelectric Power Commission.*

By ARTHUR H. HULL.

The Province of Ontario is the largest and most populous of the provinces in Canada, having an area of 407.262 square miles and a population (census 1911) of 2.523.274. Ontario's population is about 35 per cent. of the total of Canada's population, and its area 10·9 per cent. of the total area of the Dominion. It is also the greatest manufacturing province in Canada. As there are no coal deposits in the province, its abundant wster-power resources are being increasingly utilised to furnish the power required for its varied and increasing industrial development. Natural gas and petroleum are found in the southern part of the province, but this supply is insufficient. The demand for electric power has increased greatly during the past ten years, and a great saving in coal has been effected by the use of electric power in Ontario's industries: further great savings will be, before long, brought about by the electrification of the steam railroads.

Mr. H. G. Acres in a monograph on "Water Powers of the Province of Ontario," written in 1915, gives the following summation of water power capable of development, and of water power already developed in the province :—

Division.	Potentiality.	Developed.
	H.P.	H.P.
Ottawa River and tributaries	688,000	71,000
Great Lakes tributaries	446,000	137,000
Hudson Bay Slope	250·000	22,000
James Bay Slope	1,500,000	70,000
International Boundary Rivers	2,045,000	462,000
	4,929,000	702,000

Of the total power developed, about 69,000 H.P. is used in pulp and paper manufacture, about 59,000 H.P. is used as hydraulic power directly applied, and the balance, 574,000 H.P., is converted into electric energy for light and power. This Paper deals only with the generation of electric power by the Hydro-Electric Power Commission of Ontario, now the largest producer and distributor of electric energy in the province. This Commission was formed by the Ontario Government in 1906, and first furnished power over its 110,000-volt lines from Niagara Falls in October, 1910. In subsequent year the operation expanded steadily, and the various areas in the province now served by the Commission are designated by systems as follows

System.	Main transmission voltage.	Frequency.	Phase	Power obtained from
Port Arthur system	22,000	60	3	Kaministiquia Power Company.
Nipissing system	22,000	60	3	Commission's Nipissing Station.
Muskoka system	22,000	60	3	Com. South Falls Station.
Wasdell's Falls system	22,000	60	3	Com. Wasdell's Falls Station.
Severn system ...	22,000	60	3	Com. Big Chute Station.
Eugenis system...	22,000	60	3	Com. Eugenia Station.
Central Ontario system	44,000	60	3	Com. Healy Falls Staton Com. Auburn Station. Com. Campbellford Sta. Com. Frankford Station Com. Trenton Station.
St. Lawrence system	26,400	60	3	M. F. Beach Company.
Rideau system ...	25,700	60	3	Rideau Power Company
Niagara system...	110,000	25	3	Com. Ontario Power Company's Station. Canadian Niagara Co. Electrical Development Company. Queenstown Development (future).

Port Arthur System.—In the Port Arthur system power is purchased at 22.000 volts three-phase 60 cycles from the Kaminstiquia Power Company, and is delivered to the City of Port Arthur at 22,000 and at 2,200 volts, part being transformed in the Commission's transforming station in Port Arthur, containing two banks of transformers, each consisting of three 750 k.v.a. units connected star-delta with neutral ungrounded. The first delivery of power was made on December 21, 1910. The demand has steadily increased and in order to meet future requirements the Commission propose to construct a hydroelectric station on the Nipigon River at Cameron's Pool, about 80 miles from Port Arthur, which will have an ultimate capacity of about 50,000 H.P. It is proposed to transmit the power at 110.000 volts three-phase 60 cycles to Port Arthur. Three other power sites on this same river, when developed, will, together with the Cameron's Pool site, give a total of 150,000 H.P. Another site is capable of development at Silver Falls, where with a 350 ft. head a total of 25,000 H.P. can be developed. The electric energy supplied at Port Arthur is used for operation on the street railway, for public and domestic lighting, and for large grain elevators, ship yards, coal docks and miscellaneous industrial purposes.

Nipissing System.—The Nipissing system comprises a generating station on the South River near Nipissing Village, sub-stations in Callander, Powassan and North Bay. The transmission system comprises 26·5 miles of 22,000-volt three-phase circuit on wooden poles. The generating station contains two 450 kw. three-phase 2,200-volt 60-cycle 450 revs. per min. horizontal generators with 12·5 kw. 125-volt direct-connected exciters, each unit direct coupled to a water wheel of 925 B.H.P. at 86 ft. head. A 37·5 kw. 125-volt motor-driven exciter is also provided. Three 300 k.v.a. 2,200/22,000-volt single-phase water-cooled transformers connected delta-delta are installed, with one 22,000-volt outgoing feeder. Water for this plant is taken from the South River through an open canal 900 ft. long, then through a wood stave pipe 6 ft. diameter 2,300 ft. long to a differential surge tank 72·5 ft. high, close to the power house, a steel penstock connecting thence to the turbines. The storage pond has an area of about 100 acres, and the drainage area of the river is about 350 square miles. By additional storage works it is possible to increase the capacity to 2,500 H.P.

Muskoka System.—The power house on the south branch of the Muskoka River at Muskoka Village was taken over by the Commission in 1915, and has been remodelled and enlarged. It now supplies power over a single circuit 22,000-volt three phase 60-cycle line about 26 miles long to Huntsville, and at 6,600 volts three-phase 60 cycles to the Municipality of Gravenhurst. The equipment in this station comprises one 450 k.v.a. three-phase 6,600-volt 720 revs. per min. 60-cycle generator direct connected to a 500 B.H.P. turbine; one 750 k.v.a. similar 720 revs. per min. generator direct connected to a 1,000 B.H.P. turbine; one bank of three 400 k.v.a. 6,600/22,000-volt transformers connected delta-delta; double low-tension 'bus and single high-tension 'bus. Four outgoing 6,600-volt feeders are provided, two feeding to Gravenhurst and two for future use. There will ultimately be three 1,500 k.v.a. generators with a turbine capacity of 6,000 H.P. installed. The excitation at this plant is provided by a turbine-driven exciter for the 450 k.v.a. unit, a motor-driven exciter for the 750 k.v.a. unit, which also has a belted exciter for emergency use, which is so arranged that it may excite either generator. The hydraulic head at this plant is 102 ft. The water is conducted through one steel and one wood stave pipe, each 946 ft. long to the turbines.

Wasdell's Falls System.—This system comprises a hydraulic generating station on the Severn River, near Severn Bridge, and sub-stations at Beaverton and Cannington. Power is transmitted to Beaverton and Cannington over a single-circuit steel-conductor line at 22,000 volts three-phase 60 cycles, and over a single-circuit aluminium tie line at the same voltage to the Commission's Severn system.

The generating station was constructed by the Commission in 1914, and is interesting on account of the low hydraulic head. The normal head is 12 ft., but variations from 9 ft. to 15 ft. occur. The equipment consists of two 400 k.v.a. 90 revs. per min. vertical type 60 cycles three-phase 2,300-volt generators connected through flexible couplings to turbines rated at 600 H.P. at 100 per cent. gate opening with 12 ft. head. Two exciters, one 20 kw. turbine-driven, and one 30 kw. motor-driven are provided. Two banks of transformers, each consisting of three 2,200/22,000-volt 150 k.v.a. units connected delta-delta are installed. Two outgoing 22,000-volt lines were provided. There are 37 miles of 22,000-volt circuit and 23 miles of 4,000-volt circuits from the two sub-stations.

Severn System.—This system comprises a hydraulic generating station on Severn River at Big Chute, with various sub-stations. The generating station as originally built in 1909 contained three

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* Abstract of a Paper read before the American Institute of Electrical Engineers.

900 k.v.a., three-phase, 2,200-volt, 60-cycle, 300 revs. per min., horizontal-shaft generators direct connected to turbines each rated at 1,300 H.P. under 56 ft. head; two 100 kw. 580 revs. per min., 125 volt exciters direct connected to 200 H.P. turbines; two transformer banks, each consisting of three 600 k.v.a., 2,200/25,000-volt water-cooled transformers connected delta-delta, with two outgoing 25,000-volt lines. There is now being installed one 1,600 k.v.a., three-phase, 60-cycle, 2,200-volt 300 revs. per min. horizontal generator direct-connected to a 2,300 H.P. turbine.

An interesting feature of the transmission lines of this system is the long spans across Matchedash Bay at Waubaushene, one being 1,135 ft. long and one 858 ft. long. The west shore tower is 175 ft. high, the middle and east shore towers are 88 ft. high.

Eugenia System.—This system obtains power from a hydraulic generating station on the Beaver River, being placed in service in November, 1915. Extensions are being completed to provide double the output. This development, with one exception, has the highest hydraulic head of any plant in Canada, being 552 ft. gross. It is also one of the highest heads in the world using reaction wheels. The first installation consisted of two 2,250 H.P. turbines each direct-connected to 1,410 k.v.a., three-phase, 4,000-volt, 60-cycle, 900 revs. per min., horizontal shaft generators having neutral grounded without resistance; one bank of three 900 k.v.a., 4,000/25,000-volt transformers connected delta-delta, single high-tension and low-tension buses, two outgoing 25,000-volt feeders and two 4,000 volt feeders, one each to Markdale and Flesherton. The extensions involve two additional generating units, and for double high-tension and low-tension buses, and for six 25,000-volt feeders. The new unit consists of a 2,810 k.v.a., three-phase, 60-cycle, 720 revs. per min. horizontal maximum rated generator direct connected to a 4,000 H.P. turbine. Each generator has a direct connected 125-volt exciter of sufficient capacity to excite two generators.

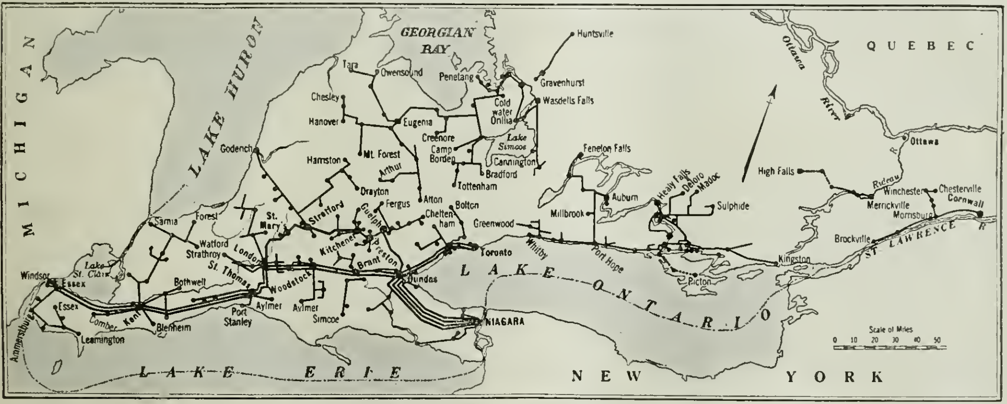

FIG. 1.—ELECTRIC GENERATING AND TRANSMISSION SYSTEMS OF THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO.

The storage of the water of the Beaver River was effected by two large storage dams. From the head works a wood stave pipe 46 in. in diameter conducts the water 3,400 ft. to a differential surge tank, 105 ft. high. From this tank a 52 in. diameter steel pipe is carried 1,550 ft. to the power house. Actual tests at this station gave an overall full-load efficiency of 80 per cent. Additional power will be obtained, when required, by the construction of further water storage, a second pipe line at the Eugenia Falls, the installation of a fourth unit, and the construction of a station near Lake Huron, which will make available a total output for the system of 15,000 H.P. The Eugenia system comprises 245 miles of 22,000-volt circuit (176 miles of lines), supplying sub-stations, and 50 miles of 4,000-volt circuits. This system is connected to the Severn system by a single circuit three-phase tie line from Eugenia to Collingwood, a distance of 24 miles.

Central Ontario System.—Five main generating stations, one on the Otonabee River and four on the Trent River, operating in parallel, supply this system. These are now fully loaded and plans are being prepared for new stations near Campbellford. The five exciting stations were built by the subsidiary companies of the Electric Power Company. The table gives particulars of existing developments, all generators being three-phase, 60 cycles, with 25 per cent. overload guarantees.

In addition, a 1,000 k.v.a., three-phase, 60-cycle, 120 revs. per min. horizontal generator owned by the town of Campbellford, delivers its output to the 2,400-volt bus in this station. Also at Fenelon Falls, a small generating station is operated, containing two 400 kw., 600-volt, three-phase, 60-cycle, 200 revs. per min. generators, connected to two 700 H.P. turbines. These feed into the 44,000-volt network of the Central Ontario system at Lindsay, the voltage being stepped up in the generating station through two banks of transformers to 11,000 volts for transmission to Lindsay.

The Trenton station was placed in operation in August, 1911. The four generators feed into a single sectionalised bus, and two 6,600-volt feeders conduct the current to a transforming station, which receives the output of the Frankford generating station at 6,600 volts. Two 75 kw. 125-volt exciter units are installed, one being a vertical turbine-driven unit and the other a motor-driven unit. Each of these exciters is capable of exciting all generators at 25 per cent. overload with 65 per cent. power factor current lagging. The Frankford station has a single unsectionalised 6,600-volt bus and its entire output is fed over two 6,600-volt circuits to the transforming station. The Trenton transforming station contains three 3,000 k.v.a., 6,600/44,000-volt, three-phase, 60-cycle, shell type transformers, connected delta-star with ungrounded neutral, double high-tension and low-tension buses, switching equipment for three 44,000-volt lines and for six 6,600-volt lines. The Campbellford station contains four 1,125 k.v.a., three-phase, core-type, 2,400/44,000-volt transformers and two outgoing 44,000-volt line equipments. Excitation is obtained from two 60 kw. 125-volt exciters, one turbine-driven and one motor-driven, with two 17½ kw. belted exciters for emergency use.

Location.	River.	Gross head feet.	Units.				Speed. revs. per min.	Type.	Generator voltage.
			Number.		Rated capacity.				
			Present.	Future.	Generator k.v.-a.	Turbine H.P.			
Trenton	Trent	20	4	...	937·5	1,400	120·0	Vertical	6,600
Frankford	Trent	18	4	...	812·5	1,200	112·5	Vertical	6,600
Campbellford	Trent	23	5	...	750·0	1,100	150·0	Vertical	2,400
Healy Falls	Trent	76	3*	1	3,750·0	5,600	240·0	Horizontal	6,600
Auburn	Otonabee	18	3	1	625·0	950	150·0	Horizontal	2–6,600 1–2,400

* One unit now being installed.

At the station at Healy Falls there are three 3,750 k.v.a.. three-phase, shell-type, 6,600/44,000-volt transformers installed, with very flexible switching equipment consisting of double 6,600-volt buses, two 44,000-volt outgoing lines, a sectionalised 44,000-volt single transfer 'bus, with a transformer and an outgoing line forming a unit which may be operated independent of the bus.

At the Auburn generating station the turbines are of the four runner type in open wheel pits, 40 ft. long, 16 ft. wide and 14 ft. deep. Two 90 kw. 125-volt exciters, one being turbine driven and one motor driven, furnish the excitation of this plant. One generator is wound for 2,400 volts and feeds a section of the bus from which 2,400-volt feeders may be taken. This section of 'bus is connected to the 6,600-volt section of the bus through a bank of three 200 k.v.a. 2,400/6,600-volt transformers. Feeders at 6,600 volts, three-phase, connect this station to the transformer station adjacent which contains two 1,875 k.v.a., three-phase, core-type 6,600/44,000-volt transformers and one outgoing 44,000-volt line connecting into the 44,000-volt network of the Central Ontario system.

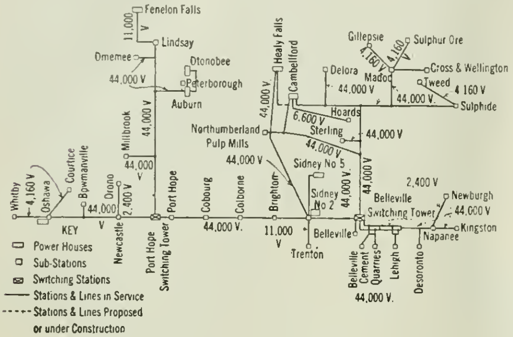

Fig. 2.—Central Ontario System.

The accompanying map, Fig. 1, and the diagram, Fig. 2, show the location of the generating stations of the Central Ontario system, and the extent of the transmission network with sub-stations. Other power sites along the Trent Valley Canal will, when developed, bring the total supply up to 60,000 electrical horse power, with a maximum capacity of 75,000 electrical horse power. The present power output of the system is used for lighting street railway and manufacturing purposes. All transmission lines are constructed on wood poles. The total mileage of 44,000-volt circuits is 372, with 15 miles of 11,000-volt circuit, 16·4 miles of 6,600-volt circuits, and 52 miles of 4,000-volt circuits.

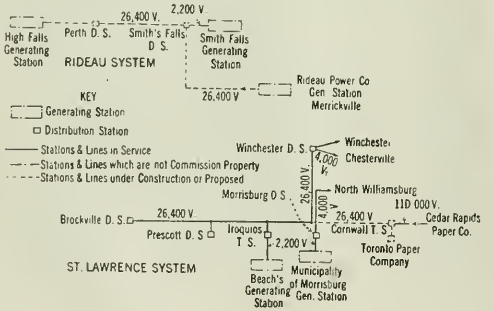

Fig. 3.—St Lawrence and Rideau Systems.

St. Lawrence System.—This system at the present time has no generating station owned by the Commission. Power is secured by contract from the hydraulic station of the M. F. Beach Company at Iroquois. As additional power is needed arrangements are now being made to obtain an adequate supply from another source, near Cornwall. To take this power the Commission is now constructing a transforming station near Cornwall, which will contain one bank of three 1,250 k.v.a., single-phase, 63,500/26,400-volt, 60-cycle transformers connected star-delta and switching equipment for two incoming 110,000-volt circuits and for two outgoing 26,400-volt circuits.

Rideau System.—A new network is being developed called the Rideau system and covering a district in the neighbourhood of the Rideau River. The installation will consist of four 350 kw., 2,200-volt, three-phase, 60-cycle, 300 revs. per min. horizontal generators connected to two turbines, one generator being at each end of turbine, and one 875 k.v.a. 80 per cent. power-factor, three-phase, 60-cycle, 2,200-volt, 300 revs. per min. generator, direct connected to its turbine with necessary switching and transformer equipment to transmit the full 2,100 kw. output, at 26,400 volts to the Rideau system.

Niagara System.—The Niagara system comprises all lines and sub-stations that receive power from Niagara Falls. Power is received at a transformer station at Niagara Falls from the Ontario Power Company (now controlled and operated by the Commission), and from the Canadian Niagara Power Company, at 12,000 volts, three-phase, 25-cycles, and is transformed to 110,000 volts and to 45,700 volts for transmission. There is now installed in the Niagara transformer station 132,000 k.v.a. of 110,000-volt transformers in eight banks and 42,000 k.v.a. of 45,700-volt transformers in four banks, not including spare units. Four banks of 110,000-volt units are composed of 12 7,500 k.v.a., single-phase, shell type 12,000/63,500-volt transformers, all other transformers being of 3,500 k.v.a. rating. This station, in point of transformer capacity, is the largest in the world, having a total capacity of 174,000 k.v.a., with 7,000 k.v.a. in spare units additional.

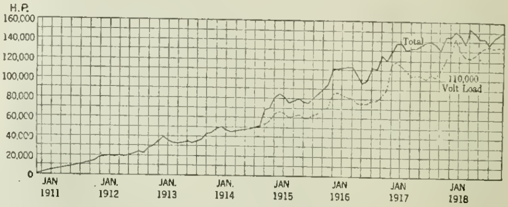

Fig. 4.—Curve showing Monthly Increase of Power Load of Municipalities' Niagara System, October, 1910, to October, 1918.

Four outgoing 110,000-volt circuits feed to Dundas transformer and switching station, and from there power is distributed to 13 110,000-volt transformer stations. Four 45,700 volt lines feed to Welland to the sub-stations of the Electric Steel & Metals Company, the Union Carbide Company and the city of Welland. From this latter point a single-circuit, 45,700-volt line runs to Dunnville.

This system was placed in operation in October, 1910. The curve in Fig. 4 shows the monthly increase in power load of municipalities on this system from October, 1910, to October, 1918. Fig. 5 contains a general plan of the system.

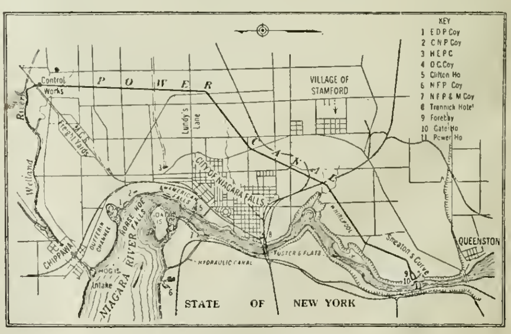

Fig. 5.—General Plan of Niagara Power Development, Hydro-Electric Commission.

The transmission network on this system contains 760 miles of 110,000-volt circuits, 65 miles of 45,700-volt circuits, 529 miles of 26,400-volt circuits, 489 miles of 13,200-volt circuits, 27 miles of 6,600-volt circuits, 180 miles of 4,000-volt circuits, and 20 miles of 2,200-volt circuits.

The original article also contains some account of the Erindale Power Company's hydraulic generating station, which the Commission took over in 1917, and some details of the plant of the Ontario Power Company, to which extensions are also being made.

The Queenstown Development.—This development presents some interesting features and in the original article the method of applying and collecting the water power is described in some detail.

The development now under construction is designed as regards canal, forebay, gatehouse sub-structure and power house substructure, for a capacity of 300,000 H.P. It is proposed to construct the gatehouse and power house superstructure for an initial installation of 200,000 H.P. in four units. The designs are made so that extensions of power house and gatehouse can be made to almost any extent. Future plans contemplate the use of 100,000 H.P. units. The turbine speed has been fixed at 187·5 revs. per min., and specification for the generators are now being issued calling for 45,000 k.v.a. 85 per cent. power-factor, 12,000-volt, three-phase, maximum rated generators of vertical type, equipped with thrust bearings to take the weight of the rotating part of the generator plus the downward thrust of the turbines. Direct-connected exciters mounted above the thrust bearings are proposed. The generators will be liberally equipped with embedded temperature detectors so that close and accurate observations may be kept of operating temperatures. The specified maximum temperature of any part of the generator at rated load is 100°C., with cooling air at 40°C. The ventilating problem for such units is of great importance, each unit requiring approximately 125,000 cubic ft. of air per minute.

Another feature of interest is the extensive use of electric power for shovels, trains, air compressors, &c., and electrified railway to assist in the constructive work. It is hoped that this use of electric power, derived hydraulically, will be of great assistance in saving coal

In conclusion, a list of some reports and publications dealing with electric power generation in Ontario, is given in the original article.

Pulsation of the D.C. Terminal Voltage in Rotary Converters.

By J. K. KOSTKO.

(Continued from p. 39.)

PULSATIONS DUE TO THE REVERSE M.M.F. OF THE ARMATURE IN SINGLE-PHASE CONVERTERS.

The primary cause of these pulsations is the same as of the reactance E.M.F.—*i.e.*, the self-induction of the armature; but in this case the problem is complicated by the reaction of field windings and by the absence of standardised construction of the field member and arrangement of field windings, which are largely dependent on the method of the starting of a particular type. In what follows two characteristic cases will be studied: (1) The field member has pronounced poles, concentrated shunt winding and a squirrel-cage amortisseur winding; (2) the field member has no pronounced poles and carries two distributed windings at right angles to each other, the shunt field winding and a short-circuited winding, forming together an amortisseur winding. The method, however, can be applied to any other arrangement. It is based on the following remark:

The revolving reverse M.M.F. may be considered as due to a system of fictitious M.M.F.s, polyphase in time and in space and distributed in the air-gap according to the sine law; for instance, to two M.M.F.s of the same amplitude as the reverse M.M.F., one coaxial with the line of the direct current brushes, the other coaxial with the line of the poles; if the field member is symmetrical with respect to these two axes, the M.M.F.s will act independently from each other; E.M.F.s between the direct current brushes will then be induced by the transformer action of the resultant field coaxial with the line of the brushes ("transformer E.M.F."), and by the rotation of the armature in the resultant field coaxial with the line of the poles ("rotation E.M.F.").

Incidentally, the knowledge of these two resultant fields throws some light on another difficult point of the design of single phase converters—sparking due to the action of the reverse M.M.F.; a coil short-circuited by the brushes moves across the resultant field in line with the brushes and is subject to the inductive action of the resultant field in line with the poles; E.M.F.s induced in the coil by these fields are very nearly in phase opposition; as the speed of the machine is constant, their values—for a given current—depend only on the constitution of electric and magnetic circuits along respective axes: therefore, they can be made to neutralise each other by a suitable arrangement of the stator and stator windings.

In the calculation of these fields the influence of eddy currents in the iron will be neglected; this is permissible in the case of small single phase converters which are usually built with completely laminated magnetic circuit in order to facilitate the starting from the alternating current side, either as commutator motors or as induction motors.

Let N be the total number of conductors on armature, a—the number of pairs of armature paths, p—the number of pairs of poles, τ—the pole pitch, f—the frequency of the supply, $\omega=2\pi f$, and $2I$—the amplitude of the alternating current in the line; the amplitude A of the reverse M.M.F. is $0{\cdot}4\frac{NI_m}{ap\pi}$;* therefore, counting the peripheral distance y from the axis of the pole, the M.M.F. coaxial with the line of poles may be represented by $Q_1=A\sin 2\omega t\cos\frac{\pi y}{\tau}$, and that coaxial with the line of brushes—by $Q_2=A\cos 2\omega t\sin\frac{\pi y}{\tau}$.

PRONOUNCED POLES, CONCENTRATED SHUNT FIELD WINDING AND SQUIRREL CAGE AMORTISSEUR WINDING.

Considering the current in a bar of the squirrel cage winding as super-position of currents set up by the M.M.F.s Q_1 and Q_2, let i_x be the current due to Q_1 in the x^{th} bar counted from the axis of the pole; r_x and l_x—the resistance and the local inductance respectively of the x^{th} bar, R_x and L_x—the resistance and the local inductance of sections of end rings (both sides in series) between the axis of poles and the x^{th} bar, P_x—the permeance (for the single air-gap) of the magnetic circuit for the flux crossing the air-gap between the axis of poles and the x^{th} bar; R_s, L_s and P_s—the resistance, the local inductance and the permeance for the shunt field coil consisting of n turns. All these elements can be calculated from the design data of the machine; if the air-gap is uniform, $P_x=\frac{Wc}{g}$, W being the axial length of the armature, c_x—the distance between the axis of poles and the x^{th} bar, and g—the equivalent air-gap corrected for the average saturation of the magnetic circuit; all dimensions expressed in cm.

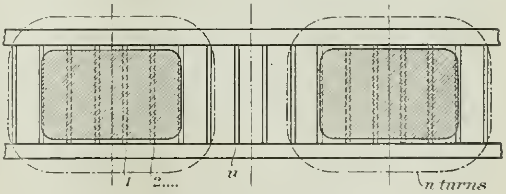

FIG. 3.

The flux due to the M.M.F. Q_1 and comprised between the axis of poles and the x^{th} bar can be represented by $F\sin 2\omega t$, ($F_s\sin 2\omega t$ for the shunt coil), where

$$F_x=\int_0^{c_x}A\frac{W}{g}\cos\frac{\pi y}{\tau}dy.$$

If g is uniform, this expression becomes $F_x=A\frac{W}{g}\frac{\tau}{\pi}\sin\frac{\pi c_x}{\tau}$.

As the distribution of the currents i_x is symmetrical with respect to the axis of poles, the flux in the main magnetic circuit comprised between the axis and the x^{th} bar and due to various currents is

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* See Note No. 3.

$$0{\cdot}4\pi\sum_{\kappa=1}^{\kappa=x}P_\kappa i_\kappa+0{\cdot}4\pi P_x\ \Big(\sum_{\kappa=x+1}^{\kappa=u}i_\kappa+ni_s\Big),$$

where u is the total number of bars in one half of the pole pitch, both embedded in the pole face and located between the pole pieces, and i_s is the alternating current in the shunt field winding.

In the circuit consisting of the two bars x symmetrical with respect to the axis and connected by sections of the end rings, the current in the latter can be considered as super-position of various currents flowing from the bars; the equation of the E.M.F.s in this circuit is

$$-2\omega F_x\cos 2\omega t\times10^{-8}=r_x i_x+l_x\frac{di_x}{dt}$$
$$+\sum_{\kappa=1}^{\kappa=x}\Big[R_\kappa i_\kappa+\frac{di_\kappa}{dt}\,(0{\cdot}4\pi P_\kappa\times10^{-8}+L_\kappa)\Big]$$
$$+R_x\sum_{\kappa=x+1}^{\kappa=u}i_\kappa+(0{\cdot}4\pi P_x\times10^{-8}+L_x)\sum_{\kappa=x+1}^{\kappa=u}\frac{di_\kappa}{dt}+0{\cdot}4\pi P_x n\,\frac{di_s}{dt}\times10^{-8},$$

and for the shunt winding (considering as negligible the permeance of the main magnetic circuit in the space between the poles),

$$-2\omega nF_s\cos 2\omega t\times10^{-8}=R_s i_s+(0{\cdot}4\pi P_s n^2\times10^{-8}+L_s)\,\frac{di_s}{dt}$$
$$+2\times0{\cdot}4\pi n\times10^{-8}\sum_{\kappa=1}^{\kappa=u}P_\kappa\,\frac{di_\kappa}{dt}.$$

Currents i_x and i_s can be calculated from these equations as follows:—

The general expression of i_x is $i_x=a_x\sin 2\omega t-b_x\cos 2\omega t$, hence: $\frac{di_x}{dt}=2\omega a_x\cos 2\omega t+2\omega b_x\sin 2\omega t$; substitution of these values in the above equations transforms them into equations of the form,

$$M_x\sin 2\omega t+N_x\cos 2\omega t=0,$$

equivalent to $M_x=0$ and $N_x=0$.
M_x and N_x being linear functions of the unknown coefficients a_x and b_x. This gives a system of $2u+2$ linear equations from which the $2u+2$ coefficients for currents in the bars and in the shunt coil can be easily calculated, the number u seldom exceeding 3 or 4. All currents are thus determined in amplitude and in phase

$$i_x=\sqrt{a^2{}_x+b^2{}_x}\,\sin\Big(2\omega t-\tan^{-1}\frac{b_x}{a_x}\Big).$$

It may be remarked that the method is not based on the uniformity of section of bars and end-rings and the regular spacing of bars: the symmetry with respect to the two axes is the only assumption.

Neglecting the flux set up by the M.M.F. Q_1 but not linked with the shunt coil, the amplitude H of the resultant flux (per pole) coaxial with the line of poles and its angle of lag δ with respect to the M.M.F. Q_1 can be calculated from the equation

$$H\sin(2\omega t-\delta)=F_s\sin 2\omega t+2\times0{\cdot}4\pi\sum_{\kappa=1}^{\kappa=u}P_\kappa i_\kappa,$$

and the rotation E.M.F.s expression is $\frac{HNf}{a}10^{-8}\sin(2\omega t-\delta)$.

Currents due to the component Q_2 can be calculated in a similar way; the transformer E.M.F. can then be determined as follows: let $F(y,t)$ be, at the moment t, the alternating flux linked with an armature coil having one side located at a distance y from the axis of the pole. If the armature winding be followed from this point, the peripheral advance dy will be accomplished after passing $\frac{N\,dy}{4a\tau}$ turns in series; therefore, the transformer E.M.F. per element dy is

$$-\frac{N\,dy}{4a\tau}\frac{\partial F}{\partial t}10^{-8},$$

and the transformer E.M.F. between the brushes

$$-\frac{N}{4a\tau}10^{-8}\int_{-\tau/2}^{+\tau/2}\frac{\partial F}{\partial t}\,dy.\quad.\quad.\quad.\quad.\quad(4)$$

The distribution of currents in the squirrel cage having been determined, the function $F(y,t)$ can be easily calculated for each interval between bars; the application of formula (4) gives then the transformer E.M.F. which can be reduced to the form,

$$-T\sin(2\omega t-\delta_1),$$

δ_1 being a small angle of lag of the transformer E.M.F. against the E.M.F. which would be set up by the field of Q_2 acting alone (*i.e.*, without squirrel cage winding).

It remains now to find the phase relation of these two E.M.F.s to the impedance E.M.F. e. Considering first the rotation E.M.F.: when $a=\psi$ in Fig. 1 (ψ being taken with its proper sign), *i.e.*, when the alternating current in the armature is maximum, the axis of the revolving reverse M.M.F. is directed along $A'A$, and the angle $(A'A,NS)$ is equal to $\frac{\pi}{2}-\psi$; as the velocity of the reverse M.M.F. is twice as great as that of the armature, the reverse M.M.F. will be directed along $N-S$ when $a=\psi+\frac{1}{2}\left(\frac{\pi}{2}-\psi\right)=\frac{\pi}{4}+\frac{\psi}{2}$; its stationary component Q_1 will then have the same direction and pass through the maximum; since δ is the angle of lag between Q_1 and the resultant field H, the rotation E.M.F. will be maximum and in the same direction as the direct current E.M.F. E_d when $a=\frac{\pi}{4}+\frac{\psi}{2}+\frac{\delta}{2}$; therefore, its expression in function of a will be

$$\frac{HNf}{a}10^{-8}\sin(2a-\psi-\delta).$$

In a similar way the transformer E.M.F. can be represented by $-T\sin(2a-\psi-\delta_1)$, and the complete expression of the direct current terminal voltage V_d of a single-phase converter is

$$V_d=E_d-\text{drop under the brushes}-I_dR+e$$
$$+\frac{HNf}{a}10^{-8}\sin(2a-\psi-\delta)-T\sin(2a-\psi-\delta_1)\quad.\quad.\quad.\quad(5)$$

No Pronounced Poles, Distributed Shunt Field Winding and Short-Circuited Amortisseur Winding at Right Angles to the Shunt Winding.

Assume that the shunt winding consists of n turns per pair of poles distributed over S cm. per pole pitch. The current i set up in this winding by Q_1 can be calculated as follows: since the small resultant alternating flux in line with the pole does not affect appreciably the state of saturation of the main magnetic circuit, the equivalent air-gap g can be corrected for the average saturation; the fluxes due to Q_1 and to the current i can then be considered as existing separately. The self-induction coefficient L of the distributed shunt winding (for the lines linked with the entire magnetic circuit) is

$$0{\cdot}4\pi\frac{W}{g}n^2\left(\frac{\tau}{2}-\frac{S}{3}\right)\times10^{-8}\ \text{henry}\ *;$$

the E.M.F. induced in this winding by the field set up by Q_1 is equal to † $-8A\omega\cos 2\omega t\,\frac{\tau^2}{\pi^2}\frac{W}{g}\frac{n}{S}\sin\frac{\pi S}{2\tau}10^{-8}$ volts; therefore, if r and l are the resistance and the local inductance of the shunt winding (in comparison with which the corresponding elements of the armature winding completing the circuit are usually negligible), the equation of the alternating current in the shunt winding is

$$-8A\omega\cos 2\omega t\,\frac{\tau^2}{\pi^2}\frac{W}{g}\frac{n}{S}\sin\frac{\pi S}{2\tau}\,10^{-8}=ri$$
$$+\Big[l+0{\cdot}4\,\pi\,\frac{W}{g}\,n^2\Big(\frac{\tau}{2}-\frac{S}{3}\Big)10^{-8}\Big]\frac{di}{dt}.$$

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* See Note No. 4. † See Note No. 5.

From this equation of the familiar type i can be determined in amplitude and phase. The alternating flux between the direct current brushes is the algebraic sum of the sinusoidal field due to Q_1 and the trapezoidal field due to the current i in the shunt winding; the maximum value of the latter extends over $\tau - S$ cm. and is equal to $0{\cdot}4\pi\frac{1}{g}\frac{ni}{2}$. This flux is, therefore,

$$\frac{W}{g}\left[\frac{2\tau}{\pi} A \sin 2\omega t + 0{\cdot}4\,\pi\frac{ni}{2}\left(\tau - \frac{S}{2}\right)\right].$$

Since i is known, this expression can be transformed into $H \sin(2\omega t - \delta)$; the rotation E.M.F. is then

$$\frac{HNf}{a} 10^{-8} \sin(2\omega t - \delta),$$

or, in function of α (Fig. 1), $\frac{HNf}{a} 10^{-8} \sin(2\alpha - \psi - \delta)$.

For the calculation of the transformer E.M.F. the current i_1 in the distributed amortisseur winding is calculated by the same method as in the shunt winding: the function $F(y,t)$, *i.e.*, the flux linked with the armature coil having one side at y, is then determined as the sum of the sine wave field due to Q_2 and of the trapezoidal field due to the current i_1; finally the transformer E.M.F. is calculated by the formula (4) and is found to be *: (n'=amortisseur coil turns per pole, S' cm.= width of coil-side)

$$\frac{N}{4a}\frac{W}{g}\left[\frac{8\omega\tau A}{\pi^2}\sin 2\omega t - 0{\cdot}4\,\pi\, n'\left(\frac{\tau}{4} - \frac{S'^2}{12\tau}\right)\frac{di_1}{dt}\right]10^{-8},$$

which may be transformed into $-T \sin(2\omega t - \delta_1)$, or, in function of α, into $-T \sin(2\alpha - \psi - \delta_1)$; the direct current terminal voltage is then expressed by formula (5).

(To be concluded.)

Incentives to Efficiency in Scientific Management.

Mr. Henry Atkinson recently delivered a lecture on the above subject before the Industrial Reconstruction Council.

In the course of his lecture, Mr. **Atkinson** said he would make a point of not saying anything about the war and of dealing with nothing but the necessity for greatly increased production, which was almost as important in peace as it was for war. Before dealing with the technical part of the subject, he wished to make a few remarks about the present aspect of the question of production. We all had our own ideas of life and what it meant, and to him the whole thing seemed to resolve itself into the value of this question of production—the value of leisure which enabled us to do the things we wanted to do. The work of the world must be done, and to live decently and normally a man must have food and clothing. He must produce them himself or get someone to produce them for him. Most of us earned them ourselves. Our first interest was to do the things we had to do, and then if we were fortunate enough to earn enough we could set about the things we wanted to do. If we were to have leisure the provision for our necessities during that leisure depended upon greater production during working hours. The greater the production the greater the wealth, and the greater the wealth the greater the leisure. But production was only a means to an end. The real need was to gain such material wealth as would give us leisure, and hence a greater and fuller life. Every able-bodied man could produce more than was consumed by an average family, and a degree of luxury was even now within reach under proper organisation and distribution. The degree of difference between production and consumption was the measure of the surplus wealth of the world. It was obvious that the easier and quicker wealth was produced the better it would be for each of us and for the world in general. The distribution of the wealth was a matter he could not deal with there. Some attempt at better distribution was being made and incentives to greater production involved a more even distribution of wealth. The more efficient our operations and processes and organisation the easier it would be to produce wealth, and it was in scientific management that he saw a way whereby one might have a reasonable chance of attaining the end. It meant greater output per man to increase leisure and leave the workers free to do those things most desired. Leisure was the chief thing in life. One wanted to do many things that could not be done because one had to work for a living.

Scientific management was not purely an American production. Its principles were applied here even before America was discovered. About 1240 it was recorded that Walker, of Henley, divided an agricultural holding into three sections, of which one was allowed to lie fallow every year, and adopted a system of which the present system of rotation of crops was an amplification. He calculated that a man should plough a given number of acres per day, having due regard to the quality of the land, and he pointed out that if a man did not carry out that task, it was restriction of output and should be severely dealt with. But Taylor carried out the investigation to a fine degree of detail which enabled one to get to the bedrock of production. It was often thought that scientific management meant hurry and scurry—get on or get off—but the facts were directly contrary. It had been realised by Taylor and others that industry was being carried on in a slovenly and inefficient manner, and that by a better organisation and closer study of the conditions and operations a good deal of waste could be eliminated, higher wages could be paid and goods produced at a lower cost, and as a natural result there would be larger markets, wider sales and the employment of an increased number of workers. They argued further that a strong, healthy, contented worker could do his work better than a weak, unhealthy type of man, and therefore the conditions under which he worked must be such that he was contented and healthy, and that at the end of the day he was sufficiently fresh to enjoy his leisure. Under those conditions the more intelligent worker would introduce labour-saving devices and methods by which economical production was furthered.

The monotony of work was relieved if an interest was created. No man cared to do his best continuously unless there was some incentive to encourage him. Therefore, incentives were an important factor in production under scientific management, and the greatest incentive to production was the commercial spirit which set its own standard of life and progress and provided that a man would receive a reward if he produced what he could in the shortest possible time. That was an ideal condition, and the incentives adopted in industry generally and under scientific management had a more material basis. An incentive might be an inducement to the worker by increased reward or it might be something which induced a man not to become indifferent to the work in which he was engaged. A forced incentive was to compel a man, against his will, to perform his task, and an induced incentive was to induce a man willingly to do his work to the best of his ability. Bullying foremen and fear of discharge were amongst the forced incentives, while induced incentives took the form of profit sharing, co-partnership, co-operation in production, better conditions of working, security of employment and payment by results. There were also incentives which might pass from one class to the other, such as promotion and the making and keeping of a reputation. Purely forced incentives in their commonest forms were anachronisms and would probably disappear before long. High wages tended to make a man willingly perform his work, but the fear of losing a good job and the fear of being reduced were also incentives, and the fear that a reputation might be lost unless a man kept steadily to his work. Profit-sharing as an incentive was no part of scientific management as at present practised. This became co-partnership if the profit were given in shares instead of cash, and the fact that the worker stood to lose something if he neglected his work was an incentive to production. Co-operative production was the name given to the group form of production. Good conditions of working had no material effect as incentives. They were taken more as a right, as they should be. If a factory offered 2s. or 3s. more in wages, men preferred the money rather than good conditions. There was, however, one advantage; the better class of workman preferred better conditions in preference to 2s. or 3s. a week more. Security of employment was not usually practised, but if it were understood by workers that they would never be discharged except for misconduct, that would be one of the most valuable incentives.

Payment by results might be in the form of profit-sharing payment according to group output, bonus, or individual reward for efficiency. A contractor, say, for a bridge, quoted for the contract, and the sooner the job was done the more profit he got. He offered a bonus to the men if the job were done in a certain time. In the case of group output, if the output exceeded a definite quantity for a minimum period the bonus was given. Messrs. Priestman Bros. having decided that production could be considerably increased, took a three-years' average of the work done in the shop, and on that basis they determined to pay their employees, including managers and clerks, as well as other workers, a bonus on the increased output. The output had been increased about 40 per cent. in the last two years, and the scheme had been satisfactory. That was where profit-sharing had led to group output. He understood Messrs. Priestman's were adopting a method similar to Taylor's in regard to profit-sharing. The employees received not only a special bonus for the extra production, but when the profit exceeded a certain percentage on capital they also got a share of that. There could be no justification in that case for saying the employers profited at the expense of labour. It had not yet been tried, however, under peace conditions. When a shop began to empty and men had to be put off, then would be the test of the system, but he thought it would come through it satisfactorily.

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* See Note No. 6.

Piece work was one of the best forms of payment for work done. The disadvantages consisted of the cutting of rates when one man earned more than a certain proportion above the day rate, which prejudiced the system. With regard to the premium bonus system, a reasonable time the job should take was fixed by a rate fixer or by mutual understanding, and an extra bonus was given in proportion to the time saved. An important method, and the one used in scientific management was that of giving a reward for individual efficiency. It was, in principle, similar to the premium bonus system, the difference being that the rate instead of being fixed arbitrarily was fixed by an exact study of the job, the speed of the machine and the best kind of tools and materials, which enabled the work to be done in the shortest possible time. Mr. Allingham dealt in his recent lecture with determination of standards. When the standards were determined the question arose what incentive should be given to induce the worker to act in accordance with those standards. The conditions should be such as to make the worker comfortable and contented. Good lighting, first rate rest rooms, canteens, &c., might be regarded as incentives. An important incentive was giving the worker some responsibility. Any suggestion he made in connection with the work was brought before the manager and considered, and a reward given if the suggestion were adopted. The difficulty in that was that the men in putting forward suggestions claimed that it was making the fortune of the firm, and it was difficult to make a man understand that his suggestion was only a little one. Men used their brains and took out patents. The firm bought one or two, but the men wanted an enormous price and they could not understand that unless the firm took them up they were useless to them. In regard to payment for individual efficiency, if the work were done according to instructions, the rates were arranged so that every worker was able to earn at least 25 per cent. more than his day rate of wages. The basis of payment was the instruction card. The Taylor system was a straight piece rate, and when the men reached an output which Taylor called the test they got an increased rate of payment. Take an article for which the piece rate was 1s. If the men got 10 per cent. of their efficiency, which was rated at 100 per cent., they got 10 per cent. of the wage rate. When they reached 100 per cent. efficiency they got an increase of 40 per cent. above the piece rate. If the piece rate for the article were 10d., they got 14d. A certain number of pieces ought to be done in a certain time—say, 10 per day. If the worker turned out 9·9 pieces he received 9 9 shillings at the price of 1s. each. If he did 10 he received 14s.

In the Halsey system the method was different. A man was assumed to have a certain efficiency, and he got paid his day rate. It did not matter whether he had 10, 20 or 30 per cent. efficiency until he came to a certain point. The operation was studied, and it was found a good average worker could turn out a certain number of pieces in a certain time. That was called the standard quantity, and was considered to be 100 per cent. efficiency. To give some encouragement the men got a bonus even if they took a longer time on the job. If the standard quantity were 10 pieces a day and a worker did nine pieces he got a certain bonus in addition to the day rate. Instead of waiting till he reached 100 per cent. efficiency he might get it on as low as 62½ per cent. efficiency. The method was so well adapted to ordinary payment that it was the commonest form of payment under scientific management. The Taylor method was the first, but it was only used in very few shops, because the standard set was so high that few men could reach it. Taylor got rid of the men who could not reach it. Gant's method was somewhat similar to Taylor's He guaranteed a man a certain percentage according to his efficiency. If a man did no work at all he got 75 per cent. of his day wages. As he did more and more work his wages went up until when he reached 100 per cent. he got the same as under the Taylor system. Otherwise the system was the same as Taylor's.

He thought that the Halsey system was, on the whole, the most satisfactory. The day rate was guaranteed and a bonus was reached some time before 100 per cent. efficiency was reached. The 100 per cent. efficiency could be fixed where one liked. It depended on the study of the operation. There was a jump when 100 per cent. efficiency was reached. In a chart which he showed, only 10 per cent. was added at 100 per cent. efficiency, making the same wages as under the Taylor system, because a considerable increase had been given below that point. With automatic or semi-automatic machinery it had been found better to begin the bonus at a higher efficiency, say, about 80 per cent. At 100 per cent. efficiency the bonus was 25 per cent. The Rowan system was not in use in this country, and it was a most unscientific method. The time was given to the job by a rate fixer or the time was given that it had been done in before. For every 10 per cent. that the time was reduced 10 per cent. was added to the wages. It was contrary to scientific management principles. With scientific management the increase was not only pro rata, but a better bonus was given for producing the job in the shortest time. The Rowan system was not found satisfactory. The worker claimed that if he saved the time he was entitled to the result of the saving. He overlooked the fact that it necessitated having highly scientific men to make the time studies, and also the fact that his day wages had to be guaranteed. In one works the machinery was automatic. The times of the machines were not altered when they should have been, and the average efficiency of the workers was about 55 per cent. They did not get any bonus. They were compensated by giving them 2s. a day each, and their efficiency dropped to 45 per cent., which showed that the incentive had previously been constantly there. Some of the men would have made 100 per cent. efficiency if the times had been altered. Under scientific management every worker could obtain extra wages, and every worker had an opportunity, but some men could do twice or three times as much as others. In works he had in mind they had one girl with an efficiency of between 300 and 400 per cent. on one job. She was doing something in connection with a shell. She had to unscrew the nose, put on another, and perform another operation. She found that instead of needing to stop the machine she could unscrew faster than the thing went round. She put the other nose there, and the machine screwed it up. The other girls wanted to know why they were not earning as much money. Another time study of the job had to be made. The day wage being guaranteed, the incentive to attempt greater production continued throughout the day, and the result immediately followed the effort. That was the finest system he had come across.

Under the Ford system there was a straight piece rate and no bonus. In some respects, however, the Ford system was most scientific. Every single job was timed. Ford engaged men at 50 per cent. (he thought it was more now) above the wages they had earned previously, but only on condition that they worked according to instructions. He got the pick of the workers, and when he adopted the system he got a thousand applications a day from all parts of the United States. The adoption of scientific management would, he thought, do much to bring about a condition of permanent prosperity to employers and employed. An efficient man would earn a wage that would place him in a highly satisfactory condition. The question of the minimum wage would doubtless be a bone of contention for some time. It was often overlooked by both sides that the worker ceased to be a worker in the ordinary sense of the word, and was as a matter of fact a contractor to the firm, and agreed to produce a certain quantity of work of a certain quality at a definite price and under certain conditions. Failure to fulfil his contract renders him liable to lose his money, and failure on the part of the employer to keep to his part of the contract renders him liable damages. The worker has the right to know how the rates are determined and to receive instructions as to how to do the work. He looked upon the whole of these methods of operation and payment by results as emancipation from trade slavery.

DISCUSSION.

Mr. BUTTERWORTH said he had come to the conclusion that the methods the lecturer spoke of as having been used in this country must have been used in shops where scientific management as such was not properly installed, otherwise the question of the cutting of rates would not have arisen. Rate-cutting had caused the bulk of the labour troubles in this country. When a rate was cut once a man began to think, and when it was cut twice he was done with the job. Well lighted and sanitary workshops should not be regarded as a reward. It was simply a duty to one's fellow men to provide them. Many of the systems the lecturer had spoken of were more or less obsolete. The first origin of these was the Towne system of the Yale & Towne Manufacturing Company in America. Then Halsey came along and improved the system, and it was known as the Towne-Halsey principle, and was undoubtedly a good one. After that Taylor came along with his piece rate, but the lecturer had not referred to that specifically as a differential rate. Supposing the standard were 20 pieces a day, a man got 20s. for 20, but if he only did 19 he only got about 8d. each. That was a tremendous penalty for dropping one piece. Taylor was undoubtedly a driver. His system was right, but his methods were wrong, and his system came into more or less disrepute. Gant, one of Taylor's able lieutenants, devised the day work, plus bonus plan. That was a good system. Every man had a day rate while learning. A man should not be penalised because he was learning to do a job in the way the employer wanted it done. A combination of the Taylor and Gant systems was regarded by some manufacturers as about as ideal as one could get. The stop watch was a most unreliable instrument. One could judge the interval that elapsed between receiving an impression and acting upon it by touching a person on the neck or back and asking the person to tap a table with the right or left hand respectively in response to the touches. The interval was sometimes quite considerable. Years of Taylor's work had recently been proved to be useless for the reason that he took his stop-watch records without regard to the conditions.

Mr. H. W. Allingham did not think stop watches unreliable in the hands of a trained observer. Stop watches were largely used at the front in fixing and calculating the position of the enemy's artillery. Our observers recorded by stop watches the time betwween a flash of a gun and the time the report reached them, calculating, from the known velocity of sound. the approximate distance of the gun. When these observations could be taken at two or three points the position of the gun was fixed by triangulation. The Germans had a complete system of sound ranging. They had a series of observers with stop watches, and connected up by telephones. Each man stopped his watch as the sound of the gun reached him, and he sent a buzz to the other observers behind him. They got results which showed an accuracy of something like 1/50 sec. Stop watches might be of great value in time-study work, but they should be used quite openly with the consent of the workmen. Profit sharing had the disadvantages that in lean years the workers were dissatisfied, the incentive was not immediate, and it was not an incentive to the individual worker. It might be a useful and fair arrangement, but should be in addition to other incentives.

Major Pells, R.E., said the Rowan system was considered by the lecturer to be unscientific, but he thought it scientific because it was designed to protect the worker against himself. It was based on the assumption that a man who got a piece rate and bonus worked very hard and might do himself real harm, and the Rowan system allowed him to work up to a certain efficiency, and then forced a rest factor upon him.

Lt.-Col. Pottinger said Mr. Ernest Benn, the chairman of that Council, had held a conference with directors of Priestman Bros. on their system of profit sharing, combined with bonus, and he (Col. Pottinger) thought a memorandum on the subject would probably be printed and placed on sale, and that it would deal with points Mr. Allingham had raised. It was laid down that rates were never to be cut except by a work's committee, which combined employers and employed. In a series of lectures early in next autumn it was proposed to deal with bonus systems and payment at various rates.

The Chairman said the great difficulty of these scientific systems was that if the men earned a lot of money the employer thought he was being done, and if a man did not earn a lot of money easily he thought he was being done. In the business with which he was connected the profit, after providing for certain requirements, was simply divided between the shareholders and all the employees.

Mr. Armstrong asked the lecturer if he could explain why scientific management should have been so viciously attacked by Mr. Cole in his recent book on wages.

Mr. Wilson asked on what grounds the lecturer based his opinion that fixity of tenure would secure better workmen and better output. In the services that was not found to be the case. All this efficiency seemed to be based on labour, and on output rather than efficiency. Would the lecturer explain what he meant by efficiency. He thought much might be said for employers insuring their employees against death or accident.

Miss Voysey asked what happened to the money when the rate was cut because the worker had earned too much ? Was there a method to improve the quality of the work as well as increase the quantity ?

The Lecturer, replying to the discussion, said the output he spoke of was output of good work. The work was tested to see whether it was up to standard. The best workers first took up the jobs and the time was fixed on the strength of that. Mr. Butterworth said rates could not be cut under scientific management, but it was nearly always done. He did not think a workshop could be found in America where rates were not cut. It was not cutting the rate in the ordinary sense. The new timing was done in such a way that the worker would always get that 30 per cent., or whatever it might be, over his wages. With regard to fixity of tenure, that was only an opinion of his own. If men were assured that they would not be discharged, except for misconduct, they would be more satisfied. Mr. Cole, in his book did not deal with the real scientific management. He was disappointed to find such a clever university man playing down to the men he was supposed to be guiding, and misleading them on that point. The systems Mr. Butterworth said were obsolete, were in use all the time. In the works with which he was concerned they were gradually coming round to the 80 per cent. basis, and payment for all the time saved. They had found stop watches reliable in every way. One could not get the time without taking it with a stop-watch. He had not dealt with profit sharing, which was not a part of scientific management as understood at present. It was working satisfactorily in some places, but the workman would rather have an immediate reward for his efficiency. With regard to rewards for suggestions, if the suggestion referred to a small matter £10, or something less, was given as a reward. In the case of a patent, also a certain sum of money was given to the man making the invention, the firm reserving the right to the benefits that accrued from the inventions.

In reply to a question whether taking the girl off the shell machine which she could work with such consummate skill was not equivalent to cutting the rate, the lecturer said she was not taken off the machine, but instead of getting about 300 per cent. efficiency, her efficiency came down to about 175, while the other girls got about 150.

Heating and Cooking Notes.

The Coupon System for Developing Sales and Improving Load Factor.

In the old days most attention was devoted toward improving the efficiency of the production and distribution of electrical energy, without due consideration being given to the development of the demand for this important utility service. It is little use generating electric current if you cannot sell it. So far electricity has been more or less left to sell itself on its own merits, without adequate attention being given to see that due prominence is given to the advantages to be obtained by its use. Certainly, in some quarters successful methods have been employed to popularise this product, but so far as the supply industry as a whole is concerned, collective and national effort has been lacking. The war has taught the industrial section of the nation the value of electricity as a factor in rapid and economical production. With the removal of war-time restrictions on electricity supply and the proposed developments in bulk supply will come the opportunity to popularise the use of electricity amongst the masses, firstly, for lighting purposes, and then, later, for cooking, heating and household utility appliances. We are likely to tend more and more to the conditions existing for some years past in the United States. Domestic help will become scarcer and more expensive, which factors will help to increase the demand for household labour-saving devices. It is interesting, therefore, to notice how the Commonwealth Edison Company of Chicago has developed its sale of household electric appliances by means of the old coupon system, so often associated in the Englishman's mind with the sale of tea.

In reality the coupon system is nothing more nor less than a method of giving a cash discount on small purchases. The threepenny or sixpenny customer is just as valuable in the aggregate in the retail trade as the ten and twenty-pound purchaser in the wholesale trade. The latter gets a cash discount of, say, 2½ per cent. as a matter of course ; the former does not, because no coin of the realm represents 2½ per cent. on sixpence. But coupons can be issued, which when collected represent the cash discount on a number of small purchases. Further, the exchange of coupons for agreed articles ensures that these articles are obtained by a number of persons. Cash can be spent as and where the purchaser likes. Coupons can only be exchanged for specified articles. The Commonwealth Edison Company entered into an agreement with the Federal Profit Sharing Company for a supply of Federal Dividend Coupons, and these coupons were sold to retail merchants contracting for a Federal electric sign. Note that only merchants using an electric sign can purchase the coupons. This alone created an additional demand for electric current from the supply company. The coupons are given by the retailers to their customers (one coupon for each five cents) who pay cash for goods supplied. The customers then exchange their coupons at special shops maintained by the supply company for the purpose, for various pieces of cooking, heating and utility apparatus. The benefit obtained by the supply company is a resulting rise in the day load, due to the wide distribution of current-consuming devices obtained without the usual and more expensive method of personal solicitation, missionary and educational work. There is an increase in the number of persons attending the supply company's showrooms, and when exchanging coupons for one article, another is often sold for cash in addition.

Many consumers are by this method induced to try electric household appliances that they would otherwise not do, and finding the first one to be satisfactory are encouraged to increase their equipment by adding further articles from time to time. The following figures show the progress obtained in sales of electrical apparatus by this method, the articles supplied being washing machines, vacuum cleaners, portable lamps, shades, coffee percolators, toasters, grills, irons, kettles, &c. :—

	£
In 1915 (before using the coupon system) total sales were ...	57,000
In 1916 (after coupon service was installed)	124,600
In 1917	145,600
In 1918	200,000
In 1919 (estimated)	500,000

The rate of acceleration in sales during 1917 and 1918 was not maintained at the same rate as 1916, due to war conditions. In addition to the above, during these years contracts have been obtained for the installation of 1,850 additional electric signs, and the goodwill of the company has been greatly increased by the publicity obtained through this scheme. We commend this method to the attention of those interested in the development of electricity supply.

New Belling Apparatus.—This firm are now getting well into swing with the production of domestic cooking and heating appliances on a peace-time basis. We take the opportunity of illustrating four articles recently produced by them. Fig. 1 is the Belling "Modernette Cooker," designed for use by small families (up to six people). The frame and carcase are of planished steel, and the provision of legs to bring the oven to a convenient height obviates the disadvantages of stooping and consequent fatigue, the overall height being 36 in. and width 24 in. The oven portion is 16 in. high and 14 in. wide, and heated by top and bottom elements, controlled by multiple-circuit rotary switches. The top element is used in place of a grill. A shelf is provided below the oven, and a plate warming compartment is placed at the side. Two multiple-heat hot-plate elements for boiling, stewing and simmering purposes are mounted in the centre of the hot-plate, and all the controlling switches are fixed vertically on the right-hand side of the oven. The total loading is 4 k.w., and in all there are eight 500-watt spirals fitted into four interchangeable three-heat 1 kw. heating elements. Accessories in the form of two enamelled trays, two rod shelves, one solid shelf, grill pan, two spare spirals and two spare insulators are supplied with the cooker, which sells at £15. It certainly seems a wise plan to include spare elements amongst the accessories. Radiant-type boiling elements are used, so that there is no necessity for the purchaser to buy new ground or flat-bottomed utensils.

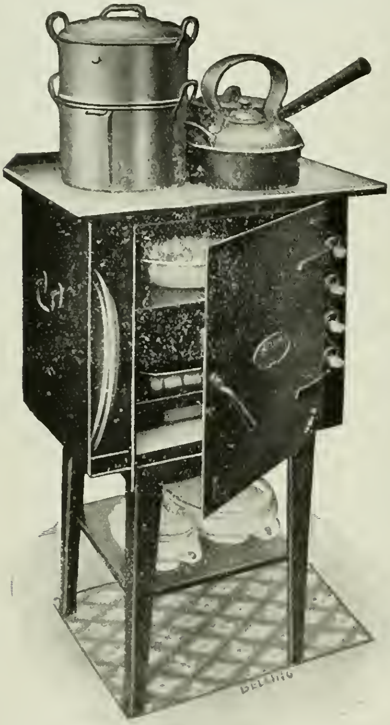

Fig. 1.—Belling "Modernette" Cooker.

Another serviceable piece of Belling apparatus is the Boiling Ring and Toaster, shown in Fig. 2, designed mainly for kitchen use, and is an improved design of a former piece of apparatus of similar type. The band is now finished in white enamel, and a new form of insulator has been employed for connecting the flex to the resistance circuit, with a view to preventing charring of the insulator on the flex. The usual Belling Radiant elements are employed, and the hotplate is supplied complete with flex connected to the elements. Single-heat rings loaded to 600 watts sell at 30s., and three-heat rings (consuming 1,000 watts at full heat, 500 watts at medium, and 250 watts at low heat) at 40s.. The rings are 7 in. in diameter and 4¾ in. high, and, if desired, a hotplate measuring 15 in. by 9 in. can be supplied to fit over either ring, at an extra cost of 10s.

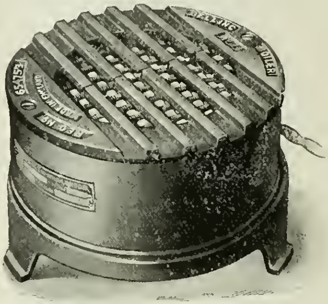

Fig. 2.—Belling Boiling Ring and Toaster.

Figs. 3 and 4 show two patterns of combined grill and boiling plate, the one for kitchen purposes and the other adapted for table use. The former is controlled by a rotary switch mounted at the base of the grill, and the latter is adapted for use with a flex.

Amongst other new patterns of apparatus produced by this firm are a table electric warming plate suitable for connection to any lamp-holder by means of flex and an adapter. The element is entirely enclosed and consumes 100 watts. The outer casing is nickel-plated and highly polished. The article is thoroughly well made and finished, and proves that a British manufacturer *can* make electric table accessories equal in quality and appearance to American appliances of similar nature. The warming plate, complete with 6 ft. of flexible, sells for 22s. 6d., a price which seems exceedingly reasonable in these days, and an example of what can be done with standardisation and quantity production. Two sizes of electric kettles, both polished copper, have also been produced, one holding four pints of water and the other six. The former consumes 750 watts and the latter 1,500 watts. The two pint kettle boils two pints of water in 10 minutes and four pints in 20 minutes, whilst the larger kettle will boil six pints in 15 minutes. In both cases the heating elements are entirely immersed. The smaller kettle sells for 27s. 6d. and the larger 47s. 6d., complete with connector and flex in each case. If desired, the elements can be supplied separately and used for converting existing kettles, urns and similar apparatus.

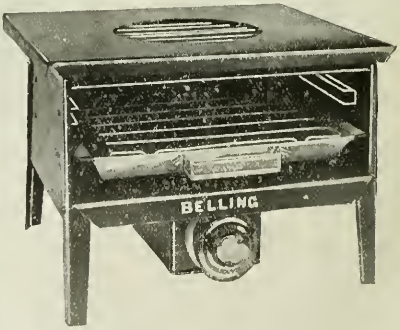

Fig. 3.—Belling Combined Grill and Boiling Plate.

Another item is a bath water heater, which essentially consists of a solid copper tank finished in highly polished nickel plate. The water is heated by two layers of Belling immersion heaters, one layer being fixed at the bottom of the tank and one at the top. When the bottom layer only is switched on, the whole of the water in the tank is heated in about one hour. The second or top layer of heating elements are provided for obtaining an immediate supply of smaller quantities of hot water. Two gallons of warm water can be obtained in three minutes, or a supply of very hot water in five minutes. The total loading is 4 kw., and the tank is 12 in. in diameter and 32 in. in height. It is supplied complete with a two-way and "off" control panel, ready for separate mounting, and complete with flexible tubing and necessary cable for connecting to the tank. A suitable earthing terminal is provided, and the cable can be brought into either side of the terminal box, which factor allows the switch frame to be mounted in the most convenient position. A plug is provided for emptying the tank when it is required to examine or repair the elements. There are eight 1 kw. immersion heaters in each tank, but only four can be used at one time, depending on whether a small supply of hot water is wanted quickly or a large supply over a longer period. A double pole switch entirely disconnects the heater when in the "off" position. The tank complete sells for £18.

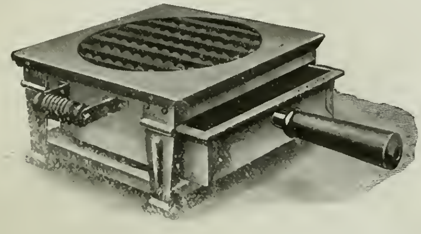

Fig. 4.—Belling Table Grill and Boiling Plate.

There is evidently no necessity for the supply industry to purchase foreign made domestic electric appliances, because there is here a range of well-made and finished, carefully-designed apparatus sold at a price reasonable in comparison with existing conditions and demand.

The Determination of the Hysteresis Curve.*

By M. SCHLEICHER.

The following plan depends on a ring method, and the connections are shown in Fig. 1, which is very similar to that used for the determination of commutating curves. The only difference is that the resistances used for altering the field strength are divided into two groups, R_1 and R_2, the latter group being, if necessary, short-circuited by the switch S. The resistances of group R_1 are so designed that when S is closed, the heaviest currents can pass at steady values in spite of variations in the resistance of the circuit owing to heating. The resistance must be able to carry this current permanently. With resistance R_2, the current must be capable of being steadily decreased by small decrements without any change in the value of R_1. The carrying capacity of these resistances need not be very great, as they will only carry current for short periods. A double-pole change-over switch is used for altering the direction of the current.

The four main points of the hysteresis curve are (in Fig. 2) the points 1 and 3, and the two points of remanence, 2 and 4. The points 1 and 3 are obtained with the maximum current in the two directions. The two points 2 and 4 are obtained by opening the switch U_1. The observer now proceeds, with the switch S closed, to commutate the current at its maximum strength several times, and then to leave the switch U_1 in the position corresponding to the point 1. The group R_2 is now adjusted to a certain value, and the galvanometer is then joined up. The switch S is then opened and the readings on the ammeter and galvanometer are noted. The deflection on the galvanometer is the ordinate, corresponding to the given current as abscissa. Next the galvanometer is taken out of the circuit; the switch S is closed; the direction of the current is changed, after regulating, if necessary, the main current by means of R_1; the resistance in R_2 is increased; the above process is repeated until by degrees the remanence-point 2 is approached. The position of point 2 is determined as described above; it is best to make several determinations, as it is now to serve as starting point. The switch U_1 is now put in the other position, after the switch S has been opened and the resistance R_2 made as large as possible. Thus the current now flows in the opposite direction. The readings of the galvanometer and ammeter are noted, the deflections of the galvanometer being measured downwards. The remanence point 2 is now found again, starting from the positive maximum value of the current, without taking readings on the galvanometer; R_2 is decreased; the switch U_1 is changed over, after S has been opened, and the test is continued, till point 3 is reached. The process is then reversed till the starting point 1 is reached. It may be here stated that tests have shown that, even with very soft iron and low inductions, the sum of the deflections corresponding to changes from the positive maximum current to zero and from zero to the negative maximum current differ by very few tenths of 1 per cent. from that obtained by directly commutating from tip to tip. The origin of co-ordinates can therefore be determined by halving the extreme deflections; or, on the other hand, the axes of co-ordinates can be inserted when the loop has been completed.

The advantages of this plan are two-fold. Firstly, the number of instruments is reduced to a minimum, as compared with the method of Evershed and Vignoles. Secondly, any point can be determined independently of any other point, and the observation can be repeated; this cannot be done by Rowland & Weber's method without upsetting the whole test. Moreover, by dividing the loop into four portions, a greater sensitiveness of the galvanometer is possible. The length of time required for the test is not greater than that taken by other ring methods. Even if the needle of the galvanometer swings very slowly, the loop can be determined from 30 readings in 20 minutes. The present method is published by the author because, in his opinion, the ordinary methods fail in some material respect; on his plan, too, the heavy resistances only carry current for very short intervals. (The usual methods, to which reference is made in footnotes, are those of Rowland and Weber, Evershed and Vignoles, Asle Ytterberg, and finally that of Fritz Holm, which is a modification of that due to Evershed and Vignoles.)

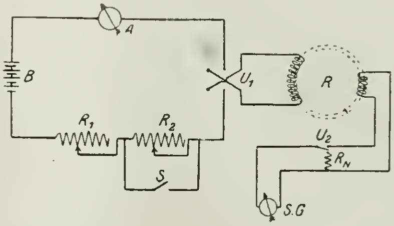

Fig. 1.—Diagram Showing Arrangement of the Apparatus.

Something may be said about the certainty with which the loss of energy can be found from this loop. Doubtless this value on the present method is somewhat less than that determined by a steady variation of the field strength. This is because of the shaking of the molecular structure. The main value of the determination of hysteresis is in connection with alternate-current work. Here it is not quite certain whether the loss of energy in any way depends on the speed with which the magnetisation changes. The hysteresis losses, determined by Epstein's method, seem to be slightly less than those found in the same iron by the magnetometer. Ewing found that with small indications there were certain re-actions which could be observed over considerable intervals of time, but these re-actions were very small if the time-intervals were short. On the present method, one starts always from the tip, and the reactions due to long time-intervals are thus in some measure suppressed; this is also the case with points in the neighbourhood of the remanence-point, becaues one passes rapidly away. Eddy currents may be generated in the iron by the large changes of field-strength; however, it has been shown that the losses due to eddy currents are of no importance, when the ballistic method is used. Fritz Holm has shown that if the maximum induction is the same, the hysteresis losses on alternate current are the same as those found by Evershed and Vignoles on direct current, and their method is similar to the author's, inasmuch as it works by leaps from the tip of the loop. It, therefore, seems likely that when direct current is used, a shaking of the molecular structure produces results very similar to those found with alternate current in so far as energy losses are concerned, if the maximum induction is the same in the two cases.

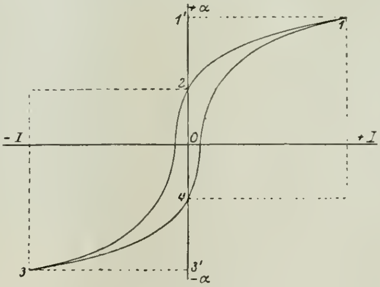

Fig. 2.—The Hysteresis Loop.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 40. 1918.

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The Electricity (Supply) Bill in Committee.

It is to be hoped that, now the Electricity Bill is actually before Committee B, that the Committee in deciding the details will keep before them the main objects which it is intended that the Bill should achieve. This is particularly necessary in view of the chaos of minor ambitions and subsidiary projects which have gradually become interwoven with the general idea of a national electricity scheme. The purpose of the scheme is admirably laid down in the original report of the Board of Trade Committee, viz., cheap power for industries. It was unanimously agreed by this Committee that when the British industry would be subjected "to the test of keen international competition after the War," its success would depend upon its manufacturing costs being reduced, and an important element in this was cheap electric power. The supply of power for industrial purposes is therefore not only the primary, but infinitely the most pressing need. Electricity for agriculture is obviously of secondary importance, and even more so the supply for ordinary domestic uses. Everything cannot be done at once, and it is better for the housewife to be disappointed in her expectations, as raised by the daily press, than for our industries to be handicapped in the international markets. Further, the Committee should bear in mind that the need of the work being put in hand immediately is only secondary to that of its being done at all. Delay is obviously one of the most disastrous things which could come about if the Board of Trade Committee are correct in their findings. From the financial point of view of the undertakings also, delay is to be greatly deprecated, since it would be impossible for capital to be found while uncertainty hung over the immediate future of the undertakings, and when by the nature of the case nothing in the shape of definite security was forthcoming.

We are pleased to note the business-like course taken by the Government this week by which Committee B conferred with the Board of Trade and arrived at some sort of concord on the revision of the clause constituting District Boards. A revised clause was handed round to the members at the meeting on Tuesday and an adjournment took place to give them an opportunity of digesting same. If this is approved a huge batch of amendments will disappear automatically and the procedure be considerably shortened. Until the consequential clauses are to hand it is impossible to see the full bearing of the new clause, but *prima facie* it appears to meet the case adequately, and certainly will have very wide support. The clause, in a word, makes the machinery elastic. Voluntary effort will have first chance. Only as a last resort will formal District Boards be imposed, the provision of District Boards, in fact, being merely the "big stick." The crucial point to be safeguarded all through is that the Commissioners shall have the fullest powers in order that they *can do* things and can do them with the least possible delay. A further point for the House of Commons Committee to bear in mind, especially if the work of centralisation and such like is to go forward immediately, is that the Commissioners will have to rely upon the existing undertakings, municipal and company, largely to assist in the work. A great deal of loose and vague talk has led to a kind of idea among the non-technical, that the project is in the nature of some sort of new scheme altogether. As a matter of fact, the chief, and the basic, elements with which the Commissioners will have to deal has been throughout the existing undertakings. The new proposal of the Home Secretary provides for a re-arrangement and re-adjustment of these same elements wherever possible.

As the municipal and company undertakers have not any status for appearing before this Committee (it not being a Special Committee), it is hoped that those Members of the Committee who are better acquainted with the facts than their colleagues will make it quite clear in the discussions as to the important and crucial part which the undertakings will have to play in the scheme of reconstruction, and see that the claims which the undertakings are making for equitable treatment in regard to purchase terms and other financial points of importance are dealt with justly. We trust also, in this connection, that the good work done by the Undertakers in the past will be fully explained to the Committee, and that it will be pointed out that the present scheme would, perhaps, never have been necessary had it not been for the legislative restrictions which prevented Undertakings from proceeding on broader engineering lines. Our Municipal friends might very aptly quote the splendid work done during the war by the big municipalities, such as Manchester, Sheffield, Birmingham, and so forth, and the same testimony could be put forward for many of the companies as evidence that there is no lack of initiative in the industry, or ability to carry out the most ambitious schemes, provided the hampering conditions under which they have always worked are removed. In saying this we are not harping back to the "leave us alone" plea, which has, perhaps, characterised a certain batch of conservative undertakings and locally-minded Councils. We agree that laggards must be provided for, and consequently not only must restrictions be removed, but there must be Commissioners and an Administration to see that things are actually done. With the best of boys it is always well to have a cane in the cupboard. Father O'Flynn might be a worthy exemplar to the Commissioners in this direction—

> Helping the hazy ones, coaxing the crazy ones,
> Urging the lazy ones on with th' stick.

In all quarters there has been considerable discussion in regard to the terms of purchase proposed under the Bill. The local authorities have felt that they are not being treated as well as the companies, whereas the companies in their turn felt that the terms were unsatisfactory for private enterprise. A memorandum has now been prepared by the Board of Trade in which the terms of purchase by municipal undertakings are upheld, these terms being simply the taking over of the outstanding loans. As regards the companies, it has been felt that the proposed terms are unjust in view of the conditions under which the companies are at present operating. It is pointed out in the memorandum that a valuation basis under present conditions of high cost of buildings, &c., would result in very high terms, and after a discussion with the representatives of the companies the Board of Trade have come to the conclusion that the "standard price" in the case of London companies should be the actual capital invested in the assets taken over by the District Electricity Boards. The same point does not arise so much in regard to provincial companies, as they are less likely to be purchased. In regard to power companies, there is the difficulty that these deal mainly with bulk supplies, and consequently the distribution cannot be separated from the station without loss of efficiency. Further, competition by a District Board might destroy the business. The companies, therefore, ask that they should be given an option requiring the District Board to purchase the whole of a power company's undertaking if the generating station is purchased. Having regard to the circumstances, the Board of Trade are prepared to accept this view. It will be agreed that these are important modifications and should render the position much more acceptable to the companies.

We are glad to see that the Committee last week decided that three out of the five Commissioners are to be engineers. That is certainly a step in the right direction. The chief fear for the ultimate future is that the Commissioners may be subjected to political pressure. In other words, that the development of the scheme may be found beyond the limits, whether of space or time, that would be dictated by sound engineering and commercial considerations. If that happens, then the industry will once again suffer, not through legislation but through its misapplication.

Static Transformers for Use with Electric Furnaces.

INTRODUCTION.

With the increased demand for steel of all grades, carbide, ferro-silicon, carborundum, &c., the electric furnace has rapidly developed into an efficient piece of commercial apparatus. Practically all electric furnaces require electrical energy in the form of alternating current at low pressures. The energy required is generally drawn from large supply systems and transformed to the required pressure by means of static transformers situated near the furnace. It is with transformers used in this capacity that this article deals.

Of the three types of electric furnace in use—the arc furnace, the induction furnace, and the resistance furnace—the two first-named are used for melting and refining metals; the resistance furnace is for use in the manufacture of ferro-silicon, carbide, carborundum, &c. For metals, the arc furnace has been proved to be the most efficient.

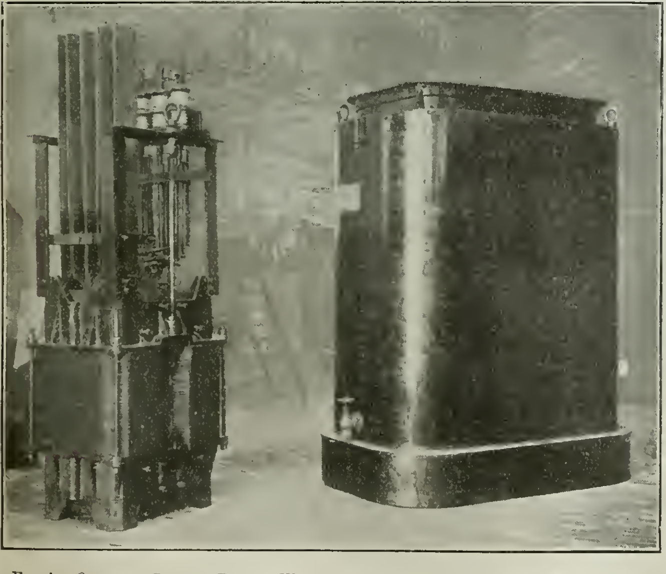

FIG. 1.—ONE OF A PAIR OF BRITISH WESTINGHOUSE TRANSFORMERS FORMING A 3.000 K.V.A. SCOTT-CONNECTED UNIT FOR USE IN CONJUNCTION WITH A 10-12-TON ELECTRO-METALS TWO-PHASE FURNACE.

There are various types of arc furnaces, but in principle they are much the same as far as the transformer is concerned, in that they require electrical energy at low pressure which must be variable. These furnaces, according to different makes, may be either single, two, or three phase. Of the best-known types, the Héroult, Stobie three-phase, Rennerfelt, and Stassano have a non-conducting hearth, while the remainder have a conducting hearth, *i.e.*, current passes through the bed of the furnace.

The voltage required for furnace operation depends upon the type of furnace and the material to be produced, and varies from 60 to 120; in the particular case of the Snyder furnace the pressure may require to be 220 volts. In general, however, the voltage is from 65 to 85, in three steps to meet the furnace requirements during progressive stages of operation.

For instance, during the melting period, a high voltage is required to accelerate this operation by supplying the maximum heat. It is also necessary to keep the voltage across the arc within required limits, on account of the voltage drop due to the lower power factor consequent on the magnetic properties of the bath at temperatures below 700 C.

During the molten and refining stages, the heat required is less, due to the charge being hot; the kilovolt-ampere load is also less, since the power factor has improved, and hence the voltage of supply can be reduced.

DESIGN OF FURNACE TRANSFORMERS.

There are distinct reasons for developing a special type of transformers for furnace work and generally speaking, standard transformers are unsuitable. For example, a voltage ratio requiring a range of 65 to 85 volts, or possibly a wider range, is not in general a requirement of the standard transformer; in order to obtain these voltages with efficient results, special precautions in design are necessary.

Further, as low voltages are in general used, heavy currents must be catered for, possibly up to 50,000 amperes, and, in order to obviate unnecessary local heating and heavy voltage drops, special technical precautions must be taken.

During furnace operation, violent and frequent fluctuations of load are met with, which in turn bring heavy mechanical and electrical strains to bear on the windings; this necessitates a robust and heavy construction of windings, core and leads. The internal reactance in furnace transformers is usually higher than in power transformers, for the reasons given later

With the rapid fluctuations of load possible, voltage surges may be encountered on the high-tension side of the transformer, necessitating heavily reinforced end-turn insulation. Due to this, the tappings for voltage regulation should be internal to the winding whenever possible, so as to leave the reinforced turns free from any break in their insulation.

Heavy and frequent overloads must be allowed for and out-of-balance loads must be provided against in such a manner that the voltage does not fall away in consequence. In Scott-connected transformers special connections internal to the windings are necessary in order to preserve current and voltage balance.

GENERAL CHARACTERISTICS OF BRITISH WESTINGHOUSE FURNACE TRANSFORMERS.

The characteristics of British Westinghouse furnace transformers are here described under various headings.

Windings and Insulation.—The type of transformer manufactured by the British Westinghouse Company is, in general, the shell type, which is the most suitable for the service required; it allows of strong and robust construction, as well as flexibility of design to meet all reactance requirements and accommodation of heavy low-tension currents.

Compactness is a feature of the design and a minimum of floor space is required. There is good oil circulation and mechanically strong insulation; while full protection of all windings is provided against damage during shipment and erection.

The coils are partially visible, and inspection of them is, therefore, possible. Cleaning of coils may be carried out if, due to the sludging of oil, this is necessary. The windings are arranged in sandwich fashion and are strongly insulated between primary and secondary, and also to ground, with heavy and sound mechanical insulation of high insulation resistance.

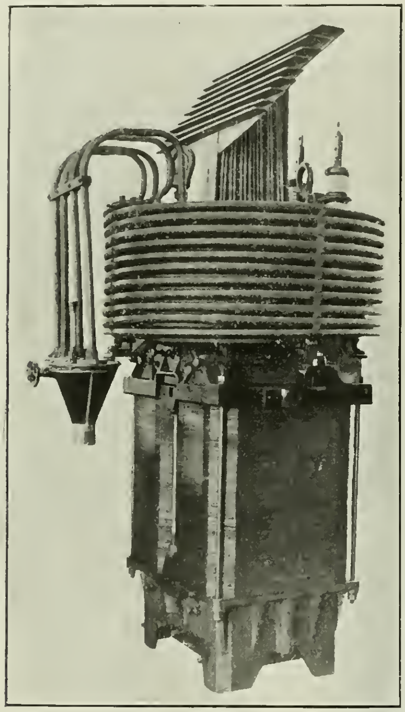

Fig. 2.—A 2,000 k.v.a. British Westinghouse Furnace Transformer showing Cooling Coils in Position.

The high-tension windings are wound in sections, and each turn is individually insulated so that the pressure between adjacent turns does not exceed the voltage maintained per turn. From 8 to 10 per cent. of the end turns are reinforced, being individually wrapped and insulated to withstand a test pressure of at least full-line volts per turn, or a minimum of 6,000 volts per turn, according to the supply pressure.

Cooling.—Transformers are cooled by any of the following methods, according to the output and situation. In general, those up to 1,000 k.v.a. are self-cooled, that is, they are immersed in oil in a tank with flutes to provide sufficient radiating surface. Transformers of larger capacity are, in general, cooled by artificial means.

Oil-insulated air-blast transformers are mounted in tanks, similar to the self-cooled units, with the difference that the flutes are closed at the periphery by a sheet steel casing, and air under a few inches pressure is passed up the flutes from below, either from a fan or from compressed air mains. A transformer of this type is shown in Fig. 1; this is one of a pair forming a 3,000 k.v.a. Scott-connected unit, 11,200/65-75-85-95 volts, 50 periods, for use in conjunction with a 10-12 ton Electro-Metals two-phase furnace.

Oil-insulated water-cooled transformers are mounted in plain tanks of heavy boiler plate and the cooling is obtained by circulating water through a copper cooling coil immersed in the upper part of the oil. Fig. 2 shows a 2,000-k.v.a. transformer with the cooling coils in position; this is one of a 6,000-k.v.a. three-phase unit for use with a carbide furnace.

In oil-insulated force-cooled transformers the transformer is mounted in a plain heavy boiler plate tank. The cooling is effected by circulating the oil through an external cooler of the surface-condenser type, or through a cooling coil immersed in a reservoir of water. The oil is always circulated by drawing from the top of the tank, and then passing it into the tank at the base after passing through the cooler. The oil is circulated under pressure, so that should any leak or fault occur in the cooling system the oil will be forced out, and no water permitted to enter with the oil into the transformer tank.

Transformers are at times also cooled partly by natural radiation and partly by water, as is shown in Fig. 3. This method safeguards the transformer from being run at excessive temperatures in case the circulation of water has been overlooked. This illustration shows a 625 k.v.a. 5,800/47-volt 40-period 13,100-ampere transformer, forming one of a group of three in a 1,875 k.v.a. three-phase unit.

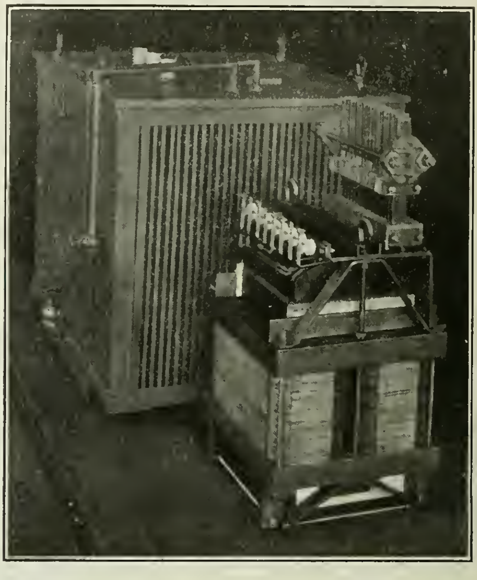

Fig. 3.—A British Westinghouse 625 k.v.a. Oil-immersed, Self-cooled and Oil-immersed, Water-cooled, 40-period, Single-phase, 5,800/47-volts Furnace Transformer.

(*To be concluded.*)

Electricity and the Layman.—In a communication to The "Engineer" under the above title a correspondent refers to some experience with the forces of occupation as illustrating a condition of life in which every farmer within five miles of a town could have electric lighting throughout his buildings. "When we got to the end of the march to the Rhine about Christmas time last year," he remarks, "we were much interested to see that the richly agricultural country for a big distance all round Cologne was supplied with electric light and power exactly in the way you describe. I, among many other R.E. subalterns, was set to collect much information about this electric supply. Many of the villages investigated were as much as 20 miles from the Rhine, and many obtained their electric supply from Dinen, which was 20 or 30 miles in the other direction. The thoroughness with which all this system had been carried out was very noticeable. But the crux of the question is 'What did it all cost?'" Presumably, the scheme had all been established and maintained at the expense of the taxpayer. It would be interesting to obtain fuller data regarding the financing of these German electric supply schemes.

Report of the Yorkshire Electricity Supply Linking-Up Committee.

This Committee was formed on October 25, 1916, and consists of the following: Messrs. E. Cross (Rotherham Corporation), S. E. Fedden (Sheffield Corporation) C. N. Hefford (Leeds Corporation) C. J. Jewell (Yorkshire (West Riding) Electric Tramways Company, Ltd.), S. D. Jones (Batley Corporation), H. A. Nevill (Wakefield Corporation), E. S. Rayner (Doncaster Corporation), W. M. Rogerson (Halifax Corporation), T. Roles (Bradford Corporation), H. Webber (Keighley Corporation), G. Wilkinson (Harrogate Corporation), W. B. Woodhouse (Yorkshire Electric Power Company). At the first meeting Mr. T. Roles was appointed Chairman and Mr. W. M. Rogerson as honorary Secretary. The report is of some length and is accompanied by a large map showing the way in which the district is divided up among the various authorities. For the most part a frequency of 50 has been adopted, but there are five undertakings whose frequencies are different. Linking-up in this district presents but little difficulty. The number of kilowatt-hours generated in the area for the year ended March 31, 1916, whs 355,062,025. The coal consumption varied from 2·49 to 10·6 lb. per kilowatt-hour generated, and the average coal consumption for the 30 undertakings was 3·45 lb. If the whole of the energy had been generated at a figure attained by the most efficient generating station a saving of 150,000 tons of coal per annum would have been effected.

Examination of the map showed that most of the undertakings lie south of the rivers Wharfe and Ouse and are closely adjacent. This area has, therefore, been particularly considered. It has been divided up into northern, southern and eastern sections. The northern section includes Bradford, Dewsbury, Halifax, Huddersfield, Leeds, Wakefield, Yorkshire Electric Power Company and other undertakings. The southern section includes Barnsley, Mexborough, Rotherham, Sheffield and Yorkshire Electric Power Company. The eastern section is chiefly occupied by the Yorkshire Electric Power Company.

In the northern section interlinking is already in existence between Bradford Corporation and the systems of the Yorkshire Electric Power Company, and the Shipley Urban District Council respectively. It is estimated that the total maximum demand in 10 years' time will be 400,000 kw. It has been ascertained that the present large stations might be extended to deal with an additional load of 70,000 kw., and it is estimated that it will be necessary to provide approximately 250,000 kw.

In the southern section linking-up is in existence between the Yorkshire Electric Power Company, Sheffield Corporation, and the Rotherham Corporation, and between the Yorkshire Electric Power Company and the Mexborough Urban District Council. 83 per cent. of the total load and 85 per cent. of the total units generated were provided by one authority alone for the year ended December 31, 1918. It is anticipated that continued extension in electrical energy to the steel industry will take place, and it is thought that in 10 years' time another 300,000 kw. will be necessary. No station at present in operation in this section is capable of much further efficient extension.

The eastern section is not of the same importance as the other two sections, to which reference has been made.

Various sites have been inspected where there is ample condensing water. With regard to transmission, however, the view is taken that the greater part of the mains would have to be laid underground. Further, the cost of conveying coal over existing railways and canals is low in the district, and, therefore, it would be preferable to develop local resources to the full before instituting generation at points remote from the industrial centres,

In the northern section there are three stations capable of efficient extension to 40,000 kw. or over, and at least five sites are available, four at a capacity of not less than 100,000 kw. can be erected and one at a capacity of 60,000 kw. In the southern section one station of 100,000 kw., and another of 70,000 kw., are already under construction, and a third of 100,000 kw. is contemplated. Artificial cooling will be necessary to some extent.

The conclusion is reached that a central authority is necessary. This authority would encourage the linking-up of stations, decide on routes, running hours, charges to be made, amount of compensation to be paid to officials whose status is affected, &c. Further, the authority would decide upon the position and size of additional generating stations, standardised supplies, consider and investigate complaints as to prices, charges, &c. It is not suggested that the authority should own or operate stations, in fact, such powers are deemed to be inadvisable. It is recommended that the Board should consist of 68 members, of which 57 are municipal, 9 would be nominated by railway companies, tramway companies, canal companies, purchasers in the coal, iron and steel, engineering, textile, chemical and agricultural industries, and there would be one member nominated by the Yorkshire Electric Power Company, and one by the Electrical Distribution of Yorkshire, Ltd. A number of the members of the Committee felt that the Board should be wholly municipal. It was, however, felt by the majority that if no representatives of the company undertakings were placed on the Board these undertakings might feel that their interests were prejudiced owing to the fact that a number of the municipal representatives would, by virtue of their nominators being electricity supply authorities, not be regarded as disinterested from the electricity undertakers' point of view. It is suggested that the Board should permanently appoint an engineer of high standing, together with sufficient staff to carry out the duties of advising the Board. The principal function of the Board would be to protect and further the interests of the public in matters relating to electricity supply. It is suggested that both generating and distributing authorities should be given the right to appeal to the Board of Trade in any case of dispute arising between them and the Board. The opinion is also expressed that no further erection of generating stations or of additions to plant should be made until the Board is formed.

Mr. E. S. Rayner agrees in general with the report but puts forward two exceptions, one of these being in regard to the cost of current to a distributing authority. Mr W. B. Woodhouse does not sign the report, but is in agreement with most of the recommendations. He feels, however, that some of the powers suggested for the Board should be exercised by the Electricity Commissioners. Also, he does not agree with the suggested constitution of the Board.

Correspondence.

OVERHEAD TRANSMISSION LINES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With regard to Mr. Welbourn's letter in the current number of your paper in reference to my article "The Practicability of Transmission Lines at Highest Voltages in this Country," in your issue of June 27, 1919, I quoted Mr. Welbourn's comparative figures for the cost of overhead and underground lines out of compliment to him, and I am sorry to note that he disclaims the application of this relationship (approximately two to one in favour of overhead lines) at present day costs.

I might, however, have quoted Mr. J. S. Highfield, who stated in his recent Paper before the Royal Society of Arts that "the cost of overhead transmission lines varies from less than one-half to slightly over one-third of that of underground lines." Also Mr. Pearce's Paper, before the I.M.E.A., gives figures for, *inter alia*, a 30-mile transmission line to transmit 100,000 kw., which show the following comparison :—

Voltage.		Cables.		Overhead lines.		Ratio of cost.
30,000	...	£1,816,740	...	£891,000	...	2·04 to 1 in favour of overhead lines
60,000	...	1,433,760	...	594,000	...	2·4 to 1 ditto

Even if the above figures for overhead lines may be "somewhat underestimated," as Mr. Pearce states, the ratio is so great that the figures for overhead lines can be materially increased, and/or the price of cables materially decreased, and still show a ratio very favourable towards overhead lines.

Both of the above references are reasonably checked by comparative figures on transmissions which have come to my notice during the last few months.

In view of the above figures given by Mr. Pearce, it is curious that his Paper should have been taken by some of the engineers, including Mr. Welbourn, who took part in the discussion, as supporting the use of cables, though it is satisfactory to note that there were eminent exceptions to the view that main transmissions should be exclusively by cables.

Notwithstanding Mr. Welbourn's view in favour of cables, I personally believe that there are many cases of main transmission which can be accomplished by means of overhead lines with reasonably comparable efficiency at very considerable saving in cost. Moreover, in my opinion, even if the above-shown considerable saving were not so great, it would still pay this country handsomely to develop overhead lines at the highest voltages as a necessary step toward securing a proper share of the very considerable and increasing foreign trade in high-voltage material, and to enable our engineers to obtain the necessary experience to hold most important engineering positions throughout the world.—I am, &c.,

London, July 9. Geo. V. Twiss.

SUSTAINING OSCILLATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Re the article by Dr. Eccles and F. W. Jordan in The Electrician June 20, 1919, on "Sustaining the Vibration of a Tuning Fork," the following method of sustaining the oscillations of a low-frequency pendulum may be of interest to readers. It is very similar in its action to Dr. Eccles' and F. W. Jordan's circuit. I devised the method for the regulation and actuation of an electric clock. In the diagram, p is a pendulum tuned to whatever time period required, M' is a permanent magnet rigidly fixed to and part of the pendulum. M^2 M^3 M^4 are electromagnets. T is a step-down transformer. p is set in motion and inducing alternating E.M.F.s in M^2, and therefore producing alternating P.D.s across $g \,.\, f \,.\, V^{(g)}$. This will cause periodic variations in the anode current (I^a), inducing E.M.F.s and corresponding currents in secondary of T, and therefore in M^3 and M^4 ($I^{(\text{mag.})}$), which may be in phase with or 180 deg. of phase with, the oscillations of p as indicated.

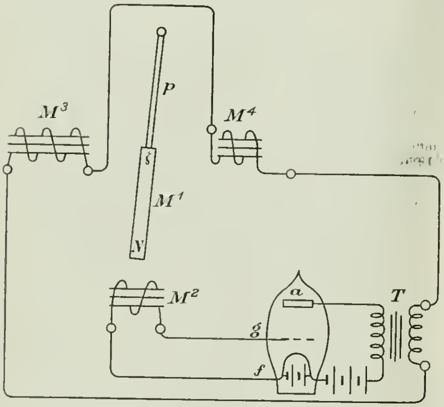

Fig. 1.

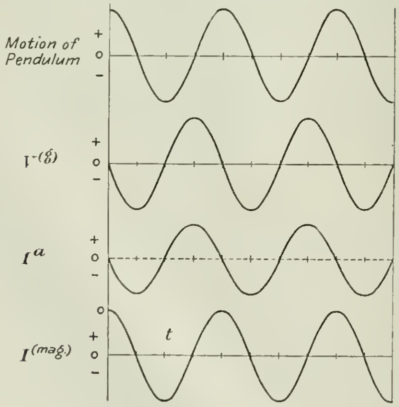

Fig. 2.

In the above-mentioned electric clock there are two similar circuits, the two pendulums 90 deg. out of phase. If we have two coils, M^5 M^6, in series with M^3 M^4, and two coils, M^7 M^8 in series with the corresponding electromagnets of the second pendulum, a revolving field will be produced, which can be made to actuate an armature or magnetised wheel, and cause it to revolve at a certain speed—*i.e.*, revs. per sec. = frequency of pendulum.—I am, &c.,

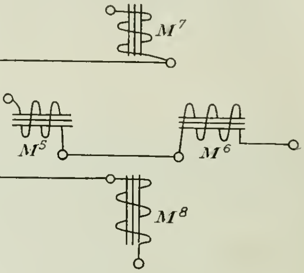

Fig. 3.

Bletchley, June 20. H. L. Kirke, Capt. R.F., attd. R.E.

ALTERNATING CURRENT DEMONSTRATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have now tried the ingenious experiment for demonstrating phase difference, described in Mr. Cady's letter in your issue of July 4. It appears to be difficult to obtain sufficient phase difference with the connections shown in the diagram, but I have secured better results by connecting the plate B to the middle point between L and R and connecting the prongs to the outer terminals.

It may be of interest if I mention another application of centre-zero moving-coil instruments in the demonstration of alternating current principles. Current at a frequency of about one period per second will give a reading which is very nearly steady, on a suitable hot-wire ammeter. If a centre-zero moving-coil ammeter is put in series it will indicate the continuous variation of current. In this way there is available a simple means of demonstrating the relation between R.M.S. and maximum values of an alternating current. The hot-wire ammeter reads the R.M.S. value and the maximum deflection on the moving-coil instruments show the maximum value of the current.—I am, &c.

Edinburgh, July 10. J. H. Buchanan.

ARC STATIONS IN WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In some letters published in your issues of May 2nd and 16th and June 6th, the development of the high-power Poulsen arc is discussed from various points of view. The contributors seem to agree with regard to the excellency of the present high-power arc, but do not agree as to the question to whom the credit for the last years' development is due. I do not think this question a very important one, and I certainly think it is too early to write the history of that subject. I should, therefore, not have joined in this discussion had it not been for your editorial note on the development of the arc in your issue of June 6th. There is no doubt that great credit is due to the American engineers in that respect, especially in view of the enthusiastic manner in which they grasped the possibilities of the arc and found the necessary financial backing for the construction of a system of arc stations. In so far I heartily agree with you.

On the other hand, I think it is very seldom that a new piece of apparatus opening up new technical possibilities has retained its original principal features in so high a degree as is the case with the present high-power Poulsen arc.

I also want to call your attention to a few points which you seem to have overlooked or at least not to have given the consideration as they, in my opinion, deserve. (1) The Danish engineers had successfully demonstrated a 100 kw. arc at Arlington in 1913 at a time when the American Company had only built 30 kw. arcs. (2) The commencement of the war put an absolute stop to Danish engineers partaking in the practical development of high-power arcs. (3) Danish engineers have, during the war, studied the working of the arc and thereby cleared the ground for rational technical progress in the construction of big arcs. I confidently expect that these investigations will prove to be more important for the future of the arc system than the question of how many high-power arcs have been constructed by the different parties.—I am, &c.,

Copenhagen, June 24. P. O. Pedersen.

Imperial Institute of Patentees.

A meeting was held at Cannon-street Hotel (London) on the 10th inst. to consider the question of forming an institute with the above or a similar title.

Sir Joseph Lawrence, Bart., who presided, said there had long been a necessity for some combination between inventors and owners of patents in this country. He referred to his co-operation with Mr. Ivan Levinstein, which commenced some 20 or 30 years ago, and had for its object the bringing about of a reform in the patent laws. The immediate object of the present movement was to ask the Government to give an extension of time to those patents which had been held up during the war. He did not know of any other body that represented so much labour and capital as the owners of patents in this country, and yet they were without an organisation of patentees. Amongst the other objects of the proposed institute was one which they asked for 20 years ago—viz., the reduction of the cost of patents. It cost a man £100 during the 14 years of his patent here, whereas in America it cost £7. 5s. 10d. The report of the British Patent Office showed receipts of £292,000 from patents in 1917, and expenses £124,000, leaving a balance of about £170,000. A State department like the Patent Office ought not to make a profit out of the "struggling brains" of inventors, and the fees could be comfortably reduced by 50 per cent., if not abolished.

Mr. Harry Foster moved a resolution approving of the formation of an organisation to safeguard and promote the interests of patentees, and pledging itself to use all legitimate means to obtain from Parliament an extension of the life of patents which had been prevented from being worked and developed in consequence of the war, and expressing the opinion that an alteration in the law was desirable.

Mr. Walter F. Reid (President of the Institute of Inventors) supported the resolution, and said the objects of the Institute of Inventors, which had existed more than six years, were to some extent parallel to those of the proposed new association, and it moved in the matter of the prolongation of patents some time ago. A conference was convened at which 26 of the chief technical institutions were represented. A deputation went to the Board of Trade, and, as a consequence, he thought, all that was objectionable in the Government Bill was withdrawn. But that was only a negative advantage. They wanted to induce the Government to rectify the injustice done to patentees by preventing them from working their patents during the war while making them pay fees to keep the patents alive. Our best inventors went to America, where they were received with open arms, because our Government picked their pockets.

Mr. Morgan Morgan seconded the resolution, and it was carried with one dissentient.

Mr. Geo. Terrell, M.P., proposed, and Mr. Arthur Barclay seconded, a resolution in favour of organising a deputation to wait upon the President of the Board upon the subject of Trade.

Mr. Barclay referred to the desirability of having technical cases tried by judges who were capable of grasping the technicalities.

Mr. W. R. Rawlings and Mr. W. M. Mordey referred to the work that had already been done in regard to the matters dealt with in the first resolution. Mr. Mordey said the Board of Trade had already received a deputation of 26 representatives of engineering and learned societies and organisations such as the Federation of British Industries, the whole representing, he was informed, 2,500 millions of capital invested in England. That deputation went to the Board of Trade on that very subject, and urged that there should be a moratorium as regarded patents affected by the time lost during the war.

The Chairman said the deputation would take it as an instruction that they should co-operate with the societies and bodies just mentioned. There was no intention to work in any hostile spirit to anybody.

The Joint Housing Committee of the Federation of British Industries and the National Alliance of Employers and Employed regret that the promise made by Lord Downham when President of the L.G. Board—that the terms of financial assistance to be given to Public Utility Societies in the Housing Bill would not be less favourable than those given to local authorities—has not been fulfilled, and is of opinion that, as a result, the housing of the working classes of the country will be seriously delayed.

Electricity (Supply) Bill.

Standing Committee B of the House of Commons, presided over by Sir Samuel Roberts, sat again on Tuesday to consider proposed amendments to leave out of the Bill the part of clause 3 authorising the Electricity Commissioners to conduct experiments or trials "through any District Electricity Board."

The Home Secretary (Mr. Shortt) said the amendments raised the whole question of District Electricity Boards. After discussion with certain members, the Government had come to the conclusion that it would be much better if local authorities, local undertakers and local people generally could be brought into closer touch with the whole electricity supply organisation. To give effect to this, it was proposed to substitute for clause 5 of the Bill the following new clause :—

5.—(1) The Electricity Commissioners may, after holding a local inquiry in any case where they consider it necessary, determine that any district in the United Kingdom shall be constituted a separate electricity district for the purposes of this Act, and in determining what areas are to be included in a district, areas shall be grouped in such manner as may seem to the Commissioners most conducive to the efficiency and economy of the supply of electricity in the several groups.

(2) Where it appears to the Electricity Commissioners with respect to any electricity district so constituted that it is expedient that the existing organisation for the supply of electricity therein should be improved, the Commissioners shall give notice of their intention to hold a local inquiry into the matter, and shall give authorised undertakers, local authorities, large consumers of electricity and other associations or bodies within the district which appear to the Commissioners to be interested, an opportunity to submit, within such time as the Commissioners may allow, a scheme or schemes for effecting such improvement.

(3) If no such scheme is submitted within the time so allowed, or if no scheme submitted is approved by the Commissioners, the Commissioners may either themselves formulate such a scheme, or, if it appears to them that no satisfactory scheme for joint action by existing organisations can be formulated, propose a scheme for the constitution of a District Electricity Board for the district.

(4) The Electricity Commissioners shall publish, in such manner as they think best adapted for ensuring publicity, any scheme which they have approved, subject, in the case where they approve the scheme with modifications, to those modifications, or the scheme which they have themselves formulated, or a scheme for the constitution of a District Electricity Board, and shall hold a local inquiry thereon.

(5) A scheme under this section for the establishment of a joint electricity authority may provide for the constitution of an authority representative of authorised undertakers within the district, either with or without the addition of representatives of other local authorities, large consumers of electricity, and other interests within the district and for the exercise by that authority of all or any of the powers of the authorised undertakers within the district, and for the transfer to the authority of the whole or any part of the undertakings of any of those undertakers, upon such terms as may be provided by the scheme, and for applying in relation to the joint electricity authority any of the provisions of this Act relating to district electricity boards (including the provisions as to borrowing, lending and giving financial assistance by and to those boards), and the scheme may contain any consequential, incidental and supplemental provisions which appear to be expedient or proper for the purpose of the scheme.

(6) A scheme for the establishment of a district electricity board shall incorporate the board with power to hold land without licence in mortmain, and shall provide for the inclusion, as members of the board of representatives, of local authorities, companies and persons who are authorised undertakers within the district of large consumers of electricity within the district, and of labour, and, where any councils (not being authorised undertakers) or the Electricity Commissioners agree to afford financial assistance to the board in manner provided by this Act, also of representatives of those councils or persons nominated by the Commissioners, and the members shall be appointed or elected in such manner, and shall hold office for such term, as may be provided by the order.

The scheme may provide for the appointment as chairman of the district electricity board of a person selected by the Electricity Commissioners from a list submitted by the board, for enabling the board to delegate, with or without restrictions, to committees of the board any of the powers or duties of the board, &c.

(7) The Electricity Commissioners may make an order giving effect to the decisions they arrive at as the result of the inquiry, and present the order for confirmation by the Board of Trade, who may confirm the order either without modification or subject to such modifications as they think fit. Any such order shall be laid, as soon as may be after it is made, before each House of Parliament, but shall not come into operation unless and until it has been approved by a resolution passed by each such House.

(8) An order made under this Act may be altered or revoked by a subsequent order made and confirmed in like manner as the original order.

To enable members to study the new clause before discussing it, the Committee again adjourned until Tuesday next.

The Association of Officers and Staff members of Electricity (Power and Supply) Companies of Great Britain, has submitted to the Board of Trade, and to members of the Standing Committee, an amended form of Clause 17, relating to the compensation of officers and servants of undertakings for deprivation of office.

The Fuel and Lighting Order.

As stated in our last issue the Household Fuel and Lighting Order, 1919, which came into operation on the 1st inst., follows closely upon the lines of the 1918 provisions, with the important difference that it is no longer necessary to obtain certificates from the local Fuel Overseer where the consumption is not in excess of:—Coal 5 tons, gas 50,000 cubic ft., or electricity 1,600 units in the year.

Any consumer may, therefore, take up to 12,500 cubic ft. of gas and 400 units of electricity in any quarter without a certificate. Consumers who were entitled, by virtue of a certificate issued under the 1918 Order, to take quantities *in excess of these amounts* (the 25 per cent. increase being allowed for) may consume the quantity previously allowed, the old certificates having been extended for another year. For periods of less than a year the quarterly quantity of electricity shall be allocated equally to each month of the year. Consumers requiring certificates shall be permitted so far as possible to take their allowances as coal, gas and/or electricity in such proportions as they desire. Consumers who give up a portion of their allowance of coal in order to obtain more gas or electricity cannot be allowed to alter their allocation so as to obtain more coal.

One ton of coal is equal to 18,750 cubic ft. of gas, 1,000 Board of Trade units of electricity or $1\frac{1}{2}$ tons of coke (variations by nearest $\frac{1}{4}$ ton).

Provision is made for relieving supply authorities from their obligations to supply where prevented by the operations of the Order. The keeping of records, taking meter readings and the return of excess consumptions by supply authorities are as before. Power is given to cut off and restore supplies by request of the Local Fuel Overseer in order to check excess consumption.

The London Electricians.

We regret that the London electricians should have selected the present week for what appears to be a demonstration against the electrical contractors. There has been a dispute between the parties since the Armistice, but recently the men demanded a special rate of 2s. 6d. an hour, plus a bonus of $12\frac{1}{2}$ per cent., for peace illumination work. The contractors refused to give this figure, and the electricians then declined, and have during the week declined, to carry out any work connected with illuminations. In consequence, many schemes of illumination have had to be abandoned. The Office of Works were unable to proceed with the proposed official illuminations, and several private firms, banks, &c., were placed in the same position.

In a statement issued by the National Federated Electrical Association on behalf of the contractors it is stated that the present rate of wages is fully commensurate with rates existing in kindred trades. The last award of the Interim Court of Arbitration stated that no further advance in the rates were then justified. At a meeting of the London members it was decided to refuse to pay any addition to the standard rate of wages for illumination work, or to comply with any other special condition that the E.T.U. sought to impose.

On behalf of the men, it was urged that the Electrical Trades Union and the National Federated Electrical Association had not since the Armistice been able to come to terms with regard to rates of pay and working conditions. The employers recently offered an increase of $3\frac{1}{4}$d. an hour, but on conditions which the union felt themselves unable to accept, and negotiations have now been broken off. The E.T.U. have determined to deal with the employers individually.

Legal Intelligence.

The Marconi Arbitration.

The hearing of the Marconi Company's claim against the Postmaster-General for damages for breach of contract to erect wireless telegraph stations has been continued by Mr. Justice A. T Lawrence.

In further cross-examination, Mr. G. C. ISAACS said that his company had erected a long-distance station in Norway and in that case it was agreed that the Company should receive a royalty of 10 per cent. on the receipts, but the royalty might be commuted by a payment of £30,000. The Postmaster-General could have dispensed with the services of the company if he found something else which superseded everything that the Marconi Company was able to offer. He did not think there were wireless stations working independently of the existing valid patents of the Marconi Company. It was a mistake to refer to the Poulsen system as a system of wireless telegraphy; it was only a part. For strategic purposes those were stations for transmitting only. Poulsen was controlled by the Marconi Company. He thought the Postmaster-General entered into the contract for 28 years, because he had great belief in the company's work and he thought that it would continue to improve year by year. The original patent for the Poulsen Arc expired last year, but there were several subsequent patents.

In re-examination Mr. Isaacs said that no efficient commercial station had been erected in these islands or anywhere else except under the Marconi patents, and if the Postmaster-General used an old system that had run out, he could not conduct a commercial service without employing some of the Marconi patents. He must employ the duplex system to enable him to receive and send out the same at the same time.

Mr. JOHN ST. V. PLETTS said that since 1910 he had had charge of the Marconi patents, and in his opinion there was no system which equalled the Marconi system of long-distance wireless telegraphy. The Poulsen installation did not avoid the use of Marconi patents.

Mr. TERRELL, K.C., said that the Crown proposed to show that they need not have used any of the Marconi patents. The Marconi Company declared that a wireless service could not have been carried on without using some of its patents, and he wanted to know which patents the Company said it would have been necessary to use.

Mr. PLETTS said that each part of the transmitting apparatus, from the dynamo to the aerial, was covered by patents. The Marconi Company had a specially patented apparatus for receiving, but he did not think that it had been decided what type of receiving apparatus was to be used for the Imperial chain of stations. The No. 7777 patent, which enabled the receiver and transmitter to be used on different circuits, had expired everywhere. The Fleming valve for internal receiving and detecting had expired, but as a detector it was not essential. Other patents having been referred to, witness was asked whether a certain patent was essential.

Mr. TERRELL: I mean something without which the Postmaster-General could not have established an alternative effective system.

Mr. PLETTS: You are simply shifting the burden to the word "effective." We were in communication across the Atlantic in 1901.

Mr. JUSTICE LAWRENCE: I do not see how I am to determine the question of the extent to which the Postmaster-General would regard efficiency as satisfied if it was mere economy. It seems to me that the scheme was really intended to have as good a wireless service as he reasonably could, not to have one as reasonably cheap as he could. Is not the point whether it would have been commercially useful?

In the course of further examination, Mr. Terrell proposed to put questions to the witness to show that an efficient alternative system was available in 1918.

Sir EDWARD CARSON pointed out that they had had no notice.

Mr. JUSTICE LAWRENCE: It would have been only fair to have given them notice. I may have to adjourn the arbitration to give them an opportunity of dealing with it.

Mr. TERRELL said that he would not object to that, and then put in a diagram of the Poulsen transmitter which he claimed did not involve the use of any existing Marconi patents.

Mr. JUSTICE LAWRENCE: Suppose you show that there was an equally efficient alternative system available in 1918, would not that involve me in an inquiry into the terms on which the Postmaster-General could use that alternative system?

Mr. TERRELL: It contains nothing but what is open to the whole world.

In answer to further questions witness said that it was highly probable that there were several Marconi patents involved. The diagram omitted a lot of essential details, and the Poulsen arc system was not comparable with the Marconi system in efficiency.

Mr. S. PEARS, C.A., said that he had prepared the figures showing the estimated royalties due to the Marconi Wireless Company, and he estimated that the wireless traffic for the 28 years of the contract would work out at 33 million words a year. On the basis of the figures for 1913, the total amount of royalty which the company would have received under the contract down to 1943, would have been about £8,000,000.

Mr. S. G. WARNER said he had come to the conclusion that the appropriate rate to pay for the royalties would be $4\frac{1}{2}$ per cent.

Mr. GODFREY ISAACS, recalled, expressed his opinion that there would have been an enormous increase in the volume of business in consequence of the advent of wireless telegraphy. The cost of sending messages would be less and the speed would be greater with wireless than with cables.

Mr. Andrew Gray also gave evidence, and the company's case was closed.

The ATTORNEY-GENERAL opened the case for the Crown, and said that the company's claim represented five times the capital of the company, which was £1,500,000. At 5 per cent. the sum claimed would produce £365,000 a year, or about 23 per cent. in perpetuity, upon the capital. The matter even went so far as to be considered by the Cabinet. There was a prolonged effort to work out some agreement which would get the work done by the company on reasonable terms. The erection of the Imperial stations involved an expenditure of £36,000, and could it be suggested that the company, by the abandonment of a scheme which involved the expenditure of that sum lost a sum in royalties which was estimated at £7,000,000? He submitted that the Postmaster-General was under no legal obligation to use the Marconi patents or any of them. If a system of substantially equal efficiency could have been found it would have been the duty of the Postmaster-General to put an end to the payment of the royalties to the company. He would endeavour to show (1) that up to the end of 1918 no commercial messages would have been allowed to be sent, and after that period it would have been possible, apart from the existing Marconi patents, to provide substantially an equally efficient system.

Mr. F. J. BROWN, Assistant Secretary of the Post Office, said the Government were spending a large sum in wireless research, and already the progress made in the Government laboratories had been enormous. Many independent discoveries had been made. The royalties payable under the contract would be very small, because the traffic would probably not be large. But if it turned out that the royalties would be large, then, as practical people, they would have had to consider whether there was an equally efficient alternative system. In regard to the station erected at Ballybunion by the Poulsen Company, he had been informed that the Marconi Company had offered to purchase the station for £30,000; the Poulsen Company never tried to carry on a commercial service. They made experiments with the consent of the Post Office, and some of the later experiments were quite satisfactory. During the war the Marconi Company erected 13 stations for the Admiralty. The Poulsen arc was put into all the stations by the Admiralty. The Latour high-frequency alternator was being tried experimentally at the Lyons station, and he knew that the Marconi Company was interested in the alternator. The experience of the South African and Russo-Japanese wars and the recent war showed that the war cable traffic was considerably greater than the peace traffic. The post-war traffic would go down largely, and he put in tables in support of this statement. There was no justification for expecting anything like a 10 per cent. increase in traffic. He did not think the proportion of Government messages would be much altered after the war. There was no evidence that in 1916 and 1917 Government traffic had excluded any commercial cable traffic. In those years there was no serious delay by the Eastern system of cables. Since the Armistice there had been an enormous increase in Government traffic which had caused great delay to other traffic until steps were taken to prevent it. In his opinion there was no justification for the suggetion that there would be an increase of $33\frac{1}{3}$ per cent. in traffic as a result of the advent of wireless telegraphy. He had reason to believe that cable rates in certain cases would shortly be reduced, as there were agreements to that effect. Those reductions were being delayed until conditions became more normal. Broadly speaking, a reduction of rate led to an increase of traffic, but not such an increase as would recoup the reduction in value. The reductions made by the Marconi Company in the rates for their various services did not lead to anything like an assured increase of traffic which would have corresponded with the reduction in the rates. There was not the remotest possibility that within 28 years the general telegraphic traffic would increase as suggested by Mr. Godfrey Isaacs, unless the rates were reduced to the level which Mr. Henniker Heaton used to advise—namely, of 1d. or 2d. per word throughout the Empire.

The hearing had not concluded when we went to press.

Pole Shoes.

Last week Mr. Justice Astbury dismissed, with costs, an action by Edward C. Langton against Otto Bartschi, by which plaintiff claimed under an agreement that he was entitled to a fourth share in letters patent 19,963 of 1912, for improvements in magneto-electric machines granted to defendant. The particular invention related to pole-shoes, a component part of the magneto. His Lordship, in giving judgment, said the defendant relied on the defence that he signed the agreement on the faith of a promise by plaintiff to obtain the signature of another, and only on that condition, and that the condition not having been carried out plaintiff could not sue on the agreement.

Patent Record.

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

May 13, 1919.

12,006 Round. Apparatus for wireless telegraphy and telephony.
12,007 Round. Telephone receivers.
12,008 Round. Receiving aerials for wireless telegraphy and telephony.
12,009 Marconi. Electric storage batteries.
12,033 Sterling Telephone & Electric Co. Cutting and shaping vulcanite, &c.

May 14, 1919.

12,041 Angel. Operating cable or ocean telegraphy.
12,042 Taylor. Obtaining single-pole current from three-phase systems.
12,080 Offord & Parker. Electric horns.
12,081 Terrey. Battery system for sparking plugs, &c.
12,095 Nolan. Electric heater.
12,153 Cock. Coating electric conductors, &c., with liquids.
12,157 British Westinghouse Electric & Mfg. Co. Dynamos. (17/6/18, U.S.)
12,158 British Westinghouse Electric & Mfg. Co. Protective apparatus for dynamos. (29/6/18, U.S.)
12,159 Westinghouse Gear & Dynamometer Co. Magnetic reduction gear. (8/6/18, U.S.)
12,165 Biles & Sharp. Electric switches.
12,172 & 12,173 Creed & McLennan. Electrical receiving apparatus.

May 15, 1919.

12,189 Offord & Parker. Electric generators.
12,195 Hadwen & Willis. Ceiling roses, &c., of electric lamps.
12,229 Mann. Contactor devices for electric circuits.
12,233 Claremont & Scholes. Tool for electric cable.
12,254 Haviland & Morris. Electrical precipitation of particles from gases.
12,269 Pouchain. Negative elements for electric batteries.
12,285 Tilling-Stevens, Ltd., & Carter. Petrol electric rail coach or truck for use as fire engine.

May 16, 1919.

12,319 Lishman. Electrical measuring instruments.
12,325 Seymour. Protective covering of electric wires and cables.
12,337 Craig. Electric switches.
12,351 Wilkinson. Electric cookers.
12,373 Hinton. System of wireless direction finding.

May 17, 1919.

12,429 Samanson. Electric heating apparatus.
12,430 Peckham. Sponge appliances for administration of electricity.
12,447 Lundberg & Pegg. Electric switches.
12,455 British Westinghouse Electric & Mfg. Co and Ayres. Electric hoisting motors, &c.
12,431 Amberton. Electric controllers.

May 19, 1919.

12,516 Thomson & Woods. Electrical thief-proof device for motor-cars.
12,530 Barker & Mallins. Trolley wheel fittings.
12,560 Craig. Electrical signal lamps.
12,587 Jenkins & Lucas. Securing ends of electric conductors.
12,589 Kuntzmann. Electric welding tongs.

May 20, 1919.

12,656 Lowne. Electric driving gear for talking machines, &c.
12,610 Aurynger. Wireless telegraphy.
12,654 Greville & Read. Electric lighter.
12,664 Landon. Electric lights, &c., fitting.
12,673 Manners-Smith. Fittings for incandescent lamps.
12,683 B. T.-H. Co. (G. E. Co.) Amplifying electrical variations.
12,686 Bey & Bundy. Grouping and supporting electric lamps for decorative illumination.
12,695 Cataloi. Electrolytic decomposition of chlorides. (20/5/18, Italy.)
12,700 Jorgensen. Temporarily generating an electric current.
12,713 Suchastawer. Producing electricity and mechanical power by permanent magnets.
12,714 Suchastawer. Dynamos.
12,727 Robinson. Electrical devices for transmitting signals and receiving same at a distance.

May 21, 1919.

12,265 Norton. Operating and tripping mechanism of oil break switches.
12,738 Nadin. Electric water heater.
12,784 New Switchgear Construction Co. Time lag devices for electric automatic switches, &c.
12,821 Round. Wireless telegraph and telephone transmission.
12,841 Graham & Sanftleben. Electrical switching means.

May 22, 1919.

12,862 Roderick & Thomas. Mechanical coupling for electric conductors.
12,900 Venturini. Insulators.
12,925 Marconi Wireless Telegraph Co. Receiving radio signals. (7/2/19, U.S.)
12,939 Untranikian. Alternator for high-frequency currents.

May 23, 1919.

12,784 Fuke. Time-lag devices for electric automatic switches, &c.
12,952 Stockel. Accumulators.
12,955 British Insulated & Helsby Cables, Ltd., Higham & Bayles. Electrica condensers.
12,970 Field. Measuring electric currents.
13,004 Fellows. Magnetos.
13,005 Fellows. Electric horns.
13,007 Automatic Telephone Mfg. Co. & Ray. Automatic or semi-automatic telephone systems.
13,014 B. T.-H. Co. (G. E. Co.) Electrical systems of power transmission.
13,015 B. T.-H. Co. (G. E. Co.) Electric welding electrodes.
13,017 Antonoff. Electric batteries other than Leclanché dry cells.
13,022 Assersohn. Electric lampholders, &c.
13,023 Johnson & Phillips & Porteous. Electric cables for currents in parallels.
13,024 Johnson & Phillips & Tracey. Whipping for telephone and telegraph cables.
13,026 Christian. Relay for electric circuits.
13,028 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Control of electromagnetic reciprocating devices.
13,029 Svenska Ackumulator Aktiebolaget Jungner. Electrodes for primary cells and storage batteries.
13,031 Humbert & Leflon. Electric igniters.
13,036 Graham & Sanftleben. Signalling systems for telephone circuits.

May 24, 1919.

13,094 British Westinghouse Electric & Mfg. Co. Protective gear for alternating-current systems.
13,105 Reilly. Method of springing overhead arm of tramcars, &c.
13,122 De Bellescize. Wireless stations on duplex systems. (22/1/19, France.)
13,132 Waistill & Watson. Arc lamps.
13,135 Lea & Ree. Electro-magnetic wave signalling systems.

May 26, 1919.

13,152 Siemens Bros. & Co. & Pettigrew. Semi-automatic telephone systems.
13,161 Garner. Emergency system of re-lighting electric tramcars, &c.
13,169 Andre & Pollefeyt. Fool-proof fuse switch.
13,172 Bygrave. Automatic and semi-automatic telephone systems.
13,175 Siemens Bros. & Co. & Wood. Cable junction boxes, &c.
13,181 Goldstone & Lightfoot. Electrical replaceable fuses.
13,191 Smith. Fusible cut-outs.
13,196 Butler, Sanderson & Winsborrow. Electric lighting systems using l.t. single-phase a.c. generator.
13,198 Ford Instrument Co. Electric step-by-step signalling apparatus.
13,199 B.T.-H. Co. (G.E. Co.) Radio signalling systems.
13,201 Berry. Electric fires.
13 247 Cowper-Coles. Continuous electrolytic production of copper wire.

May 27, 1919.

13,267 Weaver & Gibson. Attachment of electrical apparatus, &c., on mechanically-propelled vehicles.
13,298 Negromanti. Electrically-heated coverings.
13,317 Siemens Bros. Dynamo Works, Morphew & Howard. Transformers.
13,328 B.T.-H. Co. (G.E. Co.) Radio-signalling systems.
13,353 Calvert. Sealing electric conductors in glass bulbs, &c.
13,362 International Collophone Corpn. Telephone systems.
13,372 Commercial Electrolytic Corpn. Compound for cleaning guns, &c. (21/9/18, U.S.)
13,391 Automatic Telephone Mfg., Co. Electrical impulse controlling devices.

May 28, 1919.

13,409 Roberts. Telephones.
13,428 Todd. Electric bells.
13,442 Buchanan-Wollaston. Instrument for indicating position of submerged net.
13,453 Park Royal Engineering Works & Joyce. Electric switches.
13,455 Bradshaw. Electric gramophone mechanism.
13,479 B.T.-H. Co. (G.E. Co.) Signalling systems.
13,482 Vine. Conversion of ordinary clock into electric alarm clock.
13,485 Fullers United Electric Works & Palmer. Storage batteries.
13,488 Optalyte, Ltd. & Coulson. Electrical signalling lamp.
13,494 Ferranti, Ltd. & Lalofs. Oil-immersed water-cooled transformers.
13,498 Allmanna Svenska Elektriska A.B. Safety relays.
13,503 Armstrong. Electric chain welding machines.
13,510 Connecticut Telephone & Elec. Co. Electron valves. (8/8/18, U.S.)
13,512 Remy Electric Co. Distributor devices for ignition apparatus. (4/4/17, U.S.)
13,521 Relay Automatic Telephone Co., Bryant & Inman. Electro-magnets.
13,523 Marconi's Wireless Telegraph Co. Radio-signalling apparatus. (12/7/18, U.S.)
13,526 Telephone Mfg., Co. & Murray. Contacts for multiple switches.

May 29, 1919.

13,552 Walton & Barbour. Electric control gear for dynamo-electric machines.
13,581 Berthier. Electric-heating apparatus.
13,582 Westinghouse Airbrake Co. Electro-pneumatic braking apparatus.
13,625, 13,626, 13,627 & 13,629 Igranic Electric Co. & Wright. Coil-winding machines.
13,628 Igranic Electric Co. & Wright. Applying insulation of h.t. coils.
13,634 B.T.-H. Co. (G.E. Co.) Amplification of electric currents.
13,663 Ames. Magnetic cores.
13,664 Ames. Magnetos.
13,665 Ames. Electrical generators.
13,666 Ames & Gillinson. Electric coils.
13,667 Ames & Gillinson. Electrical condensers.
13,673 Krebs. Devices for attachment of electric conductors to insulators.

May 30, 1919.

13,678 Barry Increasing power factor in a.c. apparatus on three-phase systems.
13,693 Coomber & Smith. Plug and socket for connecting electric apparatus to wiring installation.

Commercial Topics.

Exports to Holland and Switzerland.

In view of the raising of the blockade, it is announced that it is no longer necessary for goods exported to Holland and Switzerland to be consigned respectively to the Netherlands Oversea Trust and the Société Suisse de Surveillance Economique.

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Trade with Germany and German-Austria.

In view of the raising ot the blockade, the Board of Trade have issued general licences under the trading with the enemy legislation authorising with certain reservations the resumption of trade with Germany and German-Austria. The licences do not remove the existing restrictions upon the payment of debts and the return of property due or deliverable to persons in Germany and German-Austria in respect of pre-war transactions: and also they do not permit the importation from Germany or German-Austria of any goods included in the Prohibition of Import Proclamations and not covered by a general licence issued under those proclamations, for which export licences must be obtained from the Export Licence Department, 1, Queen Anne's Gate, Westminster, S.W.1.

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The Nationalisation of Industry.

Several Chambers of Commerce and many associations, representative of the trade and industry of the country, have recently passed strongly worded resolutions protesting against the principle of the Nationalisation of Industry. A Special Committee of the Federation of British Industries has also been considering the question, and it is hoped that a reasoned and full report will shortly be ready for publication. In the meantime the Executive Committee of the Federation has re-affirmed the resolution (adopted by the Grand Council in May, 1919) expressing "its unanimous opinion against the nationalisation of industry." The condition of existing Government monopolies as well as the history of the telegraphs and telephones in this country certainly do not justify anyone in having the slightest confidence in nationalisation, which would, in our opinion, only lead to stagnation, inefficiency and high prices. We have seen too much of bureaucracy during the past five years to wish the slightest extension of it in any direction.

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The Excess Profits Duty.

We are pleased to learn that the Excess Profits Duty will probably be abolished at the end of the current financial year. There is no doubt that it has prevented the establishment of new industries and the expansion of existing undertakings, and our readers will, therefore, welcome the announcement that the tax will shortly come to an end. In the course of his reply on the debate which occurred in the House of Commons on Tuesday on the incidence of the tax, Mr. Austen Chamberlain said that he had to ask himself what effect the tax was having on industry under the present conditions. Was it harmless in respect to industrial revival? Having regard to all the uncertainties which faced manufacturers and traders during the transition from war to peace conditions, most members must feel that the tax was a serious obstacle to the revival of industry. The incidence of the tax was unfair as between one business and another, and it penalised new businesses. He did not regard it as a suitable way of taxing profits, and it was with reluctance that he continued the tax for another year. With regard to the strong desire to get at the war profiteer, it was not easy to define a "war profiteer," and he pointed out that it would be a very difficult problem to go back for five years and ascertain what were the profits due to the war which had been left out of income tax, super-tax, or excess profits tax. The reduction to 40 per cent. was proposed because he felt that the tax was a direct preventive of the resumption of industry, and his proposal was made in the national interest.

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Engineering Amalgamations and Combinations.

The amalgamation of engineering interests appears to be the order of the day, but the latest re-construction scheme is merely an arrangement whereby Messrs. John Birch & Company, the well-known export engineers of London, place their experience in export trade and their large overseas connection in Australasia, South Africa and the near and far East at the disposal of Messrs. Beardmore who, now that their workshops are being converted from war to peace production, are naturally anxious to find markets for their surplus output. Messrs. Birch & Company have largely increased their capital in order to cover the expansion of business involved. From another standpoint, Messrs. Beardmore's action is significant. It marks their recognition of the fact that the export merchant, or middle man, with his world-wide organisation, is a useful asset to trade and is worthy of being retained and supported, especially at the present time.

Another important development in the electrical industry is the registration of Tube Investments, Ltd., with a capital of £1,250,000 in 625,000 preference and 625,000 ordinary shares of £1 each, for the purpose of acquiring all or any of the preference or ordinary shares of Accles & Pollock, Ltd., Tubes Ltd., the Credenda Conduits Company, Ltd., and Simplex Conduits, Ltd., or any similar companies; and to carry on, either directly or by means of subsidiary companies, the business of manufacturers of and dealers in all kinds of conduit tubes and other fittings for electric wiring, and all descriptions of apparatus, articles and accessories connected with the erection and fitting up of electrical installations, &c. The first directors are: Messrs. Arthur Chamberlain, J. H. Ashton, J. Rollason, T. Pollock, C. T. Barlow, J. Baker, L. M. Waterhouse and J. Kemmal.

Electricity Supply.

The salary of the HEYWOOD borough electrical engineer (Mr. D. H. Davies) has been increased by £50 a year.

DUNDALK Urban Council has applied for sanction to borrow £1,000 for mains extensions.

WILLESDEN Council has received authority to borrow £654 for charging plant for Salusbury-road distributing station.

FOLKESTONE Council has approved of the proposal of the Folkestone Electricity Company to increase the charges for electric current by 15 per cent.

The Board of Trade have approved the draft scheme for the revised linking-up arrangements between STEPNEY, POPLAR and HACKNEY (London) Borough Councils.

An unopposed inquiry was held at CROYDON on the 10th inst. into the application of the Corporation for sanction to borrow £122,000 for extensions of the electricity supply undertaking.

BRENTWOOD Urban Council proposes to appoint a consulting engineer to deal with the question of electricity supply as soon as the Electricity (Supply) Bill is passed by Parliament.

A Select Committee of the House of Commons has passed the preamble of the ROTHERHAM Corporation Bill, which authorises the suspension until March 31, 1921, of the operation of the sinking fund on the capital expenditure incurred on electricity supply extensions carried out during the war.

Mr. D. Chapman, who has got a private electric lighting plant at PORTADOWN, proposes to carry out extensions so as to give a supply of electric current for public and private lighting. The Urban Council is friendly, and will give facilities for the erection of overhead wires and poles.

A proposed meeting of OLDHAM Electricity Committee and representatives of the ratepayers of adjoining townships regarding the supply of electricity by the Corporation to their areas, has been deferred until the Electricity (Supply) Bill has been passed. Royton and Crompton have, however, been informed that no one could supply them with electricity at cheaper rates than could Oldham Corporation. The Local Government Board has postponed its decision on the application of the Corporation for sanction to borrow £200,000 for extensions of the electric supply works until estimates based on tenders are submitted.

The accounts of the WALSALL electricity undertaking for the year ended March last, which were approved by the Town Council on Monday, show revenue £56,361 (against £40,252 in the preceding year) and expenditure £32,440 (£26,302). The net profit was £895. Mr. Hayward, who submitted the accounts, said although the net profit was only £895, the Committee had spent over £8,000 in wiping off debts on superseded plant. Applications were coming in faster than they could be dealt with, and the prospects of the concern were very hopeful.

At RHYL on Tuesday an inquiry was held into the Council's application to borrow £10,500 for the electricity undertaking. It was explained that the scheme was part of the Council's reconstruction plans, and would find employment during the winter for men. The electricity works were now paying, and, but for the heavy demand from the Kinmel Camp, the works costs would have gone down still further, despite increased cost of material, owing to the modernising of the plant. The camp demand compelled the Council to use the old steam set.

In view of the increasing cost of coal, ABERDEEN Corporation has asked the Water and Electricity Committees to consider and report upon the practicability of adopting water-power for generating the electricity required by the Corporation. Mr. Barron, who introduced the subject, said the Corporation paid nearly £200,000 per annum for the coal required for gas and electricity undertakings, water pumping, &c. At present no one could forsee what the cost of coal might be in future. Electricity was one of the best producers of power for industrial purposes, and it was of the utmost importance that every effort should be made with a view to economise and lessen the costs of production. He was convinced that the present cost could be materially reduced if water-power was used instead of steam from coal.

A Ministry of Health inquiry was held at Tynemouth on Tuesday into the application of the Corporation for sanction to borrow £10,000 for the electricity undertaking. At present the Corporation obtain current in bulk from the Newcastle-on-Tyne Electric Supply Company, but under the agreement the Council were required to run their steam plant in the winter months. In actual practice, this had been found unnecessary, as the company had been able to supply the Corporation during the winter with sufficient energy and the company was prepared to enter into an agreement to supply the Corporation without calling upon the steam-plant. It was, therefore, proposed to sell the steam-plant, as the loans outstanding on it were not far from maturity, and the Council hoped to obtain sufficient money from the sale to extinguish the outstanding balance. It was proposed to instal a 500-kw. rotary-converter, which would enable them to continue to supply current when one of the motor generators was shut down, and it was also proposed to extend the mains and service extensions. In order to economise in the cost of mains, it was proposed to change over part of the distribution system to three phase. For that purpose the Council would take supply at 3,000 volts, and would send it out on a ring main with transformer sub-stations at suitable parts of the town. One reason for the change was that a growing amount of current was required for heating and cooking purposes.

A well-attended meeting of engineers of both municipally-owned and company-owned electricity supply and tramway undertakings generating electricity in Yorkshire (with the exception of the Cleveland district), presided over by Mr. T. Roles, of Bradford, was held at Leeds, on the 11th inst, for the purpose of receiving the report of the Yorkshire Electricity Supply Linking-up Committee. After an interesting discussion the report was adopted, without a single dissentient, on a resolution moved and seconded by engineers who had not served on the Committee, and a vote of thanks to the Committee for their labours was carried. During the meeting the opportunity was taken to pass a vote of sympathy to two members of the Committee, Mr. E. Cross, of Rotherham, and Mr. S. E. Fedden, of Sheffield, who are unfortunately laid up.

During the afternoon of the same day a conference of members of committees and boards of directors, along with their legal advisers and engineers, of the undertakings above referred to took place for the purpose of considering the Linking-up Committee's report more particularly in other than its technical aspects. This conference, at which most of the undertakings were represented, elected Councillor Lupton, Chairman of Leeds Corporation Electricity Committee, to the chair. The report was discussed at some length, and finally a resolution, moved by Sir Robert Fox, the Town Clerk of Leeds, "that the best thanks of this conference be given to the Committee of Engineers for their able report, and that no action be taken upon it at present," was carried.

Electric Traction.

Newport (Mon.) Corporation has decided to adopt electric vehicles for refuse collection.

The through running of tramcars between Pontypridd and Porth, which commenced on Monday, is proving very popular, and there is no doubt that the experiment will prove successful.

An arrangement has been made by which all tramways' employees shall receive double pay for working on Peace Day. The tramway employees in Leeds and a few other districts have decided to abstain from work on that day.

Hull Tramways Committee's recently established all-night service is a success. The returns are satisfactory, particularly in relation to the traffic between 2 a.m. and 5 a.m.

During the week paragraphs have appeared in the Press to the effect that the Manchester tramways department had placed an order in America for tram rails, but we are informed by the general manager (Mr. J. M. McElroy) that there is no truth in the statement.

At a meeting of representatives of Municipal Tramways in Scotland to consider the question of appointing representatives to the National Industrial Council, it was agreed that tramway companies and their employees should come into line with the municipally-owned tramways to form a Scottish Industrial Council, and the meeting stands adjourned to see if the companies and their employees were favourable to the proposal.

The revenue of the Kirkcaldy tramways for the year ended May 15, 1919, was £28,060 (compared with £21,350 in the previous year), working expenses were £19,695 (£15,258), gross profit was £8,364 (£6,092), interest required £3,319 (£3,042), redemption of debt £2,217 (£2,153) and depreciation £500 (£500), leaving net profit £2,326 (£396). Revenue per car-mile was 10·036d. (11·933d.), and working expenses, including power were 11·26d. (8·52d.). Passengers carried were 6,263,570 (5,705,513), and car-miles run 419,938 (429,382).

The Minister designate of Ways and Communications has decided to organise the Ministry in separate departments, and although no definite appointments have been made pending the passing of the Bill, the services of the following gentlemen have been provisionally secured: Civil engineering, Sir Alex. Gibb, K.B.E.; mechanical engineering, Lieut.-Colonel L. Simpson, D.S.O., R.E.; consultant mechanical engineer, Sir John Aspinall, M.Inst.C.E.; traffic department, Sir Philip Nash, K.C.M.G. finance and statistics, Sir J. George Beharrell, D.S.O.; development department, Rear-Admiral Sir Charles Martin de Bartolome, K.C.M.G., C.B.; public safety and labour, Sir Wm. Marwood, K.C.B.; roads department, Brigadier-General Sir Henry P. Maybury, K.C.M.G.; secretarial and legal, Sir R. Francis Dunnell, K.C.B.; financial adviser on behalf of Treasury, Sir Hardman Lever.

The accounts of the Manchester tramways department for the year ended March 31, 1919, show receipts £1,369,609, including £209 balance of motor bus account and £233 balance of parcels account, working expenses, war service allowance, &c., amounted to £969,390, leaving gross profit £400,218. After providing for interest on capital, rent of leased lines, &c., the balance to appropriation account was £324,008. Sinking fund and loan instalments required £67,356, income tax £27,940, and interest and sinking fund for street improvements £6,224. Of the remainder, £110,596 has been placed to renewals fund, and £111,891 contributed in aid of rates. Total revenue per car-mile was 18·114d. (compared with 14·496d. in previous year), and working expenses, including power, were 18·821d. (10·189d.). Passengers carried were 253,940,203 (240,914,369), and car-miles run 18,146,551 (18,540,585), including motorbuses 1,821,310 (1,682,822). Units used were 1·634, (1·628) per car-mile. There are 119 route miles (=203 miles of single track) in operation. The report of the committee states that a revision of the fares and stages came into operation in July and August, 1918, the effect generally being to reduce the penny stage to two miles. The price paid for current to the electricity department was 1·25d. (1·182d.). The total paid in relief of rates now amounts to £1,326,981. Traffic revenue on the motor buses was 14·918d. (13·424d.) per bus-mile, and working expenses were 11·637d. (9·564d.). The revenue of the parcels department was £19,099 (£15,983), and the parcels carried were 1,003,186 (1,052,310).

Miscellaneous.

During Manchester's Victory Loan campaign last week, the British Westinghouse Company subscribed £250,000 towards the effort.

The success of the recreation club run in connection with Messrs. Ferranti, Ltd., of Hollinwood, was amply proved at the third annual gala, held last week. The staff orchestra played during the sports and later in the day for dancing.

It is announced that the Government are determining licences to conduct experiments in wireless telegraphy held by civilians before the war. The step is part of a general measure which has become necessary in view of the revision of the conditions under which authority for private experiments can be given. All existing experimental licences are being cancelled, but holders will be allowed to apply for fresh licences under new conditions.

The total amount collected and distributed since September, 1914, in connection with the War Relief Fund organised by the workers of Messrs. Babcock & Wilcox, Ltd., of Renfrew, was £14,981. The principal war charities (including the Red Cross Society, the Lord Provost's Fund, the Renfrew Burgh War Relief Fund, The Belgian Relief Fund, and the Y.M.C.A.) received donations, but the smaller societies also benefited by the fund. A small proportion of the contributions was retained to form a special Works Fund for the relief of soldiers and sailors who had been employed with the firm.

During their occupation of Belgium the Germans established at Franiere, near Namur, a colossal Dump of Electrical Material. In fact, this was the largest collection of such stores in a single place the world has ever seen. So huge was the dump that when the great retreat came this valuable material fell into British hands. The Disposal Board of the Ministry of Munitions is now giving an exhibition of this material, which will be for sale soon, at the Royal Agricultural Hall, Islington. Stocks vary from small quantities in some items to hundreds of thousands of articles in others. A summary includes telephones and telegraphs, wireless apparatus, earth inductor sets, daylight signalling lamps (electric or gas), &c.

Imports.—The following are official values of electrical machinery material and apparatus imported into this country (*a*) during May, 1919; and (*b*) the aggregate figures from Jan. 1 to May 31, with increase, or decrease compared with corresponding periods of 1918:—

Electrical machinery, (*a*) £66,386 (increase £45,199), (*b*) £236,304 (decrease £131,419); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £25,856 (increase £16,120), (*b*) £94,906 (increase £34,058): and electrical machinery unenumerated, (*a*) £40,500 (increase £29,079), (*b*) £141,398 (decrease £165,477); telegraph and telephone cables other than submarine, (*a*) nil, (*b*) £73,378 (increase £5,532); telegraph and telephone apparatus, (*a*) £11,847 (increase £10,388), (*b*) £97,889 (increase £83,194); other electrical wires and cables, rubber insulated, (*a*) £483 (increase £483), (*b*) £2,966 (increase £2,364); with other insulations, (*a*) £634 (increase £634), (*b*) £9,003 (increase £8,548); carbons, (*a*) £4,639 (increase £1,248), (*b*) £12,913 (decrease £6,171); glow lamps, (*a*) £54,940 (increase £50,395), (*b*) £189,498 (increase £137,527); parts of arc lamps and searchlights (other than carbons), (*a*) £7,726 (increase £1,824), (*b*) £33,407 (decrease £5,997); primary and secondary batteries, (*a*) £4,092 (decrease £5,863), (*b*) £18,331 (decrease £69,937); meters and measuring instruments, (*a*) £4,311 (increase £2,951), (*b*) £17,220 (increase £11,713): switchboards, (*a*) £284 (increase £284), (*b*) £956 (increase £690): electrical goods and apparatus unenumerated, (*a*) £35,178 (decrease £19,339), (*b*) £200,234 (increase £23,387). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £124,134 (increase £43,005), (*b*) £589,795 (increase £190,850).

Exports.—The exports of electrical machinery, material, &c., (*a* during May, 1919, and (*b*) from Jan. 1 to May 31, with increase or decrease compared with corresponding periods of 1919, were as follows:—

Electrical machinery, (*a*) £117,710 (increase £46,263), (*b*) £502,143 (increase £68,274), including railway and tramway motors, (*a*) £3,478 (decrease £1,028), (*b*) £23,379 (increase £8,299); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £74,514 (increase £31,584), (*b*) £279,104 (increase £25,200); and electrical machinery unenumerated, (*a*) £39,726 (increase £15,707), (*b*) £199,660 (increase £34,775); telegraph and telephone cables, submarine, (*a*) £37,344 (decrease £209,806), (*b*) £203,073 (decrease £121,958); other than submarine, (*a*) £26,066 (decrease £3,710), (*b*) £128,678 (increase £29,488); telegraph and telephone apparatus, (*a*) £28,011 (increase £14,418), (*b*) £126,311 (increase £39,998): other electrical wires and cables, rubber insulated, (*a*) £75,279 (increase £72,475), (*b*) £192,463 (increase £165,602); with other insulation, (*a*) £98,742 (increase £95,735), (*b*) £220,937 (increase £188,737); carbons (*a*) £692 (increase £84), (*b*) £3,152 (increase £632): glow lamps, (*a*) £15,472 (increase £10,172), (*b*) £49,517 (increase £13,614); arc lamps and searchlights, (*a*) £196 (decrease £2,656), (*b*) £6,389 (decrease £3,788); parts of arc lamps and searchlights (other than carbons), (*a*) £53 (decrease £2,372), (*b*) £6,961 (decrease £1,954); primary and secondary batteries, (*a*) £40,845 (increase £28,052), (*b*) £207,750 (increase £164,641), meters and measuring implements, (*a*) £23,914 (increase £7,098), (*b*) £84,172 (increase £34,999); transformers, (*a*) £4,544 (increase £2,138), (*b*) £18,569 (increase £8,046); switchboards, (*a*) £1,704 (increase £563), (*b*) £13,809 (decrease £835); electrical goods and apparatus unenumerated, (*a*) £101,252 (increase £66,922), (*b*) £423,974 (increase £245,052). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £454,114 (increase £79,113), (*b*) £1,685,755 (increase £762,274).

Educational.

Mr. T. Jones, A.R.C.Sc., B.Sc., of Keighley, has been appointed head of the physics department of Cardiff Technical College.

Dr. G. C. Henderson has been appointed Regius Professor of Chemistry in the University of Glasgow.

Prof. A. Findlay, of Aberystwyth College, has been appointed to the chair of chemistry at Aberdeen University in succession to Prof. Soddy.

On Tuesday Sir Joseph J Thomson, O.M., Master of Trinity College, was elected into the recently established professorship of physics at Cambridge.

Mr. H. T. Davidge, D.Sc., has been appointed lecturer in applied mathematics and Mr. C. C. Hawkins, M.A., lecturer in electrical design at University College, London.

Cardiff Technical Instruction Committee have appointed Mr. A. W. Loveridge, D.Sc., A.R.C.Sc., head of the engineering department of Cardiff Technical College at £600 per annum.

The following awards have been made in the Faculty of Engineering at University College, London: Archibald P. Head Medal and Prize, P. S. J. Bovey. Engineering Diplomas: *Civil and Municipal*—P. S. J. Bovey (with distinction), H. Droeser, N. P. Graham, C. N. Saker and A. N. Seal. *Mechanical.* N. H. Williams. *Electrical.*—J. A. Broughall and L. R. Nixon.

A Goldsmid Entrance Scholarship, tenable in the Faculty of Engineering at University College, value £30 a year for three years, may be awarded in September. Entry forms by Sept. 10th.

A large number of past and present students assembled on Monday evening in the great hall of the Merchant Venturers' Technical College, Bristol, on the occasion of a presentation to Prof. J. Munro, of Bristol University, who is retiring from the chair of engineering after 48 years' service. Prof. J. Wertheimer, who presided, referred to the good work done by Prof. Munro, whom he had known for the past 29 years. The long and valued services of Prof. Munro had been marked by his being appointed an Emeritus professor of the university.

Dr. Hele Shaw, who was one of the first students at Bristol University College, and the first professor of engineering there, said it was a great privilege to be able to voice the esteem and affection of all students for Prof. Munro. It was nearly half a century ago that he attended the night classes of the Bristol Trade and Mining School, where Prof. Munro taught mining engineering. Prof. Munro, with his great ability, had opportunities which, if devoted to the practical side of engineering, might well have placed him in a very high position, but he chose the path which had brought him much honour and respect but not much financial gain. He had the satisfaction of knowing that a large number of successful students had passed through his hands, and that they appreciated how much of their success they owed to him. They all wished him health and happiness. He then presented Prof. Munro with a carriage clock and £200 Government stock.

Prof. Munro acknowledged the gifts, and expressed his gratitude for all the kind things that had been said about him. He hoped in the next few years to see great developments in the university life of Bristol.

Tenders Invited and Accepted.

Dunedin (N.Z.) City Council require tenders by 5 p.m. Aug. 6 for the supply of a 3,500-volt three-phase regulator.

London County Council require tenders by 1 p.m. July 22 for the supply of 2,000 tons of steel conductor tees. Specifications from the Chief Engineer, County Hall, Spring Gardens, S.W.

Tenders are invited for the supply and erection of three electric travelling gantry cranes at Belfast Harbour. Specification from the Harbour Engineer, and tenders to the Secretary by July 30.

Birkenhead Guardians require tenders by noon July 28 for the installation of internal telephones at their institutions. Specifications from the Clerk, Conway-street, Birkenhead.

Manchester Tramways Committee require tenders by 10 a.m. July 29 for the supply of tramcar motors. Specification, &c., from the General Manager.

Tenders are invited by the Victorian Railway Commissioners for the supply of an electric capstan for the Newport (Victoria) power house. Tenders to the Secretary for Railways, Spencer-street, Melbourne, by 11 a.m. Aug. 27.

Heston and Isleworth Council require tenders by July 28 for the supply and erection of a 500 kw. rotary converter, transformer, operating switchgear and l.t. feeder panel, cable, &c. Specifications from the Engineer, Electricity Works, Hounslow.

Grimsby Corporation invite tenders for high-pressure steam pipes, boiler feed and other pipes, circulating water pipes, electrically-driven centrifugal pumps and water storage tank. Specifications and drawings from the borough electrical engineer, Lieut.-Col. W. A. Vignoles, and tenders by Monday, Aug. 11.

Redditch Urban District Council invite tenders for high-pressure steam, exhaust and water circulating piping. Specifications, &c., from the consulting engineers (Messrs. Handcock, Dykes & Trotter), 11, Victoria-street, London, S.W.1, and tenders to the clerk to the Council (Mr. G. W. Hobson) by noon July 28.

Durban (Natal) Corporation require tenders for the supply and delivery, c.i.f., of a quantity of Telephone Underground Cables. Specifications from Messrs. Webster, Steel & Company, 5, East India-avenue, London, E.C. 3, to whom tenders are to be sent by Aug 1.

Sunderland Tramways Committee has ordered six double-deck covered tramcar bodies from Messrs. Dick, Kerr & Company. Messrs. J. G. Brill & Company will supply the trucks.

Bethnal Green (London) Borough Council is recommended to accept the tender of the British Insulated & Helsby Cables for the supply of l.t. cables, pipes, house services, &c., at £14,578. There were eight tenders, varying in amount from that of the accepted to £16,837.

Burnley Corporation has accepted the tender of Siemens Bros. & Company for the supply of 6,300 yds. of cable at £1,818. There were six tenders before the Electricity Committee, and at first it was proposed to accept that of the Macintosh Cable Company, but Messrs. Siemens had reduced their quotation from £2,188 to £1,818.

Glasgow Corporation has accepted the following tenders: British Westinghouse Company, tramcar motor equipment; British Thomson-Houston Company, motor controllers; Manchester Armature Repair Company, armature coils; Miller & Company, scrap brake blocks; United States Steel Products Company, 5,000 tons of rails, at £17. 9s. per ton, for delivery during July, August and September.

Appointments Vacant and Filled.

Plymouth Corporation require a tramways manager. Salary £700 per annum, rising to £800. Applications to the Town Clerk by July 23.

An instructor in electric wiring will be required in September at the Huddersfield Technical College. Salary £200. Applications to the Principal.

The Council of Armstrong College, Newcastle-on-Tyne, invites applications for the post of professor of experimental physics. Salary £600, rising by biennial increments of £50 to £800 per annum. Applications to the Secretary by Aug. 30.

Mr. T. Sykes, assistant engineer and manager of Bradford Corporation tramways, has been appointed manager of the Rotherham Corporation tramways.

Business Items.

The offices of the Industrial Publicity Service, Ltd., have been removed to 4-7, Red Lion-court, London, E.C. 4. Telephone: Central 2422.

Mr. W. A. Wales, chief assistant engineer at Ashton-under-Lyne Electricity Works, has resigned in order to enter into a business partnership in Manchester.

A second return (5s. per share) is payable at General-buildings, Aldwych, London, W.C. 2, to contributories of Consolidated Diesel Engine Manufacturers, Ltd.

Amy Marion Marr and Harry Davidson Marr (trading as J. J. Marr & Company), electrical engineers, 18, Moorfields, Liverpool, have dissolved partnership. Debts by Amy Marion Marr, who continues the business.

Messrs. Geo. N. Dixon & Company, of 41, Castle-street, Liverpool, will sell by auction at the National Projectile Factory, St. Helens, on July 29 and 30, some stranding and closing machines, a 30 h.p. d.c. motor, &c.

The proprietor of patent No. 804/1912, for "Improvements in voltaic arcs," desires to grant licences or make arrangements for developing same in this country. Communications to Messrs. Haseltine, Lake & Company, 28, Southampton-buildings, Chancery-lane, W.C.

The Skefko Ball Bearing Company, Ltd., has opened a branch office at 14, Temple-street, Birmingham, and Mr. G. I. Francis, who has been connected with the company since 1910 and is well known in the Midlands, has been appointed district manager.

A pamphlet, giving particulars of the "Little Briton" vacuum cleaner, has been issued by the General Electric Company, 69, Queen Victoria-street, E.C. 4. It is claimed that the machine is simple, effective and requires no attention save starting. The leaflet can be overprinted and the company have a supply for the trade.

The British Thomson-Houston Company, Ltd., of Rugby, has just issued a list (No. 2,510A) descriptive of the B.T.-H. Shaft Couplings. The company supplies three types—viz., flexible, flanged, solid flanged and muff couplings, and the leaflet gives illustrated particulars, with ratings, prices and dimensions, &c., of each type.

The Sterling Telephone and Electric Company has recently issued the 11th edition of its catalogue, which gives particulars and prices of a great variety of telephone apparatus and accessories, electric bells, indicators, fire alarms, batteries, wires, mine exploders, &c. The catalogue, which runs to about 150 pages, is very complete, and includes an index and a list of code words for ordering goods.

Mr. Arthur J. Maginnis and Mr. Damer L. Allen have commenced business as consulting engineers, naval architects, &c., at 64, Leadenhall-chambers, 4, St. Mary Axe, London, E.C., and 28, Chapel-street, Liverpool. The London office will be under the supervision of Mr. Allen, who has wide experience as an engineer (electrical and marine) and in the erection of refrigerating machinery, &c.

Messrs. Ferranti Limited, of Hollinwood, Lancs, have recently issued a well-illustrated booklet giving particulars of the transformers manufactured by them. Excellent views of parts of the company's works and of selected machines are shown, and as the booklet is intended for the foreign market it is printed in five languages, English, French, Italian, Spanish, Portuguese. We commend the firm's enterprise, for it will enable prospective users in foreign countries to read in their own language particulars of the firm's products.

Companies' Reports, &c.

GENERAL ELECTRIC COMPANY.

In the course of a long and interesting speech at the meeting of the General Electric Company, Ltd., on the 9th inst. the chairman (Mr. Hugo Hirst) gave particulars of the work done during the war, &c., and said the company had been fortunate in that its war work had not essentially differed in character from its peace work. That had enabled the change-over to take place with less disorganisation than many firms had experienced. The accounts were so clear and self-explanatory that he would not comment on them except to make a reference to the staff bonuses. The sum set aside for staff bonuses, based on articles of association of 20 years ago, proved entirely insufficient for the satisfaction of the staff. For that reason they made an alteration in their articles at the last meeting. The report referred to an ambitious peace programme which the directors had adopted. They were steadily building up an electrical concern which would soon rank with those great organisations which had been such a potent force in industry in other countries. Gradually, but surely, they were covering the whole domain of electricity. They aimed at being able to say that there was no conceivable electrical contract that the company could not undertake and carry through, with products of its own manufacture so far as they were within the realm of the electrical industry. The war had created a new strategic position. They had to face competition from America, Japan and other countries immensely strengthened through the war. They must also realise that Germany, assisted by the low value of the mark and by American support, might make herself seriously felt again in the markets of the world.

The Future.

Their peace programme was on a large scale because they looked forward to taking part in the reconstruction of the devastated countries. There was a great lack of stocks throughout tho world, and the immediate future must see an enormous development in everything pertaining to electricity. The demand for electrical equipment in the near future would probably be double or treble what we could produce to-day. For that reason they asked for authority to increase the capital of the company to £6,000,000. The directors thought it their duty to assist the country in every possible way now, not only by absorbing demobilised men, but by finding employment for others. They had nearly 14,000 employees, and their programme would enable them to increase that number by an additional 8,000. The extensions in hand had enabled them to reinstate their demobilised men without discharging the other workers. Their measure of success would mainly depend on the workers themselves. The company provided the most efficient organisation, erected the most suitable buildings and installed the latest machinery and plant. But with larger increased wages and reduced working hours nothing could help them and the country to increased prosperity except largely augmented output. The worker of the future would have to apply his brain more if they were to succeed in regenerating industry. The worker would have to use his head as well as his hands, avoiding the scrapping of materials and deterioration of tools and plant, watching at every turn how he could improve methods of performing work and by intensive application secure the best results from his labours. If he worked in that spirit he would save heavy overhead charges and a great number of non-productive inspectors and overseers. He would thus assist in creating a low cost price—a low cost price created a larger market, and a larger market meant more and steady employment at higher wages. During the war other countries had prospered and their manufacturers had extended their factories and written off their new plant and machinery out of profits, and now we had to extend and rebuild at prices two or three times in excess of those prevailing before the war. He believed it was beginning to be realised by all classes that the higher standard of living to which the country had attained during the war could only be maintained by increased production. We must work or starve, but with conscientious endeavour on the part of every worker, combined with quantity production methods, he believed we should be able to satisfy the legitimate demands in respect to both wages and hours. Capital and Labour working in the closest association would win through and build up this country and Empire into a prosperous Commonwealth, in which every worker would have a full share. They had drawn up a carefully thought-out superannuation scheme, which embraced both workpeople and staff, when the time came for them to retire from active service with the company. The scheme would necessarily be a contributory one, based on the rate of pay of the members. The premium, which they proposed would amount to 8 per cent. of the weekly wage, payable, half by the member and half by the company, and allowed to accumulate at compound interest until the age of retirement—namely, 60 years, or earlier in the event of permanent incapacity. After giving some particulars of the scheme, he said the administration of the contributory fund would be carried out jointly by the company and representatives selected by the members.

Welfare Work and Research.

They had also been mindful of the daily needs of their people in providing liberal welfare accommodation at considerable cost, and they had recognised the needs of the workers in respect to recreation. The new programme included a sum of £40,000 for providing a club building at Witton. An opportunity should always be available to the worker to participate in the operations of the company, and it was largely for that reason that they proposed to convert the £10 shares into £1 shares. In connection with their Birmingham works they had appointed a director of education, and some 300 or 400 boys were being encouraged to take up lines of study in the company's time. A similar scheme was being started in connection with the London staff, where they had also appointed a director of education. Commercial apprentices from the County Council schools and others were encouraged to benefit by the facilities which they provided. They had also organised a special "rush course" for demobilised officers, particularly for those who left for the Front straight from Public Schools or 'Varsity. In the new Kingsway building they were providing a theatre and lecture-room, with their own staff of lecturers and demonstrators, and they had also arranged for the assistance of outside lecturers.

The principal staff of the research department had been selected. The necessary buildings had not yet been provided but were included in the programme of development. In all that process of development they should not get very far along ideal lines if they were impelled solely by selfish aims, indeed, it was a fallacy to think that the future of a concern like theirs could be successfully shaped unless it involved not only happy conditions for its employees, but a worthy contribution to the prosperity and greatness of the country.

State Control.

After referring to the manner in which the year's disposable balance had been applied, Mr. Hirst said that so far as industry was concerned, the one essential function of the State was to secure freedom from interference from outside countires, a breathing space for a few years to enable them to put their house in order. If he might use the simile of their Kingsway building now in course of completion, he would like the State to do what they had done there. While the building was being prepared for receiving the greatest flow of traffic of merchandise, staff and customers, they had put a boarding round with the notice, "During reconstruction, no trespassers." With things in a disorganised condition and valuable material lying about, unauthorised persons should be regarded as trespassers. The Company's programme, embodying as it did the doubling of their output in turbines and heavy machinery, the increase in the output of lamps, magnetos and telephones, the establishment of glass, ebonite and other industries, could not meet with success by the efforts of their employees only, however loyal and hard working they might be. They, as all other manufacturers, were dependent on the workers in other British industries for material. Their success depended upon getting these materials promptly and of the highest standard.

The report was then adopted and the retiring directors and auditors reappointed. At a subsequent extraordinary general meeting it was resolved to increase the capital of the Company to £6,000,000 by the creation of 1,800,000 additional preference and 1,200,000 additional ordinary shares of £1 each. It was also agreed to divide the existing preference and ordinary shares into 10 shares of £1 each.

The Altrincham Electric Supply, Ltd., is making an issue of 50,000 7½ per cent. cumulative participating ordinary shares of £1 each.

The directors of the Dublin United Tramways Company have declared an interim dividend of 5 per cent. per annum on the ordinary shares.

The directors of Greenwood & Batley, Ltd., recommend a final dividend of 10 per cent. on the ordinary shares, making 15 per cent. for the year ended March 31.

Messrs. Higginson & Company are offering for subscription, on behalf of the English Electric Company, Ltd., £1,000,000 5½ per cent. sinking fund first mortgage debentures.

The interest on the 4 per cent. mortgage debenture stock of the Eastern Extension Australasia and China Telegraph Company, Ltd., for the half-year ending July 31, will be paid on the 1st prox. The stock register will be closed from the 28th to the 31st inst. inclusive.

At a special general meeting the proprietors of the Blackpool & Fleetwood Tramroad Company have approved the Bill now before Parliament, for the transfer to Blackppool Corporation of the company's tramway undertaking. During the past half-year's working the receipts increased by £8,000, but the expenses are also high.

The profit of the Gravesend & Northfleet Electric Tramways Company, Ltd., for 1918, after providing £9,634 for repairs, renewals and maintenance and meeting debenture interest, &c., of £5,012, and an available sum, including £168 brought forward, of £5,179. A dividend of 3 per cent. has been declared and £1,000 transferred to reserve, leaving £1,737 to be carried forward.

After providing for income tax and mortgage and debenture stock charges, the net profit of Edmundson's Electricity Corporation for the year ended March 31 was £13,637, compared with £12,209 for the previous year. With £5,128 brought forward, the total available is £18,765, and the directors recommend that £12,000 be applied in paying the year's dividend on the cumulative preference shares, leaving £6,765 to be carried forward.

The profit of the Shanghai Electric Construction Company for the year 1918 was £71,537 (against £67,504 in 1918), and with £14,264 brought forward, the total is £85,801. The directors have transferred to reserve for renewals £10,000, to extinguish preliminary expenses account £8,000, and an interim dividend of 5 per cent. has been paid, leaving £51,802. The directors now recommend a final dividend of 5 per cent., making 10 per cent. for the year, and a bonus of 5 per cent., leaving to be carried forward £19,802. The traffics and net receipts for the current year continue to be satisfactory. Operating expenses increased, due to the greater cost of power resulting from the high price of coal.

Mr. Chas. W. Parish, chairman of the Chili Telephone Company, Ltd., stated at the annual meeting last week that Chili was one of the countries which had prospered during the war, but with the cessation of fighting new conditions arose, and until normal conditions returned they must expect that Chili would have to face a period of "marking time." The company's business continued to progress at a satisfactory rate, showing that the commercial activity of the country did not depend entirely upon the nitrate industry. In all districts in which the company operated there was a steadily increasing demand for their service. During the past year they had constructed 35 new trunk lines, opened six new offices, and in four important districts acquired their own premises. The mileage in operation increased by about 1,425, while the number of subscribers rose from 15,420 to 16,751. It was hoped that the automatic plant now in course of manufacture would be installed at Valparaiso during the year. Under the Chilian law a term of 20 years was fixed for underground cable concessions and 10 years for aerial wires. The company had underground concessions at Valparaiso, and had lately obtained permission to change their overhead wires to underground at Concepcion, Talca and Vina-del Mar. Their aerial concessions would shortly expire, and negotiations for their renewal had satisfactorily advanced. The disposable balance was £66,876, of which £16,964 had been placed to general reserve, and £15,000 to reserve for renewal of plant, and they were paying a final dividend of 3s. per share (making 6 per cent. for the year), leaving £8,510 to be carried forward. The 6 per cent. on the increased capital equalled the 8 per cent. paid last year on the £330,000.

Mr. J. B. Braithwaite, chairman of the Electric & General Investment Company, Ltd., stated at the meeting last week that since the Armistice there had been a general revival of the class of financial business which the Company was formed to participate in. The receipts from interest and dividends, &c., were £8,117. 4s., against £6,427 in the previous year. Their charges had been reduced by £212 and the net profit was £1,902 higher. There was a total reduction in liabilities of £16,576, and the carry forward was incresaed by £6,127, but the assets had been reduced by £10,449, due to sales of securities and other causes, leaving a net improvement of £12,254. On May 31, 1918, after including the carry forward and the reserve fund, and taking the stocks at the then current valuation, there was a net depreciation of £54,876, but there had been an improvement in those items during the year of £37,297. The preference dividend arrears represented £30,000, or £21,000 less income tax at 6s. in the pound. After discussing methods of dealing with the position, he invited opinions upon the subject and said that after hearing them they would convene a meeting of the largest preference shareholders and try to agree on a scheme. The corner had been turned, and the capital of the Company was practically intact—since May 31 their securities had appreciated nearly to the amount of the difference of £8,500—so that it was time they cleared up the arrears of dividend.

The report and accounts were then adopted.

New Companies.

ALADDIN RENEW ELECTRIC LAMP CORPORATION, LTD. (156,817)—Capital £200,000 in £1 shares. To adopt agreement with Seymour & Gordon, Ltd., and to carry on the business of manufacturers or renewers of electric lamps, gas mantles, &c. The first directors are: A. D. Keeling, I. Shaw, T. J. Priestman, B. E. Foster, Sir Harry S. Foster, K.B., J.P. The Renew Electric Lamp Company, Ltd., may by itself or its liquidator at all times nominate two directors. Reg. office: 82, Victoria-street, S.W.1.

ANGLO-NORWEGIAN ELECTRO-CHEMICAL & FINANCE COMPANY, LTD. (155,968.)—Private company, reg. June 12, capital £20,000 in £1 shares To carry on the business as indicated by the title. Directors, V. Vogt, G. Hartmann, W. C. Eger and G. A. Jebson, all Norwegians, of 1, Bygdo Alli, Christiania. Reg. office, 6, Great St. Helens, E.C.

ERNEST WAINWRIGHT (LONDON), LTD. (155,661).—Private company. Reg. May 31. Capital £5,000 in £1 shares. To acquire the business of an electrical engineer, manufacturer and merchant of engineering appliances, electrical fittings, &c., carried on by E. Wainwright. Directors: E. Wainwright and S. W. J. Vaisey. Reg. office: 159, Victoria-street, S.W.1.

FREDK. HODGSON & COMPANY, LTD. (156,515.)—Private company; reg. June 28, capital £2,000 in £1 shares. To acquire the business of electrical and manufacturing engineers, lighting and power specialists and contractors carried on by H. Hodgson. Directors: F. Hodgson, G. D. Blatchford, R. Tweedy-Smith. Reg. office, 24, Queen Victoria-street, E.C.

MOULSON & ANDERSON, LTD. (155,704).—Private company. Reg. June 2. Capital £5,000 in £1 shares. To enter into agreements with A. E. Moulson and G. E. Anderson, and to carry on the business of general electrical and mechanical engineers. First directors are: W. Holroyd, A. E. Moulson and G. E. Anderson. Reg. office: Ross Works, Birksland-street, Bradford.

PRIDEAUX & COMPANY, LTD. (156,071.)—Private company, reg. June 14, capital £2,000 in £1 shares. To take over the business of gas and electric fittings manufacturers and brass founders carried on at Birmingham as Prideaux & Company, and at Birmingham as Lea & Perrins. First directors, T. Phillips (permanent director and chairman) and J. W. Lea. Reg. office, 107, Macdonald-street, Birmingham.

RUSKIN WORKS, LTD. (156,498.)—Private company; reg. June 27, capital £2,000 in £1 shares. To acquire premises at Ruskin-avenue, Manor Park, and to carry on business as engineers and contractors and dealers in metal goods, and hardware, wholesale and retail ironmongers' merchants and manufacturing electricians. Directors: F. Crawford and J. Fraser. Reg. office, Ruskin Works, Ruskin-avenue, Manor Park.

SOUTH OF SCOTLAND ELECTRICAL & MECHANICAL ENGINEERING COMPANY, LTD. (10,462).—Private company. Reg. in Edinburgh. June 14, capital £5,000 in £1 shares. engineers, electricians, makers and repairers of and dealers in and hirers of aeronautical engines, motors, accumulators, &c. First directors: H. J. Berry, Edgar Moodycliffe, Samuel W. Marshall, James Clarke McGeorge, jun., and A. G. McGeorge, of Dumfries.

SUPLYAWL, LTD. (156,109.)—Private company, reg. June 16, capital £3,000 in £1 shares. Electrical, hydraulic and mechanical engineers, metal workers, &c. Reg. office, Rooms 506-7, Bank-chambers, 329, Holborn, W.C. 1.

TUNGSTEN MANUFACTURING COMPANY, LTD. (156,321).—Private company. Reg. June 21, capital £150,000 in £1 shares, to enter into an agreement with W. L. T. Wright, and to carry on the business of manufacturers of tungsten and other metals, electrical and mechanical engineers, &c. Reg. office: Thanet House, Strand, W.C.

VACTITE WIRE COMPANY (1919), LTD. (156,012.)—Private company, reg. June 12, capital £25,000 in £1 shares. To acquire the business of a manufacturer and supplier of accessories to the incandescent electric lamp industry carried on by a company of similar name at Aston and Wolverhampton.

VICKERS-ROUMANIA, LTD. (156,883)—Private company. Reg. July 9. Capital £40,000 in £1 shares. Engineers, manufacturers of and dealers in metals, metal founders and workers, shipbuilders, electricians, electrical engineers, &c.

YORKSHIRE MANUFACTURING COMPANY, LTD. (156,504).—Private Reg. June 27. Capital £1,000 in £1 shares. Mechanical, electrical, constructional and general engineers, tool makers, &c., at Sheffield.

Prices of Metals, Chemicals, &c.

		TUESDAY, July 15.
Copper—		
Best selected	per ton	£102 0 0
Electro wire bars	,,	£107 0 0
H.C. wire, basis	per lb.	1s. $2\frac{5}{16}$d.
Sheet	,,	1s. $2\frac{1}{4}$d.
Phosphor-bronze Wire—		
Phosphor-bronze wire, basis	per lb.	1s. $6\frac{5}{16}$d.
Brass 60/40—		
Rod, basis	per lb.	0s. $10\frac{3}{8}$d.
Sheet, basis	,,	1s. $1\frac{1}{4}$d.
Wire, basis	,,	1s. 1d.
Pig Iron—		
Cleveland warrants	per ton	£164 0 0
Galvanised steel wire, basis	,,	35 10 0
Lead Pig—		
English	,,	24 15 0
Foreign or colonial	,,	23 15 0
Tin—		
Ingot	,,	246 0 0
Wire, basis	per lb.	3s. 2d.

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £21.

,, (Roll Brimstone).—Per ton £20.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 17s. 6d. to £8.

Copper Sulphate.—Per ton £45–£46

Boric Acid (Crystals).—Per ton, £72–£73.

Carbon Bisulphide.—Per ton £54.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. $7\frac{1}{2}$d.–8d.

Shellac.—385s.; August delivery at 381s. to 380s.

Rubber.—Para fine, 2s. 5d.; plantation grades, 1s. $9\frac{1}{4}$d. to 1s. $10\frac{1}{4}$d. lb

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W. T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From The Electrician, July 15, 1882.]

Impromptu Electric Lighting.—During the festivities at Henley-on-Thames, consequent on the recent regatta, amongst other things there was to be seen a "roundabout" lighted up, not by the ordinary naphtha lamps, but by two electric arc lamps. This is speculating in electric light with some prospect of a speedy and remunerative return.

Telegraphing from London to India.—Up to about 7 a.m. Egyptian time, or 9 a.m. London time, on Tuesday, the Eastern Telegraph Company's office in Old Broad-street was in direct communication with Bombay, via the Egyptian land lines, and messages were sent right through from London to Bombay as usual. At this hour, or about then, however, the first shot of the bombardment was fired, and the Egyptians at once cut their land lines and stopped communication.

Electric Transmission of Power.—In a recent communication to the Société des Ecoles d'Atts et Metiers, M. J. Chrétien states that the first attempt to transmit motive power by electricity was made at the Vienna Exhibition in 1873 by M. H. Fontaine. M. Chrétien thinks that it is safe to calculate upon the transmission of 50 per cent. of the whole power. Solar heat, he thinks, when transformed into electricity, seems to offer a more desirable solution of the problem than its direct application to the production of steam.

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Notes.

The Elimination of Strays.

IN wireless telegraphy two great difficulties have always confronted the engineer in his attempts to establish a regular service over long distances: First the "fading" of signals, and second the occurrence of strays, or, as our American cousins have it, "static." These are both atmospheric disturbances, the one having all the appearance of being due to an increase of atmospheric absorption of the electric waves, the other being due, apparently, to natural electric discharges. In another column will be found a description of Mr. WEAGANT'S elaborate experiments and practical methods of alleviating the troubles due to strays. In their simplest form they are an application, or at any rate a verification, of some of the scientific work accomplished during the past decade. Looking back over this period, we may recall that the Radiotelegraphic Committee of the British Association classified strays in three types—"clicks," "grinders" and "hissing"—when it started work in 1912. This classification was based on the previous researches of some of its members, and was justified later by the observations collected by the Committee. Then Mr. C. J. DE GROOT, by a long series of investigations in the Dutch East Indies, gave evidence for believing that the clicks were due to lightning discharges in the lower atmosphere, and the grinders to electrical discharges in the upper atmosphere. DE GROOT went so far as to claim to have established that the grinders were due to cosmic bombardment of the layers more than 100 miles high, and that any particular station received these disturbances from an area vertically above it subtending, say, only 30 deg. total angle. However this may be, Mr. WEAGANT, starting from the assumption that grinder waves were propagated vertically downwards, while signal-bearing waves were, of course, propagated horizontally, conceived the idea of eliminating the grinders, without eliminating the signals, by the use of suitable aerials. This is one of the methods described in the article to which we refer.

Mr. Weagant's Methods.

THE devices that have been suggested for stopping the strays from overwhelming the signals as received either on the tape or in the telephone are very numerous; most of them have attained what success is credited to them by reducing the strength of the stray in greater proportion than that of the signal by means of some compensation or limitation supplied within the apparatus on the operator's table. The methods described now are different from the older methods in the fact that the compensation is applied outside the station—that is, in the antenna system. One method, stated broadly, consists in having two large loops of wire erected in the plane containing the sending and receiving stations, the loops having, ideally, their centres a half wave-length apart. Then the horizontally moving waves from the distant station excite the loops in turn, and therefore in opposite phase, while the vertically moving stray waves excite the loops simultaneously, and therefore in the same phase. This enables the oscillations to be passed to the detecting circuits in such a way that the effects of the stray waves are cancelled, and those of the signal waves are strengthened. This has been very successful at Belmar, in New Jersey, with aerial loops directed towards Europe. Of this method, critics of the DE GROOT theory may say that if the strays originated to the south (or north) of the receiving station, they would be cut out by the loops used, and that, therefore, the experience with these loops is no proof of the source of the grinders being in the sky. A similar comment may also be made on the second method, which is styled by the inventor the "tank" method. The "tank" is an antenna so designed and placed that the signals are not received by it, though the strays are. In the practice of the method these stray-produced oscillations in the tank are utilised to compensate the strays received along with signals in another and more ordinary kind of antenna. This method appears to have been also very successful. It is somewhat curious that the converse of the tank has not been recorded in the history of wireless telegraphy as very successful; the converse is a simple vertical aerial, which, it may be supposed, would not be able to receive stray waves from the sky, though eminently adapted to receive horizontally propagated signal waves. However, quite apart from the scientific points raised or settled by the interesting and important development now before us, we can but feel admiration and appreciation for the great energy, courage and insight with which these experiments on the grand scale have been inaugurated and carried to their conclusion; and, for the sake of the future progress of wireless telegraphy, we trust that the hopes they raise will be found to have a substantial and practical basis.

The New Patents Bill.

On the 15th inst. a new Bill was introduced in the House of Commons to amend the Patents and Designs Act. Upon comparing it with the previous Bill, which was withdrawn some time ago, it appears that comparatively little alteration has been made. There are minor differences, but the main parts of the old Bill remain, and we very much doubt whether the new version will give patentees very much satisfaction. Among the more important modifications, which will be found in another column, we may mention that it is proposed to increase the life of patents from 14 to 16 years. In the previous version the life was raised to 15 years, and this might be raised to 16 years by an Order in Council. No simple provision has been introduced to meet the case of patents which have not been worked owing to the war. The life may be extended as hitherto, and there is some reference to damage by reason of hostilities; but what the Government gives with one hand it takes away with the other, for the period of extension is now to be five years, or in exceptional cases 10 years, as compared with six years and 12 years respectively in the previous Bill. Those patentees who have dealings with the Government will be interested to find that if the Government is already using, before the date of the patent, an invention which has not been communicated directly or indirectly to them by the patentee, they may make use of such invention without payment of royalty. This is a proper provision to make, as the Government very naturally does not give publicity to such matters, and would not be in a position to prove "prior user" without publication of matters which should be maintained secret. Nothing is said in regard to reducing patent fees, as these may be fixed by the Board of Trade, which presumably means that nothing will be done in this direction. We hope that the Bill will be carefully studied by those Institutions, such as the Institution of Electrical Engineers, which looked into the old Bill, for it does not appear to mark any great advance in legislation.

The Purchase Clause in the Electricity Bill.

The "purchase clause" in the Electricity Bill is naturally the one around which vital interests converge. The electricity companies interested fall into two broad classes—one comprising the supply companies who are subject to limited tenure and the terms of purchase in the general Act of 1888, and the other covering the power companies who work under their own special Acts and who have unlimited tenure. A few general facts as indicating the extent of the capital involved may be of interest at the present moment. To make matters as simple as possible the figures we give will be to the nearest million. It must be remembered also that precise figures are very difficult to obtain and can really only be obtained by an expert accountant analysing each individual balance sheet. Approximate figures, however, are sufficient for our immediate purpose. First as to capital expenditure under the two sections mentioned above. The capital expended in connection with Provisional Orders amounts to about 30 million pounds, and that expended under Power Acts to about 10 million pounds. A slight complication is involved in the foregoing, since a number of Provisional Orders are held and worked by power companies. The relative figures for electric supply companies and power companies respectively would therefore differ from the figures above. The figures on this basis would be, for capital expenditure of electric supply companies, just under 28 millions and for power companies somewhat over 12 millions. For a sub-division of the capital expended under Provisional Orders we have for the capital expenditure of the London companies (including the Central Company) about 17 millions, and for the provincial companies about 13 millions (of which over $1\frac{3}{4}$ millions have been expended in the "Outer London" area).

The Original Terms.

It will be seen, therefore, that the total amount of investors' money which has been expended on the security given by the Electric Lighting Acts and the special Acts reaches a very considerable figure. The new Electricity (Supply) Bill does not, of course, immediately affect the whole of this expenditure. The part of the undertakings dealt with in the new "purchase clause" in the Bill is the generation (and the allied "high transmission cables"). The capital expenditure coming under this heading is somewhat less than half of the total capital expenditure, taken as a rough proportion over the whole of the companies. In the area of Greater London, therefore, the generation item would come to about 8 million pounds. For the remainder of the country to about 10 million pounds. The capital expenditure of the supply and power companies potentially affected, therefore, by the new purchase clause might be taken as over 18 million pounds. The companies have every justification, therefore, in insisting that Parliament shall not depart from the conditions of purchase as laid down in the 1888 Act (or abbreviate the unlimited tenure in the special Acts), unless terms equally good are substituted. Up to the present, an Act of Parliament has been deemed by investors as affording an inviolable security on which to invest. But if these statutory provisions are to be treated as "scraps of paper" the serious effect is bound to be felt in every industry which is operated by statutory companies. The generating stations of the local authorities come, of course, under the purchase clause, but in these cases they are under quite a different category. The total capital expended in the whole Kingdom by local authorities under "generating" comes to over 30 millions.

British Scientific Products Exhibition.—Last Tuesday the King and Queen, accompanied by Princess Mary and Prince Henry, visited the exhibition, and spent about an hour and a half inspecting the exhibits. His Majesty expressed his keen interest and appreciation of the exhibition as a work of national value.

Ampere-Hour Meters for Variable Loads.—A brief notice was made in a recent issue of "Elektrotechnick und Maschinenbau" of a new form of ampere-meter patented by the Siemens-Schückert Werke for use with very variable loads. The meter has special applications to submarines, where the battery furnishes a very fluctuating load, according as it is only required to supply current for lighting or in special circumstances to drive propellers.

"Denominations of Standards."—We are asked to make the following corrections in the article on this subject by Mr. A. P. Trotter, which appeared in our last volume, p. 300 (March 14th):—

Column 1.—The Weights and Measures (Metric System) Bill of *1879* is referred to as "of 1907."

Column 2.—Illegal use in trade of 8 ft. measuring rod.—Under an Order in Council of November 16, 1906, the denomination "8 ft." was legalised, as also 9 ft., 7 ft., &c.

Column 2.—5 lb. and 10 lb. weights forbidden.—Under an Order in Council of May 11, 1906, weights of 20, 10 and 5 lb. were legalised.

United States Coast and Geodetic Survey.—Two publications (Serials Nos. 90 and 94) have been issued by the Department of Commerce (U.S. Coast and Geodetic Survey). The former summarises observations made at the Magnetic Observatory at Vieques, P.R., during 1915-16; the latter, similar data collected at Cheltenham, Maryland, over the same period. Tabular data and charts are presented, and the work has clearly involved considerable care and effort. We notice also some tabular data referring to the chief magnetic storms and disturbances recorded.

New Source of Ultra-Violet Radiation.—A new source of ultra-violet radiation is reported in the "Schweizerische Elektrotechnische Zeitschrift." The device involves the use of an alternating discharge at 50,000 volts between aluminium electrodes 2 mm. apart, and situated under water. It appears that the nature of the water is important to secure the best results. Distilled water should be used and kept running. The ultra-violet spectrum thus produced is said to be continuous, and it has proved of great value in obtaining fuller data on certain absorption spectra. In some cases a number of additional bands have been located.

Decline of Labour Efficiency in German Mines.—It appears from a note in the "Journal" of the Royal Society of Arts that the diminution in output in mines remarked in this country is also being experienced in Germany. Thus, in the coal-mining district of Upper Silesia, the output per man before the war was 1·8 tons per shift. During the war this figure dropped to 0·8 ton, and now it is only 0·5 ton, and in some mines even 0·4 ton. The production has thus fallen to about a third of pre-war figures. At the same time wages have doubled and the cost of production has enormously increased, and in some instances is at present above the selling price. Hence a great increase in prices seems inevitable.

Fatigue Effect of Selenium Cells.—Some further particulars of the "fatigue-effect" in selenium cells are given by Dr. P. Lenard in the "Elektrotechnische Zeitschrift." Such cells have promising qualities as appliances for measuring light, but hitherto certain difficulties have prevented their general application. Among these may be mentioned the "fatigue" that sets in after exposure to light, which results in a progressive change of resistance, cells in the past having been found to be very erratic in this respect. According to the author this difficulty has been largely overcome in the latest forms of cells. Some of these apparently reached a constant resistance after an exposure of only 45 seconds.

Effect of Solar Radiation upon Balloons.—A recent Technologic Paper (No. 138), issued by the Bureau of Standards, describes some experiments conducted by Messrs. J. D. Edwards and M. B. Long on the effect of solar radiation on balloon fabrics. Measurements on typical fabrics show that great differences in absorbing power for solar radiation exist, differences from 45–90 per cent being recorded. In one experiment the temperature of the upper surface of a model balloon in bright sunlight varied from 20°C. to 39°C. at different parts. These characteristics do not seem to have been very fully studied. Yet the authors point out that they have a considerable effect on the permeability of the fabric to hydrogen, and are also responsible for buoyancy changes.

Simplified Inductance Calculations with Special Reference to Thick Coils.—A Paper on the above subject by Mr. P. A. Coursey, recently read before the Physical Society, deserves notice. Those who are not very familiar with calculations of the inductance of thick coils often find themselves on the horns of a dilemma. They are aware that the simpler formulæ do not apply sufficiently exactly to coils of more than small dimensions. Yet the treatment of thick coils usually involves somewhat elaborate formulæ, difficult of application without much analysis. Mr. Coursey's method is based on an extension of Nagaoka's formula for single layer coils, and Rosa's formula for thick coils is put into the same form as Nagaoka's. In this way the author has derived a series of curves giving the correction factors for the inductance of any form of coil likely to be met with in practice. The data are likely to be useful to many of those interested in calculations of this nature.

Progress in Range Finding.—One of the most striking exhibits at the British Scientific Products Exhibition, Central Hall, Westminster, is the 30 ft. naval rangefinder shown by Messrs. Barr & Stroud, Ltd., of Glasgow. This company proposed the construction of rangefinders of 30 ft. base as early as 1908; but the first actually ordered was constructed for the Russian Coast Defence Service, and supplied in 1913, and one was supplied to the Russian Navy in 1914. In 1914 a rangefinder of 35 ft. base was supplied to France. The 30 ft. naval rangefinders now being constructed have an uncertainty of observation, under good conditions, of less than 80 yds. at 20,000. At the commencement of the war no British battleship carried a rangefinder of greater base than 9 ft. This base had been decided upon in 1904, when the maximum effective range for the opening of fire would generally not be assumed to be greater than about 6,000 yds. In the Battle of Jutland fire was carried out at ranges up to 24,000 yds.

Eighth Annual Report of the Bureau of Mines (U.S.A.).—The report of the Bureau of Mines (Washington) for the year 1919 records a remarkable amount of useful work. Apart from its investigations relating to safety and hygiene in mines, the Bureau has been interested in many researches on minerals, especially those required for war purposes, which included many of the rarer metals. Experiments were also conducted on poison gases used in warfare, apparently with very useful results, and on flame throwers, incendiary bombs, signal lights and other war material. The Bureau also co-operated with the War Department in the manufacture of artificial nitrate, the production of sulphuric acid, the procuring from natural gases of products required for balloons, &c. As an instance of some of the curious and out-of-the-way pieces of information in this volume, we may note an investigation into relative merits of electric gongs and the release of a stench in the compressed air delivered to mines as a means of giving warning of fires or other serious danger.

Institution of Electrical Engineers.—In a statement by the Council on the Electricity (Supply) Bill, which has been forwarded to the Prime Minister, it is recommended that all the Commissioners should give whole-time service, and that they should themselves appoint an Advisory Council, membership of which should be restricted to persons possessing expert qualifications. Approval is expressed of the charging of such Commissioners with power to undertake and promote research. The view is expressed that the Bill should not attempt to impose a rigid system of uniformity for all parts of the country, and that the Commissioners should be given latitude to facilitate schemes suitable for each district, giving first attention to the co-ordination and logical extensions of existing systems. In regard to the purchase terms, it is urged that Parliament should not break faith with those who have invested their capital on the strength of the powers conferred by earlier legislation. It is also strongly urged that all whose positions may be adversely affected in consequence of changes brought about by the Bill, whether on the staff or as wage earners, should be liberally dealt with, and that if representation is given to labour on any governing body, the engineering staffs should be similarly represented, and should also have the right to refer to arbitration for the settlement of differences arising out of their employment.

Personal.

Mr. F. E. Kennard, B.Sc., M.I.E.E., late of Messrs. Siemens Bros. and Goldsmiths College, New Cross, sailed for Colombo on the 25th inst. to take up an appointment at the Technical School there.

Mr. William Polson, M.A., B.Sc., has been appointed Chief Lecturer in Physics at the Municipal Technical Institute, West Ham.

Arrangements for the Week.

MONDAY, July 28th.

BRITISH SCIENTIFIC PRODUCTS EXHIBITION.

5.30 p.m. At Central Hall, Westminster, London, S.W. Lecture on "Scientific Lighting and Industrial Efficiency," by Mr. L. Gaster.

THURSDAY, July 31st.

BRITISH SCIENTIFIC PRODUCTS EXHIBITION.

4.30 p.m. At Central Hall, Westminster, London, S.W. Conference on "Patents in Relation to Industry."

FRIDAY, Aug. 1st.

BRITISH SCIENTIFIC PRODUCTS EXHIBITION.

5.30 p.m. At Central Hall, Westminster, London, S.W. Lecture on "Applications of Science to Military Mining," by Mr. H. Standish Ball.

Weagant's Anti-Static Method in Wireless Telegraphy.

The following particulars of the method devised by Mr. R. A Weagant, chief engineer of the Marconi Wireless Telegraph Company, of America, for the elimination of atmospherics, are taken from an article by Mr. E. L. Bucher, in recent issues of the "Wireless Age."

During the course of investigation it occurred to Mr. Weagant that these static disturbances might be propagated vertically, instead of horizontally, and if so the direction of propagation would be at right angles to the direction of the advancing wireless wave. If that could be definitely proved, then advantage might be taken of the difference in direction to separate the static from the signal currents flowing in the antenna circuit. This is the fundamental working hypothesis on which the Weagant system is based.

Experimental investigations justified the assumption that the highly damped waves resulting from atmospherics are propagated in a direction perpendicular to the earth's surface.

An Early Form of Weagant's Static Eliminator.

To determine the correctness of the hypothesis that static is propagated vertically, and to ascertain if it were possible on this assumption to devise a system whereby the static currents could be balanced out while the signal was retained, Mr. Weagant erected at Belmar, N.J., the aerials and apparatus shown in Fig. 1. Two closed loops *A* and *B*, each consisting of a single turn of wire 400 ft. high with a base line of 1,000 ft., were spaced 5,000 ft. from centre to centre. Two wires, brought from each loop to a receiving station located at the centre, were supported on 10-ft. poles, 6 ft. apart. These leads were connected to the primary coils of a goniometer of the type used in direction finders; the secondary coil was connected to a sensitive oscillation detector. It was this apparatus that permitted the reception of transatlantic signals through static interference of great intensity, whereas without it it was impossible to distinguish the wireless signal.

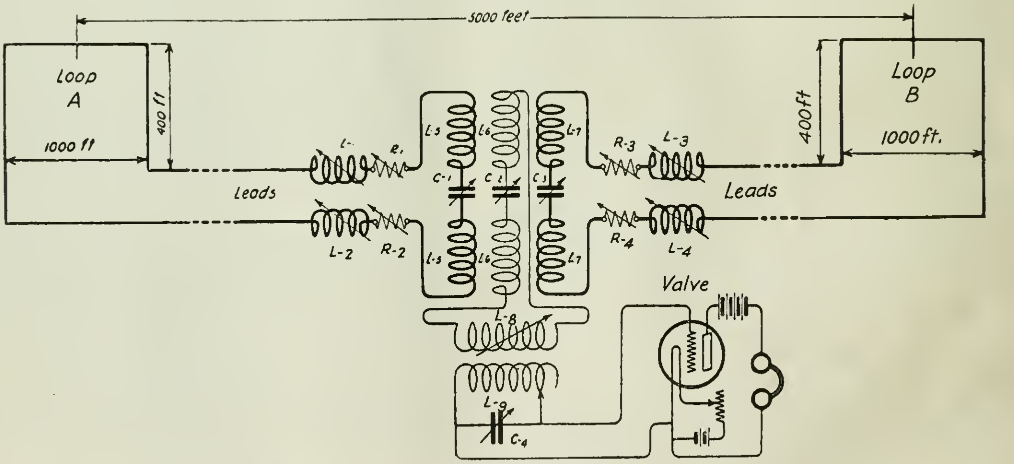

Fig. 1.—An early form of Weagant's System for Eliminating Static Interference, showing Two Single Turn Loop Antennæ spaced 5,000 ft. apart. Each Loop was 1,000 ft. long at the Base and 400 ft. high.

The connections to the receiving tuner and detector are shown in Fig. 1, where loop *A* has the loading coils *L*-1 and *L*-2, the resistances *R*-1 and *R*-2, and the coil, *L*-5, broken at the centre point for connection to the variable condenser *C*-1. The coil *L*-7 connected to the loop *B* is similarly connected. Both *L*-5 and *L*-7 are coupled to the secondary coil *L*-6 which is broken at its centre to include the variable condenser *C*-2.

The arrangement of the three coils at the receiving station was similar to that employed in the Bellini-Tosi goniometer wherein the rectangular frames *L*-5 and *L*-7 are stationary, and the rotating frame *L*-6 is mounted on a vertical axis so that it can be rotated within the resulting magnetic field.

It may be well to describe here the preliminary procedure of adjustment: The coil *L*-6 is first placed in inductive relation with *L*-5 of loop *A*, and the incoming signal tuned to maximum intensity. Next, coil *L*-6 is placed in inductive relation with *L*-7 of loop *B*, which circuit is also tuned to maximum signal intensity. Both loops are then connected in and coupled to the coil *L*-6 which is turned on its axis to receive the maximum induction from both *L*-5 and *L*-7. The two primary coils produce a resultant magnetic field which acts upon the rotating coil somewhat after the principle of the radio goniometer.

An explanatory diagram of the system of Fig. 1 appears in Fig. 2. Here the two closed circuit loops of Fig. 1 shown as *A′* and *B′* are coupled to a common secondary coil *L*-3 of the receiving apparatus which is installed in a station placed between the loops. The vertically propagated static waves are indicated by the downward arrows above the loops and the advancing signal waves which, in this diagram, are assumed to pass from left to right, are represented by the arrows *A*, *A*, *A*, *A*.

If static waves are propagated vertically, it is clear that they act upon loops *A′* and *B′* simultaneously and consequently E.M.F.s of equal intensity are generated in both loops, and the static currents resulting therefrom flow in the same direction in each loop, as indicated by the single pointed arrows. For purposes of illustration, we have assumed that the static currents flow clockwise in the two loops as shown in the diagram. The current in loop *A′* flows downwards through the coil *L*-1 and that in loop *B′* upward, through the coil *L*-2 The two currents will therefore neutralise and consequently none of the static-current will flow in the coil *L*-3

It now remains to be seen how a useful part of the energy of the signal wave is retained. From Fig. 2 it is evident that the signal wave acts upon the loop *A′* before arriving at the loop *B′*; and we may assume, for the purposes of illustration, that the arrows *A* represent the progressive movement of the advancing wave. As the wave motion progresses and the positive half acts upon the loop *B′*, the negative half of the wave is acting upon loop *A′*. We will assume that, at a particular moment, its polarity is such that in loop *A′* the static current and the signal current pass in the same direction through the coil *L*-1. The signal and static currents must therefore flow in opposite directions in the loop *B′*; and inasmuch as coils *L*-1 and *L*-2 are coupled to *L*-3 in such a way that the static currents oppose and neutralise, the signal currents must build up in phase and accordingly affect the oscillation detector connected to the terminals of the coil *L*-3. The principle, of course, holds good when the negative half of the signal wave acts upon *B′*, and the positive half on *A′*.

The foregoing may be stated in another way by saying that the static waves arrive at the two aerials at the same time, while the signals arrive at the two aerials at different times. Therefore, if the apparatus is coupled so that the static currents are in opposite phase, it follows that the signal currents are out of phase by an amount depending upon the effective spacing of the two loops in respect to the wave length being received. The signal currents therefore do not oppose.

The magnitude of the E.M.F.'s generated by the signal waves will always give a resultant depending upon the effective separation of the loops; that is, the distance from centre to centre of the loops. If this separation is one-half wave length, the E.M.F.'s generated in the coil *L*-3 by the signal currents from loops *A′* and *B′* will be in phase, and the resultant is therefore equal to the arithmetical sum of these two E.M.F.'s. If the loop separation is equal to one-quarter wave length, then the E.M.F.'s acting on the coil *L*-3 will be 90 degrees apart, and the resultant would be equal to 1·4 times that of the individual E.M.F.'s; that is, they combine in quadrature.

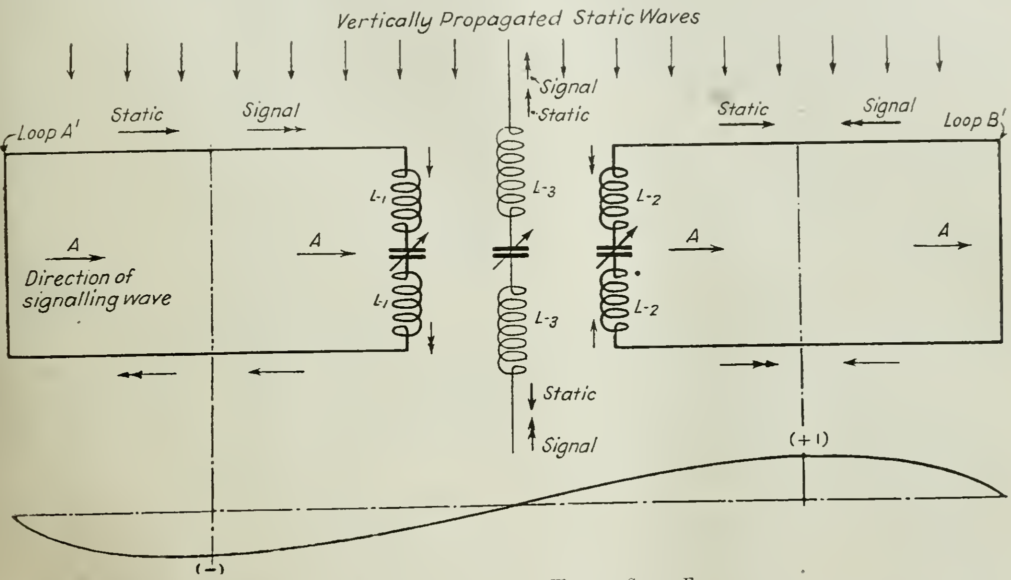

Fig. 2.—Explanatory Diagram of the Weagant Static Eliminator.

It is clear that the most effective separation for maximum signals is one-half wave length, and, therefore, from any particular wave length, the effective spacing of the loops should be selected to meet the above mentioned conditions. This, however, is not strictly essential in practice. One antenna can be employed for a considerable range of wave lengths provided one is willing to sacrifice some of the signal current at wave lengths other than that for which the loops give one-half wave length separation. This, therefore, is not an objection to the commercial application of this discovery.

Now, if the theory advanced by Mr. Weagant concerning the vertical propagation of static waves were not correct, the results described could not be secured; for, if the apparatus in the receiving station was adjusted so that the signal currents combined vectorially and in accordance with the effective aerial separation, then the static currents would combine similarly, and therefore, the entire system would show the same signal to static ratio as a single loop. Since the experiments proved that the static currents do not combine but are annulled, while the signal is retained, the theory of vertical propagation of static waves is well sustained.

Mr. Weagant observed that whenever the circuits were so adjusted that static disturbances were cancelled or reduced to a minimum, the signals received on the two loops combined, as might be expected from the spacing between them and the wave length of the incoming signal.

It is evident that the spacing between the loops in the diagram of Fig. 1 is slightly over one-quarter wave length for the wave of 6,000 meters used by Nauen, Germany, during some of the tests. In the case of the 6,000 meter wave, the resultant signal was approximately 40 per cent. greater than that due to either aerial alone, while in the case of Carnarvon, at 14,000 meters, the spacing was equal to only 1/9 of the wave length and the resultant signal was materially less than that due to either loop, which was to be expected. The system shown in Fig. 1 permitted reception from Nauen, Germany, throughout the months of July and August, and during the worst static periods of the day. Grinders, of such intensity as to render the signals unintelligible by ordinary receiving apparatus and antennæ, were eliminated to such a degree that continuous reception from foreign stations was possible. Other observations, through continued use of the circuits of Fig. 1, established the fact that the heavier the static disturbances were, the more perfect was the balance that could be secured; with a consequent greater improvement in static reduction to signal ratio.

A very interesting but erstwhile elusive phenomenon met with in the system of Fig. 1 was the fact that the long low horizontal leads picked up static and signals as well as the far distant loops, and until this feature was thoroughly worked out, the results obtained seemed to indicate that the farther apart the loops, the less perfectly could the static currents be balanced, and also, the converse.

(*To be continued.*)

Benjamin Franklin and Daylight Saving.—It has often been remarked that "there is nothing new under the face of the sun," and the "Electrical World" has unearthed an interesting example of the truth of this precept. It appears that the real originator of daylight saving was Benjamin Franklin, who in 1784 contributed an anonymous communication to the "Journal of Paris," written in a characteristically philosophic and witty manner. He suggested that every morning all bells in churches should be rung at sunrise (or, if this did not suffice, cannon fired), and he further suggested a tax on all windows with shutters, a spartan rationing in the candles allowed to each household, and the prohibition of travelling by coach after sunset, except those of physicians, surgeons and midwives. There was no gas or electricity then available to illustrate the saving to be accomplished, but Franklin entered into a calculation of the amount of wax and tallow normally burned in Paris between March 20 and September 20 and anticipated an annual saving of expenditure in the neighbourhood of four million pounds. He also did not fail to point out the hygienic advantages of working solely by daylight instead of by the "smoky, unwholesome and enormously expensive light of candles."

Pulsation of the D.C. Terminal Voltage in Rotary Converters.

By J. K. KOSTKO.

(Concluded from p. 63.)

In conclusion, it is desirable to determine the mean value of the pulsating component of the terminal voltage in formula (5), because knowledge of this value is necessary for calculation of the generated E.M.F. E_d corresponding to a desired terminal voltage. If the distortion caused by the unidirectional saturation of the magnetic circuit be neglected, the mean value of the rotation and the transformer E.M.F.s is zero, and only the impedance E.M.F. e needs be considered.*

If m is even, $e_{\text{mean}}=\frac{m}{2\pi}\int_0^{\frac{2\pi}{m}} e da$, where the value of e is that of the formula (2).

If m is odd, $e_{\text{mean}}=\frac{m}{\pi}\int_0^{\frac{\pi}{m}} e da$, where the value of e is that of the formula (3).

Both integrals give the same simple expression :—

$$e_{\text{mean}}=I_m z\frac{m^2}{\pi^2}\sin\frac{\pi}{m}\cos(\psi-\varphi),$$

or, since $I_m z=\sim\dfrac{8RI_d}{m^2\sin\frac{\pi}{m}\cos\varphi\cos\psi}$: (page 39)

$$e_{\text{mean}}=\frac{8RI_d}{\pi^2}\ \frac{\cos(\psi-\varphi)}{\cos\psi\cos\varphi}=\frac{8RI_d}{\pi^2}(1+\tan\psi\tan\varphi).$$

Substitution of this expression in formula (5) gives the value of the mean terminal voltage

$$V_{d\ \text{mean}}=E_d-\text{drop under brushes}-I_dR+\frac{8RI_d}{\pi^2}(1+\tan\psi\tan\varphi)$$

$$=E_d-\text{drop under brushes}-I_dR\left(1-\frac{8}{\pi^2}-\frac{8}{\pi^2}\tan\psi\tan\varphi\right).\quad(5\text{A})$$

Fig. 4 shows the calculated voltage curves of a small 4-pole 60-cycles converter armature rated—on the basis of equal copper losses—225 volts at 75 amperes single-phase, 117 amperes three-phase, 143 amperes two-phase, 170 amperes six-phase. Fig. 4 refers to the single-phase machine, Table I. to the single phase and polyphase machines. Armature winding data: $R=0{\cdot}068$ ohms, local reactance between the direct current brushes$=0{\cdot}22$ ohms, *i.e.*, $\varphi=72°50'$. In Fig. 4 the line 1 is the mean terminal voltage, curve 2—the impedance E.M.F. e, curve 3—the E.M.F. due to the reverse M.M.F. of the armature, curve 4—the resultant terminal voltage. Curve 3 is calculated for a stator carrying a distributed winding identical to the armature winding but reconnected so as to form two fully distributed windings (*i.e.*, $S=\tau$) at right angles to each other, with one half of the total number of conductors for each winding. All curves and data are calculated for $\cos\psi=1$.

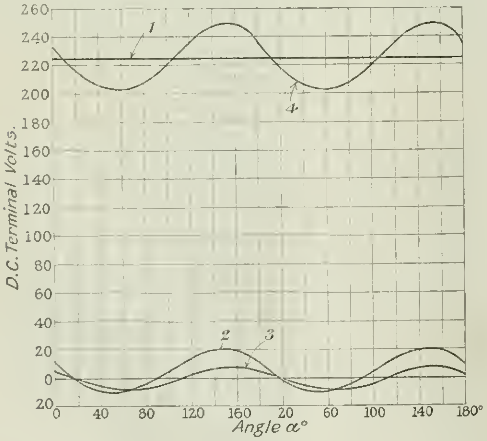

Fig. 4.

The efficiency of the machine is taken in account by assuming $I_m=120$ per cent. of its equivalent from the direct current rating for the single-phase and 110 per cent. for the polyphase machines.*

Table I.

	Terminal voltage.			Total oscillation in per cent. of mean terminal voltage.
	Mean.	Maximum.	Minimum.	
Single phase	225	249·0	202·0	20·9
Two phase ...	225	227·3	222·7	2·04
Three phase .	225	225·8	224·4	0·6
Six phase	225	225·9	224·1	0·8

Note 1.

Substitution of $\frac{\pi}{m}+a$ in place of a in the variable term of formula (3A) transforms it into

$$\frac{1}{2\sin\frac{\pi}{2m}}\cos\left(\frac{\pi}{2m}+\psi-\varphi-a\right)+\frac{\pi/m-a}{2\pi/m}\sin(\psi-\varphi-a)$$

$$-\frac{a}{2\pi/m}\sin\left(\frac{\pi}{m}+\psi-\varphi-a\right),$$

and the difference of the variable terms of (3) and (3A) is

$$\left(\frac{\cos\frac{3\pi}{2m}}{\sin\frac{\pi}{m}}-\frac{1}{2\sin\frac{\pi}{2m}}\right)\cos\left(\frac{\pi}{2m}+\psi-\varphi-a\right)-\frac{\pi/m+a+\pi/m-a}{2\pi/m}$$

$$\times\sin(\psi-\varphi-a)+\frac{2\pi/m-a+a}{2\pi/m}\sin\left(\frac{\pi}{m}+\psi-\varphi-a\right)$$

$$=\frac{\cos\frac{3\pi}{2m}-\cos\frac{\pi}{2m}}{\sin\frac{\pi}{m}}\cos\left(\frac{\pi}{2m}+\psi-\varphi-a\right)-\sin(\psi-\varphi-a)$$

$$+\sin\left(\frac{\pi}{m}+\psi-\varphi-a\right)=$$

$$-\frac{2\sin\frac{\pi}{m}\sin\frac{\pi}{2m}}{\sin\frac{\pi}{m}}\cos\left(\frac{\pi}{2m}+\psi-\varphi-a\right)+2\cos\left(\frac{\pi}{2m}+\psi-\varphi-a\right)$$

$$\times\sin\frac{\pi}{2m}=0,$$

which proves the identity of (3) and (3A).

Note 2.

Let a be the number of pairs of armature paths and I_d the total direct current in the armature. Since the effective watt alternating current and the direct current in an armature conductor are $\frac{I_m \cos\psi}{\sqrt{2}a}$ and $\frac{I_d}{2a}$ respectively, their ratio is

---

* See Note No. 7.

* See Note No. 8.

$$\frac{2I_m\cos\psi}{\sqrt{2}\,I_d}=\frac{2\sqrt{2}}{m\sin\frac{\pi}{m}},$$

from which follows

$$I_m=\frac{2I_d}{m\sin\frac{\pi}{m}\cos\psi}.$$

If R is the resistance between the direct-current brushes, then

$$r=\frac{4R}{m},\ z=\frac{r}{\cos\varphi}=\frac{4R}{m\cos\varphi};$$

therefore,

$$I_m z=\frac{8RI_d}{m^2\sin\frac{\pi}{m}\cos\varphi\cos\psi}.$$

NOTE 3.

The M.M.F. (for single air-gap) due to the single-phase current in the armature is represented by a triangular wave with the amplitude,

$$Y_m=0{\cdot}4\,\pi\frac{1}{2}\,\frac{N}{2p}\,\frac{2I_m}{2a}=\frac{N\pi I_m}{10ap}.$$

It is well known that the amplitude of the fundamental harmonic of a triangular wave is $\frac{8Y_m}{\pi^2}=0{\cdot}8\,\frac{NI_m}{\pi ap}$; therefore, the amplitude of the revolving M.M.F.=the amplitude of Q_1 and of Q_2 is

$$A=\tfrac{1}{2}\times0{\cdot}8\frac{NI_m}{\pi ap}=0{\cdot}4\,\frac{NI_m}{\pi ap}.$$

NOTE 4.

SELF-INDUCTION COEFFICIENT OF A DISTRIBUTED WINDING.

The field due to the current i in the winding has a trapezoidal shape: the total flux linked with the turn having one side at y (counted from the centre of the coil side) is the sum of two terms:—

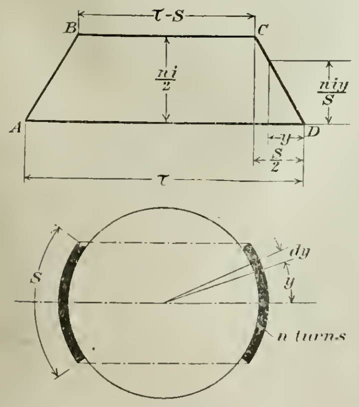

FIG 5.

1. Corresponding to the horizontal part BC of the field curve:—

$$0{\cdot}4\pi\,\frac{ni}{2}\,\frac{W(\tau-S)}{g}.$$

2. Corresponding to the inclined parts AB and CD of the field curve:—

$$2\int_y^{\frac{S}{2}}0{\cdot}4\,\pi\,\frac{niy}{S}\,\frac{W}{g}dy=2\times0{\cdot}4\,\pi\frac{ni}{S}\,\frac{W}{g}\left(\frac{y^2}{2}\right)_y^{\frac{S}{2}}=0{\cdot}4\,\pi\,\frac{W}{g}\times ni\left(\frac{S}{4}-\frac{y^2}{S}\right).$$

The sum of these components is

$$0{\cdot}4\pi\,\frac{W}{g}\,ni\left(\frac{\tau}{2}-\frac{S}{2}+\frac{S}{4}-\frac{y^2}{S}\right)=0{\cdot}4\,\pi\,\frac{W}{g}\,ni\left(\frac{\tau}{2}-\frac{S}{4}-\frac{y^2}{S}\right).$$

This flux is linked with ndy/S turns comprised in the element dy; therefore, the total flux linked with the coil is

$$\int_{-\frac{S}{2}}^{+\frac{S}{2}}0{\cdot}4\pi\frac{W}{g}\,ni\left(\frac{\tau}{2}-\frac{S}{4}-\frac{y^2}{S}\right)\frac{n}{S}\,dy=0{\cdot}4\pi\,\frac{W}{g}\,\frac{n^2}{S}\,i\left(\frac{\tau y}{2}-\frac{Sy}{4}-\frac{y^3}{3S}\right)_{-\frac{S}{2}}^{+\frac{S}{2}}$$

$$=2\times0{\cdot}4\pi\,\frac{W}{g}\,\frac{n^2}{S}\,i\left(\frac{\tau S}{4}-\frac{S^2}{8}-\frac{S^3}{24S}\right)=0{\cdot}4\pi\,\frac{W}{g}\,n^2i\left(\frac{\tau}{2}-\frac{S}{3}\right),$$

which, for $i=1$ and reduced to practical units, becomes—

$$L=0{\cdot}4\pi\,\frac{W}{g}\,n^2\left(\frac{\tau}{2}-\frac{S}{3}\right)10^{-8}\text{ henry.}$$

NOTE 5.

If y is counted from the centre of the coil side, as shown above, the expression of the M.M.F. Q coaxial with the coil becomes $A\sin 2\omega t\sin\frac{\pi y}{\tau}$; the flux due to this M.M.F. and linked with ndy/S turns having one side at y is

$$\int_y^{\tau-y}A\sin 2\omega t\sin\frac{\pi y}{\tau}\,\frac{W}{g}dy=2A\sin 2\omega t\,\frac{\tau}{\pi}\,\frac{W}{g}\cos\frac{\pi y}{\tau},$$

therefore, the flux linked with the entire coil is

$$\int_{-\frac{S}{2}}^{+\frac{S}{2}}2\times A\sin 2\omega t\,\frac{\tau}{\pi}\,\frac{W}{g}\cos\frac{\pi y}{\tau}\,\frac{n}{S}\,dy=2A\sin 2\omega t\,\frac{\tau^2}{\pi^2}\,\frac{W}{g}\,\frac{n}{S}\times2\sin\frac{\pi S}{2\tau},$$

and the E.M.F. in the entire coil, due to Q is

$$-2\omega\times2A\cos2\omega t\,\frac{\tau^2}{\pi^2}\,\frac{W}{g}\,\frac{n}{S}\times2\sin\frac{\pi S}{2\tau}10^{-8}=-8A\omega\cos 2\omega t\,\frac{\tau^2}{\pi^2}\,\frac{W}{g}\,\frac{n}{S}\sin\frac{\pi S}{2\tau}\,10^{-8}\text{ volts.}$$

NOTE 6.

Assuming a full pitch winding of the armatnre and counting y from the centre of the pole—*i.e.*, from the centre of the side of the amortisseur coil, the flux $F(yt)$ inducing a transformer E.M.F. in an armature coil having one side at y is obviously comprised between y and $\tau-y$. Considering separately the action of the M.M.F. Q_2 and that of the trapezoidal M.M.F. of the current i_1:—

1. For the M.M.F. Q_2 the function $F(y,t)$ is

$$\int_y^{\tau-y}A\cos 2\omega t\sin\frac{\pi y}{\tau}\,\frac{W}{g}dy=-A\cos 2\omega t\,\frac{\tau}{\pi}\,\frac{W}{g}\left(\cos\frac{\pi y}{\tau}\right)_y^{\tau-y}=2A\cos 2\omega t\,\frac{\tau}{\pi}\,\frac{W}{g}\cos\frac{\pi y}{\tau},$$

and the corresponding transformer E.M.F. is

$$\frac{N}{4a\tau}10^{-8}\int_{-\frac{\tau}{2}}^{+\frac{\tau}{2}}2\omega2A\sin 2\omega t\,\frac{\tau}{\pi}\,\frac{W}{g}\cos\frac{\pi y}{\tau}dy=\frac{N}{4a\tau}\,2\omega2A\sin 2\omega t\times\frac{\tau^2}{\pi^2}\,\frac{W}{g}\left(\sin\frac{\pi y}{\tau}\right)_{-\frac{\tau}{2}}^{+\frac{\tau}{2}}10^{-8}=\frac{N}{4a}\,8\omega A\sin 2\omega t\,\frac{\tau}{\pi^2}\,\frac{W}{g}\,10^{-8}. \qquad (1)$$

2. For armature coils such that $y<\frac{S'}{2}$ the function $F(y,t)$

due to the current i_1 is the sum of terms corresponding (a) to the horizontal part of the trapezoidal field curve,

$$0{\cdot}4\pi\frac{n'i_1}{2}\frac{W}{g}(\tau-S'),$$

and (b) to the inclined parts of the field curve.

$$2\int_y^{\frac{S'}{2}}0{\cdot}4\pi\frac{n'i_1}{S'}y\frac{W}{g}dy=2\times0{\cdot}4\pi\frac{n'i_1}{S'}\frac{W}{g}\left(\frac{y^2}{2}\right)_y^{\frac{S'}{2}}=0{\cdot}4\pi n'i_1\frac{W}{g}\left(\frac{S'}{4}-\frac{y^2}{S'}\right).$$

Therefore for $y<\frac{S'}{2}$.

$$F(y,t)=0{\cdot}4\pi n'i_1\frac{W}{g}\left(\frac{\tau}{2}-\frac{S'}{2}+\frac{S'}{4}-\frac{y^2}{S'}\right)=0{\cdot}4\pi n'i_1\frac{W}{g}\left(\frac{\tau}{2}-\frac{S'}{4}-\frac{y^2}{S'}\right),$$

and the corresponding transformer E.M.F. is

$$\frac{N}{4a\tau}10^{-8}\int_{-\frac{S'}{2}}^{+\frac{S'}{2}}0{\cdot}4\pi n'\frac{W}{g}\left(\frac{\tau}{2}-\frac{S'}{4}-\frac{y^2}{S'}\right)\frac{di_1}{dt}dy=$$

$$-\frac{N}{4a\tau}\times0{\cdot}4\pi\frac{W}{g}n'\frac{di_1}{dt}\left(\frac{\tau y}{2}-\frac{S'y}{4}-\frac{y^3}{3S'}\right)_{-\frac{S'}{2}}^{+\frac{S'}{2}}10^{-8}=$$

$$-\frac{2N}{4a\tau}\times0{\cdot}4\pi\frac{W}{g}n'\frac{di_1}{dt}\left(\frac{\tau S'}{4}-\frac{S'^2}{8}-\frac{S'^3}{24S'}\right)10^{-8}=$$

$$-\frac{N}{4a\tau}\times0{\cdot}4\pi\frac{W}{g}n'\frac{di_1}{dt}\left(\frac{\tau S'}{2}-\frac{S'^2}{3}\right)10^{-8}. \quad . \quad (2)$$

For armature coils such that $y>\frac{S'}{2}$ the function $F(y.t)$ due to the current i_1 is

$$F(y,t)=0{\cdot}4\pi\frac{n'i_1}{2}\frac{W}{g}(\tau-2y),$$

and the corresponding transformer E.M.F. is

$$-\frac{N}{4a\tau}10^{-8}\times2\int_{\frac{S'}{2}}^{\frac{\tau}{2}}0{\cdot}4\pi\frac{n'}{2}\frac{W}{g}(\tau-2y)\frac{di_1}{dt}dy=$$

$$-\frac{N}{4a\tau}\times0{\cdot}4\pi n'\frac{W}{g}\frac{di_1}{dt}(\tau y-y^2)_{\frac{S'}{2}}^{\frac{\tau}{2}}10^{-8}=$$

$$-\frac{N}{4a\tau}\times0{\cdot}4\pi n'\frac{W}{g}\frac{di_1}{dt}\left(\frac{\tau^2}{2}-\frac{\tau^2}{4}-\frac{\tau S'}{2}+\frac{S'^2}{4}\right)10^{-8}=$$

$$-\frac{N}{4a\tau}\times0{\cdot}4\pi n'\frac{W}{g}\frac{di_1}{dt}\left(\frac{\tau^2}{4}-\frac{\tau S'}{2}+\frac{S'^2}{4}\right)10^{-8}. \qquad (3)$$

The total transformer E.M.F. between the direct-current brushes is, therefore, the sum (1)+(2)+(3),

$$\frac{N}{4a}\frac{W}{g}\left[\frac{8\omega\tau A}{\pi^2}\sin 2\omega t-0{\cdot}4\pi n'\left(\frac{\tau}{4}-\frac{S'^2}{12\tau}\right)\frac{di_1}{di}\right]10^{-8}.$$

Note 7.

1. m is even :—

$$e_{\text{mean}}=\frac{m}{2\pi}\int_0^{\frac{2\pi}{m}}I_m z\left[\cot\frac{\pi}{m}\cos\left(\frac{\pi}{m}+\psi-\varphi-\alpha\right)\right.$$

$$\left.+\frac{\pi/m-\alpha}{\pi/m}\sin\left(\frac{\pi}{m}+\psi-\varphi-\alpha\right)\right]\alpha d$$

$$=\frac{m}{2\pi}I_m z\left\{\cos\left(\frac{\pi}{m}+\psi-\varphi-\alpha\right)-\cot\frac{\pi}{m}\sin\left(\frac{\pi}{m}+\psi-\varphi-\alpha\right)\right.$$

$$\left.-\frac{m}{\pi}\left[\alpha\cos\left(\frac{\pi}{m}+\psi-\varphi-\alpha\right)+\sin\left(\frac{\pi}{m}+\psi-\varphi-\alpha\right)\right]\right\}_0^{\frac{2\pi}{m}}$$

$$\frac{m}{2\pi}I_m z\left(-\cos\left(\psi-\varphi-\frac{\pi}{m}\right)+\cos\left(\psi-\varphi+\frac{\pi}{m}\right)\right.$$

$$\left.-\left(\frac{m}{\pi}+\cot\frac{\pi}{m}\right)\left[\sin\left(\psi-\varphi+\frac{\pi}{m}\right)-\sin\left(\psi-\varphi-\frac{\pi}{m}\right)\right]\right)$$

$$=\frac{m}{2\pi}I_m z\left[-2\cos(\psi-\varphi)\cos\frac{\pi}{m}+\left(\frac{m}{\pi}+\cot\frac{\pi}{m}\right)\right.$$

$$\left.\times2\cos(\psi-\varphi)\sin\frac{\pi}{m}\right]$$

$$=\frac{m}{2\pi}I_m z\times2\frac{m}{\pi}\cos(\psi-\varphi)\sin\frac{\pi}{m}=I_m z\frac{m^2}{\pi^2}\cos(\psi-\varphi)\sin\frac{\pi}{m}.$$

2. m is odd :—

$$e_{\text{mean}}=\frac{m}{\pi}\int_0^{\frac{\pi}{m}}I_m z\left[\frac{\cos 3\pi/2m}{\sin\pi/m}\cos\left(\frac{\pi}{2m}+\psi-\varphi-\alpha\right)+\frac{2\pi/m-\alpha}{2\pi/m}\right.$$

$$\left.\times\sin\left(\frac{\pi}{m}+\psi-\varphi-\alpha\right)-\frac{\pi/m+\alpha}{2\pi/m}\sin(\psi-\varphi-\alpha)\right]d\alpha$$

$$=\frac{m}{\pi}I_m z\left\{-\frac{\cos 3\pi/2m}{\sin\pi/m}\sin\left(\frac{\pi}{2m}+\psi-\varphi-\alpha\right)+\left(1-\frac{m\alpha}{2\pi}\right)\right.$$

$$\times\cos\left(\frac{\pi}{m}+\psi-\varphi-\alpha\right)-\left(\tfrac{1}{2}+\frac{m\alpha}{2\pi}\right)\cos(\psi-\varphi-\alpha)$$

$$\left.-\frac{m}{2\pi}\left[\sin\left(\frac{\pi}{m}+\psi-\varphi-\alpha\right)+\sin(\psi-\varphi-\alpha)\right]\right\}_0^{\frac{\pi}{m}}$$

$$=\frac{\pi}{m}I_m z\left\{-\frac{\cos 3\pi/2m}{\sin\pi/m}\left[\sin\left(\psi-\varphi-\frac{\pi}{2m}\right)-\sin\left(\psi-\varphi+\frac{\pi}{2m}\right)\right]\right.$$

$$+\tfrac{1}{2}\cos(\psi-\varphi)-\cos\left(\psi-\varphi+\frac{\pi}{m}\right)$$

$$-\cos\left(\psi-\varphi-\frac{\pi}{m}\right)+\tfrac{1}{2}\cos(\psi-\varphi)-\frac{m}{2\pi}\left[\sin(\psi-\varphi)-\sin(\psi-\varphi)\right.$$

$$\left.\left.-\sin\left(\psi-\varphi+\frac{\pi}{m}\right)+\sin\left(\psi-\varphi-\frac{\pi}{m}\right)\right]\right\}$$

$$=\frac{m}{\pi}I_m z\left[\frac{\cos 3\pi/2m}{\sin\pi/m}2\cos(\psi-\varphi)\sin\frac{\pi}{2m}+\cos(\psi-\varphi)\right.$$

$$\left.-2\cos(\psi-\varphi)\cos\frac{\pi}{m}+\frac{m}{2\pi}2\cos(\psi-\varphi)\sin\frac{\pi}{m}\right]$$

$$=\frac{m}{\pi}I_m z\cos(\psi-\varphi)\left[\frac{2\cos\frac{\pi}{2m}\left(1-4\sin^2\frac{\pi}{2m}\right)\sin\frac{\pi}{2m}}{2\sin\frac{\pi}{2m}\cos\frac{\pi}{2m}}\right.$$

$$\left.+1-2\cos\frac{\pi}{m}+\frac{m}{\pi}\sin\frac{\pi}{m}\right]$$

$$=\frac{m}{\pi}I_m z\cos(\psi-\varphi)\left[2\left(1-\cos\frac{\pi}{m}\right)-4\sin^2\frac{\pi}{2n}+\frac{m}{\pi}\sin\frac{\pi}{m}\right]$$

$$=\frac{m}{\pi}I_m z\cos(\psi-\varphi)\frac{m}{\pi}\sin\frac{\pi}{m}=I_m z\frac{m^2}{\pi^2}\cos(\psi-\varphi)\sin\frac{\pi}{m}.$$

Note 8.

Armature diameter=26 cm.—*i.e.*, $\tau=20{\cdot}5$ cm.; $W=12$ cm.; $g=0{\cdot}18$ cm.; $N=306$; $a=1$.

Electrical Development.—One of the latest bulletins issued by the Ministry of Reconstruction in the "Reconstruction Problems" series (No. 24) deals with electrical development. It is remarked that this country is now passing from the age of steam to the age of electricity, and a summary is given of the chief conclusions in the recent report of the Committee appointed by the Board of Trade to consider the question of electrical supply. An interesting section of the pamphlet deals with the first Electric Lighting Act of 1882, which is admitted to have been unwisely framed in several respects, and to subsequent legislation in which these faults were only partially corrected. A comparison is drawn between electricity and steam as a motive power (though we doubt if the figures given will bear investigation). Great importance is attached in electrical generation to avoiding the artificial restriction of boundaries confining the area of supply, and special prominence is given to the possibilities of electricity in rural as well as industrial areas. Instances of the profitable use of electrical methods on farms, for dairy work, &c., are given. As concerns industrial areas, the great fuel saving accruing from the general use of electricity from a large central supply is emphasised.

Static Transformers for Use with Electric Furnaces.

Concluded from p. 70.

Arrangement of Tappings.—In the design of Westinghouse furnace transformers very special attention is given to both the electrical and mechanical arrangement of the tappings. The voltages required being of a low order, say from 65 to 95 volts, the provision of tappings on the low-tension side is out of the question. This is due to the few low-tension turns available, to the very heavy currents, and to the switchgear being often required to change from one tapping to another at short notice. It is usual, therefore, to put the tappings on the high-tension side.

Formerly it was the practice to put these tappings at the end of the windings; this is done now for low voltages. While this practice is permissible for supply pressures up to 3,000 volts, it has been discarded by the British Westinghouse Company, who use the method described subsequently. The reason for this is that the tappings at the ends of the windings interfere with the reinforced end turns, which are subjected to severe pressure strains due to the high voltage which may exist on the transformer windings and attached switchgear on account of the auto-transformer effect.

For example, consider an 11,200-volt supply with a low-pressure range of 65-95 volts. If the tappings are at the ends of the windings, as in Fig. 4, then for 65 volts the 11,200 volts would be applied to 1 and 8, while for 95 volts the 11,200 volts would be applied to 4 and 5, with the result that across leads 1 and 8 a pressure of 16,350 volts would exist. This voltage would severely strain the transformer insulation and auxiliary switchgear unless specially provided for, which would mean more expense; also the heavy reinforcement of the end turns would have to extend within the leads 4 and 5 to an extent of 10 per cent., or, in other words, the windings would have to be heavily reinforced to the extent of 45 per cent. of the high-pressure winding between leads 1 and 8. This also involves serious extra expense and reduced efficiency, and a reduction in copper factor.

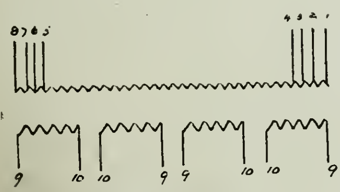

Fig. 4.—Diagram of Transformer Windings, showing Position of Tappings (usual method).

The Westinghouse practice is to arrange the tappings as in Fig. 5. This has the advantage that the pressure across the high-tension switchgear can never exceed the line voltage, and that the reinforcement necessary is reduced to 20 per cent. of the full winding. Two extra leads are required, but this disadvantage disappears with Scott-connected transformers, as the middle point of the windings must be available.

The connections of the high-tension coils are also specially arranged so that the position of the tappings shall not interfere seriously with the reactance values required or the current balance on the low-tension side, which in general has parallel groups of coils.

For three-phase furnaces three transformers are necessary, while Scott-connected sets for two-phase furnaces of the same capacity require only two transformers, and although the Scott-connected transformers are more expensive for the same output, they are cheaper for the combined unit.

Reactance Characteristics.—The internal reactance required in the transformers varies with the several types of furnace and the method adopted for control of the load. Most steel furnaces require from 8 to 12 per cent., varying according to the lay-out of the furnace leads, the capacity of the furnace, the location of the transformers and the type of material under treatment. The reactance is necessary to reduce within permissible limits the heavy fluctuations of load during melting periods, to steady the arc and to protect the supply system. In Westinghouse transformers the reactance is obtained by the grouping and arrangement of the high and low-tension coils, and no magnetic shunts are used except in special cases.

The local conditions of most furnace installations make an accidental short-circuit between furnace and transformer quite possible. Because of this it is important that the question of reactance characteristic should be carefully studied by those who intend to install furnace transformers.

Furnace transformers should be very strongly constructed in order to withstand the repeated heavy mechanical stress brought to bear on the windings, due to the violent and frequent fluctuations of load during operation.

Low-tension Heavy Current Leads.—In furnace transformers delivering up to 6,000 amperes the high-tension leads may consist of two conductors, but above this current, and especially if any length of run is required, the low-tension leads should be interleaved. The number of low-tension leads will depend on the magnitude of the low-tension current and the reactance requirements. The Westinghouse practice is to interleave the low tension bars in groups of 4, 8, or 16, according to the circumstances of the case. Fig. 1 illustrates a transformer which deals with 20,000 amperes; here the low-tension leads are brought out in four groups of alternate polarities.

Mechanical Construction.—Transformers of Westinghouse design and manufacture are invariably of robust construction. All coils are amply insulated and assembled together as a complete set, thus ensuring that all parts of every coil are rigidly supported, and that individual coils are accurately spaced from one another for purposes of insulation and ventilation.

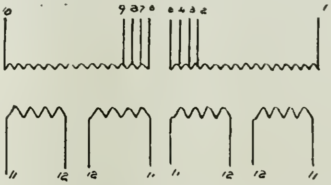

Fig. 5.—Diagram of Transformer Windings, showing Position of Tappings (Westinghouse method).

The punchings are built around the coils, so that no play is possible between them and the coils. The punchings are clamped and held together by heavy cast end-frames, which are of steel in the large sizes. The coils are also supported and strutted between these frames by an adjustable coil support; this prevents any possible movement of the coils in a vertical direction. The coil heads are also secured in a lateral direction at the top and bottom by adjustable clamping plates, but in the small sizes up to 500 k.v.a. these are replaced by heavy timber wedges.

Coils insulated and assembled in this manner never shrink. The type of insulating is shown in Fig. 6.

The cleating of the leads of furnace transformers has been given very special attention, since many failures have been traced to the movement of the leads under shocks arising from short-circuits and sudden fluctuations of the load.

Lay-out of Furnace Plant.

In order to obtain efficient service and to reduce capital outlay in copper, it is essential that the transformers should be as near the furnace as possible, and symmetrically placed in regard to it.

The transformers should not be so near as to receive heat from the furnace. This can be prevented by having a wall or partition of heat-resisting material between the furnace and the transformers.

Symmetrical lay-out is necessary, in order to make the resistance and reactance drop of the low-tension leads equal on all phases, and so ensure balanced voltages. The resistance of the leads is comparable with that of the low tension winding, and unless equality is maintained the voltage drop may be more on one phase than on the other; also, if the areas enclosed by the + and − bars of the phases are unequal, the reactance in the leads will be unbalanced and cause voltage drop, with unbalanced loading and low-power factor.

Various methods of running the low-tension leads or cables from the low-tension terminals are used. The one most favoured on small transformers—*i.e.*, up to 6,000 amperes—consists of two heavy bars in parallel up to the partition or wall, and flexible cables from these to the electrodes. The method most used for heavy currents, however, is that of multiple bus bars running interlaced to within close proximity of the furnace, split up and carried to the respective electrodes by flexible cables.

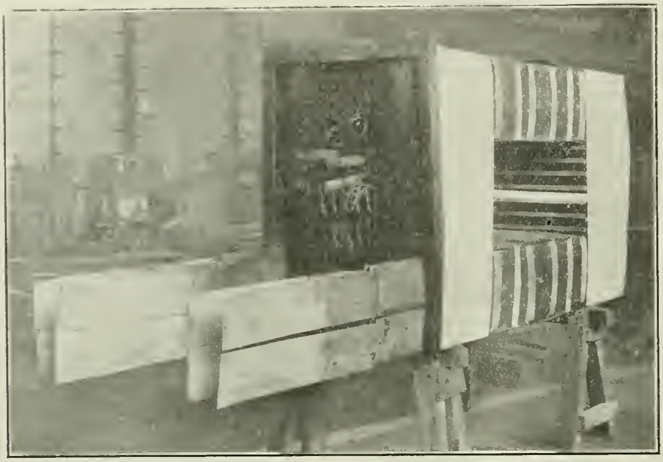

Fig. 6.—Shell-type Coils Assembled, showing Method of Insulating and Oil Ducts.

The connections of the low-tension bars to the low-tension terminals varies in accordance with the current to be dealt with. Up to 6,000 amperes the British Westinghouse Company's practice is to bolt the bars; while above that value, and with the multiple low-tension bars, connections by means of heavy spring clamps are advised. This ensures good and regular surface contact and easy erection.

To facilitate the changing of the voltage a selector switch is provided. This switch is interlocked with the main oil switch, so that it can only be operated when the transformer is dead. This is the usual practice, as the shutting down of the furnace during this operation is quite permissible, the time being so short. The apparatus which would be necessary to change over with the transformer load would be so expensive as not to warrant its inclusion.

With furnaces of the pure resistance type, such as those for carborundum manufacture, the change-over under load conditions is essential. The reduction of voltage is necessary in this case on account of the falling resistance of the bath with increased temperature, and it is not allowable that time should be lost, or the temperature will fall away and the resistance increase again.

Fig. 7 shows a transformer for use on the carborundum type of furnace.

The description which follows is chiefly concerned with furnace equipments which require two or more working voltages, these being brought into use by auxiliary selector switchgear. In the case of some manufacturing processes, change of pressure must be accomplished during operation.

Furnace Booster Regulator System.

Certain features are essential to this system. The main transformer is wound for the lowest required working pressure, and in addition it is provided with an auxiliary winding brought about in sections to a selector switch. This auxiliary winding feeds when required a booster inserted in the heavy low-tension loads, and this increases the voltage of the low-tension winding, as the pressure is supplied to the primary winding of the booster.

The advantages of this system are that high pressures are not interfered with during operation, and hence connections can be made more mechanically sound than if tappings had to be provided; the auxiliary switchgear need only be made for normal voltage, and hence is cheaper and safer; the balancing of load in the multiple low-tension windings is more easily maintained, and so there is less fear of local heating; if necessary, voltage change can be made without cutting off the load, the booster acting as a choke coil during change over.

This system is of advantage if many voltages are required, for the booster, if reversed, will double the number of voltage variations. In this case the main transformers must be wound for the middle low-tension pressure. This means that if the auxiliary winding and the booster are used both positively and negatively, these windings need only be of half the size that would be required were the boost all positive.

Cost.—If the transformer only is taken into account in the cost it will be more expensive and slightly less efficient than one provided with tappings, but when considered in conjunction with the switchgear, especially for high voltages, it is cheaper, as well as safer. These points outweight the slight loss in efficiency, which occurs at the lower voltages. This system is certainly cheaper and more efficient than having separate regulating and boosting transformers.

If, however, there is a large quantity of power for several furnaces or furnace groups, the simplest method would be to provide a large step-down unit, and then again transform from a normal pressure of 5,000 to the required low-tension pressure, but here again cost is high, and the provision of the necessary spares involves a certain amount of dead capital.

Conclusion.

The large number of installations equipped during recent years by the British Westinghouse Company is evidence of that Company's unique experience in the manufacture of transformers for the operation of every kind of furnace.

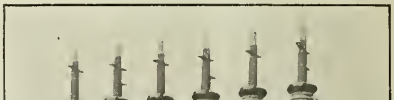

Fig. 7.—A British Westinghouse 500 k.v.a. Three-phase, 5,750/70-100 volts, 40-period, Oil-immersed, Self-cooled Transformer for Use with a Carborundum Furnace, 3,000 Amperes.

Electric Welding: Its Theory, Practice, Application and Economics.*

By H. S. MARQUAND.

(*Continued from page 41.*)

Summary.—In the present article the author deals with the preparation of welds and then passes on to certain properties of iron and mild steels which have a marked bearing on the methods adopted. The welding of copper and copper alloys has not received very much attention, but electric welding is nevertheless applicable to such work. Finally, examples are given of various types of welding.

It is highly important that a fairly long arc (2 in. to 3 in.) should be used, thus obtaining a better diffusion of the heat.

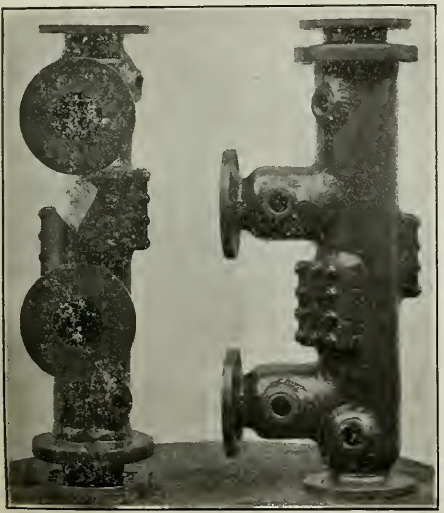

FIG. 49A.—WELD PIPEWORK.

Fig. 49 illustrates sundry small articles welded with the carbon electrode, while Figs. 52 and 52A shows illustrations of pipe work made up of pieces and welded by means of the metallic electrode method. Which ever method is used, the preparation and procedure is similar.

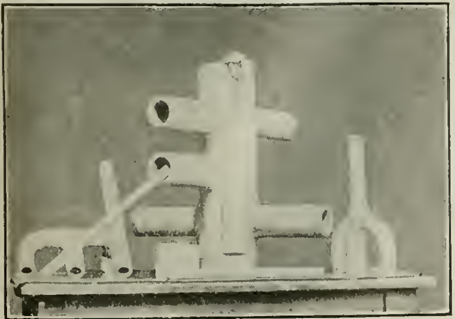

FIG. 49B.—ARTICLES WELDED BY MEANS OF A CARBON ELECTRODE

STRENGTH OF ELECTRICALLY WELDED FLANGES.

An 8 in. iron pipe, $\frac{1}{4}$ in. thick, with flanges electrically welded, when tested to destruction at Lloyd's Proving House, Netherton, broke in the body of the pipe at over 88 tons, the welded part remaining intact; a similar pipe of steel broke in the welded part of the flange at over 101 tons. These tests were tensile only, and were carried out with the view of proving the absolute soundness and consequent strength of the flanges electrically welded on. For this purpose special tackle was made. A blank flange with an eye-bolt attached was secured to each flange of the pipe, and the chain of the testing machine was connected with the eye-bolts at each end, with the results given.

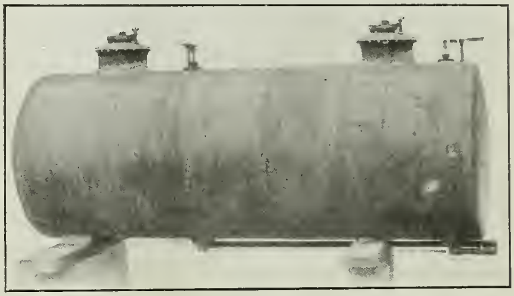

FIG. 50.—WELDED PETROL TANK FOR ROAD MOTOR TANK WAGON. CAPACITY, 1,000 GALLONS.

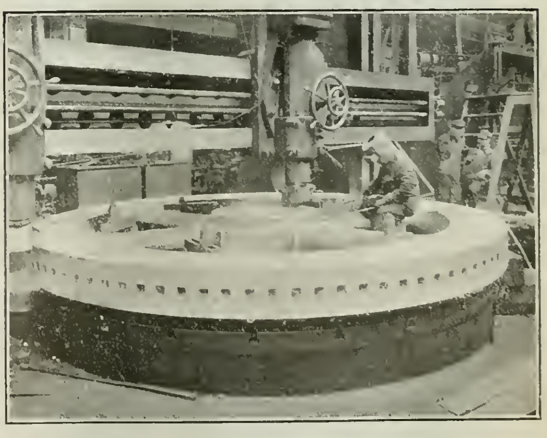

FIG. 51.—AN EXAMPLE OF HEAVY REPAIR WORK.

Fig. 50 illustrates a petrol tank of 1,000 gallons capacity completely constructed by the graphite arc welding process.

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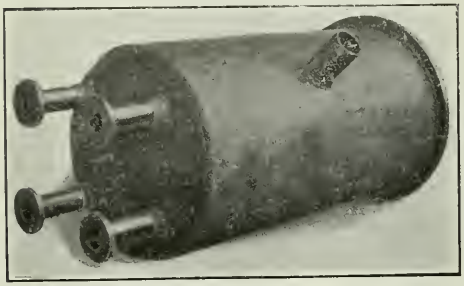
THIN METAL PIECES WELDED WITH METALLIC ELECTRODES.

TWO PIECES OF PIPE WELDED TOGETHER AND THE BRANCH PIPES WELDED IN PLACE


LARGE TANK WITH ALL SEAMS WELDED WITH METALLIC ELECTRODE.

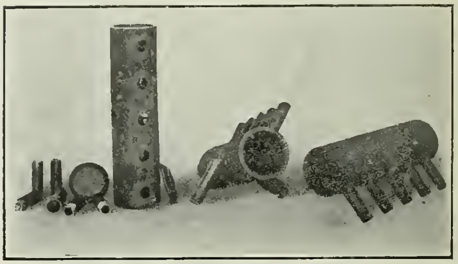

HEADERS WITH BRANCHES WELDED IN WITH METALLIC ELECTRODE.

FIG. 52

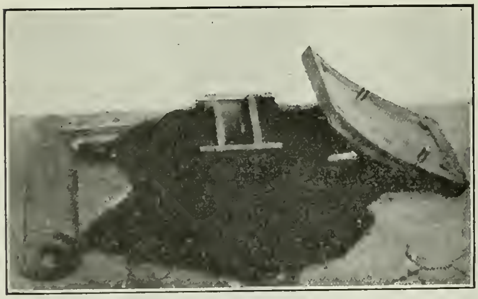


FIG. 53.—A HEAVY CASTING SET FOR WELDING.

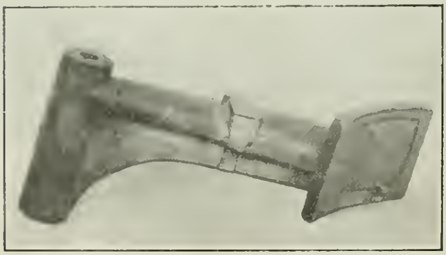


FIG. 54.—CASTING SHOWN IN FIG. 53 AFTER WELDING

The tank was extremely robust and sound, with no vestige of leakage.

As examples of heavy repair work which can be quickly and successfully undertaken with the graphite arc system, Figs. 52 and 53 are of interest. Fig. 53 shows a heavy casting set for welding up by this process, while Fig. 54 shows the same casting after the welding is completed.

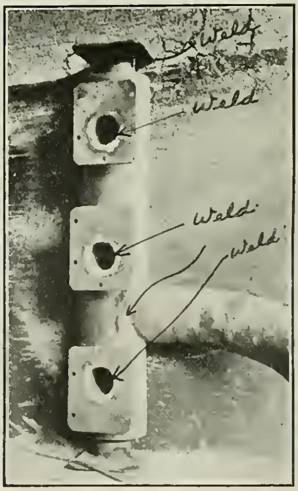


FIG. 52A.—WELD MADE BY COATED METALLIC ELECTRODE.

(*To be continued.*)

The Telegraph & Telephone Services.

In the House of Commons last week the Postmaster-General (Mr. A. Illingworth) made a detailed statement on the position of the postal, telegraph and telephone services. In the past year the profits of all the services of the Post Office were £6,500,000 against £5,200,000 in 1913-14. The estimated deficit for 1919-20 would be about £2,000,000. During the war, in order to make provision to meet to some extent the extra cost of the Post Office, the charges were increased to an extent which, during this year, would bring in £6,500,000. On the expenditure side there was an enormous increase in the work for Government Departments. This would continue during the year, but he hoped that it would be on a smaller scale. The prices of material had very largely increased. The main increase in the cost were the pensions and wages given since the war began, which now amounted to £14,500,000 per annum more than in the year before the war, and against that the charges transferred to the public were only £6,500,000 per annum.

Telephone Service.

When the National Telephone Company was running the system it had a total capital of some £11,000,000, on which the average dividend for five years before the transfer to the State was 5·13 per cent. In 1913-14, after the service had been transferred, it showed a profit of £239,000, in addition to the interest charge of £692,000. Those two figures gave a dividend of 4·29 per cent. on the total capital employed. The National Telephone Company paid in royalties to the Post Office 10 per cent. of the gross receipts, and in the last year of working that amounted to £355,000. In the company's last year it provided £13,000 for pensions, and that sum was increased when the service was taken over, to £243,000 per annum, and salaries and wages by £158,000 a year. The royalties payment of £355,000 was more than set off by the additional wages and pensions, which amounted to £400,000 a year. The plant, too, was run down, and it had been very expensive to keep it in anything near working state, while the future would call for a heavy capital outlay in order to bring it to a satisfactory state of efficiency. By degrees, on account of the war, the cost of living increased, and the pensions and the rate of wages paid to the telephone workers had been increased. It began in 1915-16, with £177,000, and this year it was £2,500,000 per annum more than when the service was taken over. That meant that the wages bill had practically doubled since 1913-14. Over and above all that provision had had to be made for the pension liability, which had increased concurrently with the rise in wages. The renewal of the plant would also be very much more expensive, and consequently the cost of new construction and the extension of the system must be very much higher. An exchange costing £100,000 before the war would now cost more than double. Towards the extra expense, all that had been done was in 1915 to transfer to the public a charge of £500,000 a year. The present position was that the increased cost of the services came out at between £2,500,000 and £3,000,000 a year, and the increased rate had only produced about £500,000. Consequently, it was obvious that the service must either be run at a loss, and so become a charge on the taxpayer, or the charges must be incresed to the public. All commercial undertakings had increased their charges, and he did not see why the charges should not be increased. He was having schemes prepared, and when they were ready he proposed to come to the House and ask for a Select Committee to advise upon them.

He had had difficulties in maintaining an experienced staff during the war. At the time of the Armistice over 800 were employed in the various Government Departments, and now the number was over 700. The supply of recruits was improving and not so many were leaving; and gradually he hoped to get more efficiency. The average number of daily calls about the time of the Armistice in London was between 900,000 and 1,000,000, and this had increased now to over 1,250,000 per day. That meant they had got a much heavier load to handle by a less experienced staff. He deprecated the language used by some of the subscribers over the telephone to the girls.

Extension Works.

Construction work had been suspended for nearly five years. In London there was a great shortage of underground cables, and this year he proposed to spend £250,000 in laying extra cables. That would not relieve the whole of the congestion until new buildings were ready or present ones extended, and the switchboards extended. The first extension—a new exchange—would be in operation towards the end of the year. It would be called Clerkenwell and would relieve Avenue and London Wall. Immediately that was ready they would be able to take 1,700 subscribers, which would afterwards be increased to 7,000 The Avenue, Victoria and Hop Exchanges would be extended. New exchanges would be built on the site of the Inns of Court Hotel and at Bishopsgate and the Tower, and three more in the West End. In outer London seven new exchanges would be built and five considerably extended. In the provinces about £250,000 was being spent in laying underground cables in over 20 towns. In Huddersfield a new exchange had been completed and was working very satisfactorily. There would be eight new exchanges this year, and extensions to seven existing exchanges. The principal item was a new underground trunk line from London to Manchester, *via* Northampton, Leicester, Loughborough and Derby; and one from Derby to Sheffield and Leeds. That was a very big undertaking, which he was afraid would not be completed for about 18 months. Eight underground telephone cables and 60 overhead circuits would be begun this year. The total cost of the work would amount to some three million pounds; about one million would be spent this year, in addition to two millions on exchanges and local works. There would be a good deal of delay owing to the difficulty of getting material, and the engineers were still in the Army to the number of 3,000 or 4,000. During the war the trunk lines had been taken over by the fighting services—342 in all, which were now reduced to 112. A multiplex telephone system had been introduced enabling several people to telephone in each direction over the same wire at the same time. He hoped to be able to get five messages over the same wire in each direction, but the system was in an experimental stage. He did not think the telephone system had really had a fair chance in this country. The National Telephone Company naturally were not going to spend large sums of money, and development had only just begun when the war started, and it was followed by another five years of neglect. Since the Armistice they had, however, put in over 60,000 telephones.

Submarine Cables.

Cables were not, strictly speaking, under the Government, but they had always worked harmoniously with the companies. The cables generally were showing rather less delay, except for Egypt and Australia. They were suffering from too much traffic and from frequent interruption. In addition there was the cessation of work which went through Germany and Russia, where the cables had naturally not been used since the war began. Under ordinary conditions the capacity of those cables was 253,000 words per day, but on account of interruptions and various other troubles, their capacity had been reduced to 167,000 words. Government traffic was 18 times more than it was before the war, and it was now occupying 25 per cent. of the total capacity of the Eastern cables. The censorship of cables would be abolished as from midnight on the 23rd inst. That would allow the introduction of private codes and a consequent decrease of between 20 and 30 per cent. in traffic. The companies were doing everything in their power to improve their service and make it as efficient as possible.

The postal services were gradually being restored. In London deliveries had been increased, and in the provinces the deliveries and collections would also be increased.

In the course of the discussion which ensued, Capt. J. C. Denison Pender mentioned among the causes of the delay the fact that the enemy submarines had led many communications to be sent over the cables which before the war were normally sent by post. The suppression of the private codes had also increased the traffic over the lines. Then there had been a great influx of cablegrams sent home by the men who had come to fight for us from all parts of the world, and the submarine menace had hampered the repair work on the cables and made it very difficult. The question of Government traffic was the most serious of all. Twenty-five per cent. of the traffic being carried by the companies at the moment was due to Government work. He wished pressure could be brought to bear on the Departments concerned, and especially the War Office, who had had the power in their hands so long that they thought they could go on without any restrictions being placed on them. The renewal of cables had been absolutely impossible during the last five years, but he hoped by the end of next month all the existing cables would be in fair working order, and in October they expected to lay a new cable from this country to Gibraltar, and gradually to extend it round the Mediterranean through Aden and on to Singapore.

American Electric Railway Statistics.

According to statistics recently published by the U.S.A. Bureau of the Census, the street and inter-urban electric railways transported over 11 billion fare-paying passengers during the year 1917, representing an average of something more than 100 trips for each person in the United States. The electric railway companies operated 102,603 cars (including 79,914 passenger cars) on 32,535 miles of line, comprising 44,812 miles of track. The employees were 294,826, and the salaries and wages aggregated \$257,240,362. The operating revenue was \$650,149,806, and the total income \$730,108,040 (against \$585,930,517 in 1912). The operating expenses were \$452,594,654 (against \$332,896,356), and after making certain deductions, the net income was \$56,45[illegible],930 (against \$68,139,889 in 1912).

The statistics cover electric light plants operated in connection with electric railways and not separable therefrom, but do not cover mixed steam and electric railroads nor railroads under construction. The total horse-power of engines was 4,200-192 (against 3,165,888 in 1912), an increase of 14·7 per cent. The steam power was 3,543,915 H.P., against 627,983 H.P. from water and 28,294 H.P. from internal-combustion engines. There is said to be a pronounced tendency to use larger units in the three classes of power. Between 1907 and 1917 the average horse-power of the steam engines increased from 716 to 2,036; of the water wheels, from 403 to 1,987; and of the internal-combustion engines, from 398 to 534. The electric power consumed in 1917 aggregated 12,187,850,831 units, of which 7,240,502,789 was generated by the operating companies, and 4,947-348,042 was purchased. There was an increase of 35·1 per cent. in the power consumed in 1917, compared with 1912, due mainly to the rapid increase in the light and power business. The revenues from railway operations increased by 21·3 per cent. during the five years, but those from light and power business increased by 89·4 per cent.

There appear to be no municipal tramways in the States, for the return relates to 1,311 companies (947 operating and 364 lessor companies), and of the operating compnaies 300 paid dividends.

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Electric Power in Chemical Works.

It may, perhaps, be said that the average engineer in this country is apt to underrate the growing importance of our chemical industries, notwithstanding the fact that the war has served to bring these industries into much greater prominence than hitherto and to cause very great developments. The need for a greater appreciation of engineering by chemists and of chemistry by engineers has become apparent, and for the first time a number of engineering questions in relation to chemistry have been discussed at the annual meeting of the Society of Chemical Industry. This is due to the fact that a chemical engineering section of the Society has recently been formed.

Chemical factories may be divided into those which are purely chemical and those which are electrochemical. The latter necessarily require very large amounts of power, and the power may be in rather special forms. Dealing, however, with those factories which are concerned with purely chemical operations, one may say that the sphere of electric power in such cases is chiefly in the provision of the electric drive in one form or another. In a Paper which was read by Mr. H. Martin last week before the Society of Chemical Industry, the author dealt briefly with these questions. We think it desirable to refer to them, for, in some respects we do not agree with the views there expressed. For example, Mr. Martin seems to be impressed with the idea that electric power in this country is only generated by the use of thermally inefficient steam engines or turbines, and by only moderately efficient steam boilers, and that because we have no hydro-electric supplies we are handicapped in the use of electricity in chemical works. Now, so far as ordinary chemical works are concerned, we do not believe that this matter is of any great consequence. What is important is that the power obtainable should be reasonably cheap. In this country there is no question that electric power is cheap. This has been frequently shown by comparison with other countries, and for ordinary load we doubt if any very great improvement would be made if hydro-electric power were available. Where this question becomes of serious importance is when electric power forms a large proportion of the whole cost.

The position is again emphasised where Mr. Martin expresses the opinion that only small factories can take their supply from a municipality or power company, and that the consideration of this question may be considerably altered in a few years' time when the Government scheme of electrification is to some extent complete and in operation. Thus Mr. Martin holds the view that electric power in this country is not cheap, and that it may become very much cheaper through a scheme of nationalisation. For the average works we doubt if the cheapening so obtained will be anything very considerable in those districts where our cheapest supplies are already available. Where, however, large loads have to be considered at a high load factor we anticipate that the Government scheme may make a very material difference when the possible economies due to generation on a large scale have been realised.

For the ordinary factory requiring lighting and motive power there can be little question that a supply from public mains is the best course to adopt. In many chemical works, however, a large amount of steam heating is necessary. Under such conditions it is a question whether it may not be worth while to put down electrical plant for the generation of electric power in the factory itself. There is no doubt that every case must be considered upon its merits. If the power can be supplied by steam turbines from which exhaust steam may be taken for chemical purposes, it may very well be that this is far and away the cheapest method of generating electric power. On the other hand, in certain cases it may be found that it is preferable to run low-pressure steam boilers for the steam heating and to take the power from public mains.

The other type of factory is that which deals in electrothermal or electrochemical processes, in which steam heating is probably not required, or only required to a very minor extent. In such cases it is doubtful whether a factory, unless on a very large scale, can compete with the modern power station in giving a supply. It must be remembered that the generation of power is a very specialised branch of engineering if the highest efficiency is to be attained. If electric energy is taken from the mains the chemical manufacturer is relieved from the responsibility of producing his power and can apply his energies entirely to his special line of manufacture. In these days there is little difficulty in obtaining electric power in any special form that may be required, as this is really a matter of transformation.

Great strides have been made during the war in the use of electrical methods in steel making and in other processes, and it will be well for our station engineers to keep such methods well in view. There will be large openings in the future, but the possibilities in this direction depend very greatly upon the electric energy being extremely cheap. It is impossible, in any manufacturing process into which electric energy enters to a serious extent, to expect developments unless the electric energy produced can be purchased below a certain figure. This point must be constantly borne in mind by our station engineers in those districts which are essentially concerned with chemical products.

Reviews.

The Year-Book of Wireless Telegraphy and Telephony, 1919. (London: The Wireless Press, Ltd.) Pp. cxvii.+1160. Price 7s. 6d.

The "Year-Book of Wireless Telegraphy and Telephony" for 1919 appears in happier circumstances than its immediate predecessors, and the hope expressed in the preface that it would be the last volume issued under war conditions has now been realised. Next year, it is hoped, circumstances will permit full publication of technical data, and there will doubtless be much to record of interest concerning developments during the war. Meantime the 1919 edition has the usual good features. The section on Laws and Regulations, which was extended last year, again occupies more space in the present volume, while the Record of Wireless Developments for 1918, despite war restrictions, is fuller than in recent years. Attention is drawn to the progress made towards continuous wave communication. There has been improvement in the arc form of generation, outputs up to 1,000 kw. having been reached, and in valve generators progress has also been rapid. The outstanding development, however, has been the remarkable progress made in the use of thermionic valves for receiving wireless signals, and wireless telephony has advanced considerably both as regards range and reliability. The use of the Marconi modification of the Bellini-Tosi radiogoniometer in directional wireless stations, announced since the armistice, has excited much interest.

Among the special articles may be mentioned contributions by Dr. J. A. Fleming on "Maxwell's Electromagnetic Theory of Light," and by Dr. W. H. Eccles on "Cartography from the Point of View of Wireless and Aeronautics." Mr. P. R. Coursey contributes a very interesting record of the evolution of radio-telephony. A very useful feature in the present volume is the complete summary of Literature of Wireless Telegraphy and Telephony published in the year 1918. Dr. J. Erskine Murray's "Definitions of Terms used in Wireless Telegraphy" and the "Dictionary of Technical Terms" (in five languages) again appear. Finally we note one other little addition (which, we understand, is not to be found in any other work of reference), namely, a list of official holidays in various countries.

The Coal Industry: Dangers of Nationalisation By Harold Cox. (London: Longmans, Green & Company.) Pp. 18. Price 6d.

This is a timely pamphlet on the dangers of nationalisation, and, as far as we remember it, it is based largely on the evidence given recently by the author before the Coal Commission. Although we do not necessarily agree with all the views expressed by Mr. Cox, he makes many serious statements which should be studied by those who are only too ready to embark on nationalisation of anything and everything without considering what this policy involves, or the great difficulty of repairing the mischief that might result from a foolish step. Such schemes as would give a uniform quality of coal at a uniform price throughout the United Kingdom, and promise such favourable terms as 15s. per ton, involve financial fallacies that cannot be disregarded. Standard coal is quite an impracticable idea, and as to the paralysing effect of Government control and Government working, there are examples already available in this country, and apparently the same thing is now occurring in the United States. It is interesting to read the statement that in the Powell Duffryn collieries in the year 1918 the average earnings per week of all colliers employed, irrespective of the number of days worked, was £5. 2s. 5¾d. Although we do not suggest that a figure of this kind is applicable throughout the country, we think that the idea of underpayment of the collier has been somewhat overdone.

Coal Conservation.

At the British Scientific Products Exhibition on July 11 Prof. H. E. Armstrong, F.R.S., gave a lecture on "Coal Conservation." This we give in abstract below. After referring to the work of Watt and the development of the coal industry, Prof. Armstrong proceeded to deal with the present position.

It is impossible to over-rate the gravity of the situation in which our industry is placed by the sudden great rise in the price of coal; we can only meet this by economising in its use, and by improved methods of using it.

I have long been an advocate of the need of a national policy with regard to fuel and power. A full inquiry and investigation should cover all the issues—that is to say, every use of coal should be brought under consideration, so that eventually all the various interests may be economically interlocked—in no other way will it be possible to conserve our coal.

At present coal is used both wastefully and harmfully; it is entirely within our power, whilst effecting great economy in its use, to diminish to a very large extent the evils arising from its use, chiefly from smoke. The interests of the general public and of industry are both to be considered.

In the scheme contemplated in the Electricity Supply Bill the supply of heating gas and of solid fuel to the public are left out of account in the measure. The mistake the gas companies made when the glow lamp was introduced in not uniting their forces with those of the purveyors of electric light should now be rectified. Unfortunately, the gas industry is very largely in parochial hands, and still has a restricted outlook.

The question to be considered before all others—the question of questions with regard to coal—is whether or no the direct burning of raw coal shall in any way be permitted; and, if permitted at all, to what extent and for what purpose it shall be allowed. I would prohibit the use of all raw coal which can be carbonised economically at a low temperature prior to use as a fuel.

In burning raw coal we not only create a nuisance—a great deal is wasted that might be saved and put to better use. When coal is heated, combustible volatile matters are given off, partly gaseous and partly condensable; the solid residue is more or less easily combustible, according to the temperature at which it is finally heated. By carrying the carbonisation only to the point at which the gas ceases to burn with a luminous flame, a solid fuel is obtained which burns easily as compared with the coke ordinarily produced at the town gas works, with which the public is familiar; moreover, such fuel is smokeless. The liquid product obtained when carbonisation is effected at a low temperature, with the object of producing such a smokeless, easily combustible fuel, in a measure resembles crude petroleum; from it may be separated an easily volatile portion which can be used as motor spirit, also a considerable proportion of "tar acids," which are valuable as antiseptics, leaving a fuel oil which can be used as a whole in engines of Diesel type or burnt directly under steam boilers.

It is unnecessary to dilate on the increasing importance of oil fuel, but essential to insist on the near coming of the world's bankruptcy in this asset. According to a recent estimate, the supplies in the U.S.A. are not likely to hold out much beyond 25 years at present rates of wastage. Not one of the oil fields known to us is of such extent that it is likely to withstand the drain that is being made upon it during any considerable period. Under these circumstances, we shall be guilty of criminal folly if we do not secure all the oil fuel that it is possible to recover from coal before burning it.

If this point of view can be made to prevail, our entire outlook will be changed. We shall first direct our attention to the development of methods of carbonising coal which will enable us to conserve the volatile matters, whilst at the same time producing an easily combustible smokeless fuel suitable both for domestic and industrial purposes. When this is accomplished, the smoke nuisance will have been abolished, the public will have been provided with a fuel which is superior as a heating agent to ordinary coal, and the volatile matters which are recovered will be of considerable value

That the problem is one that must and will be solved I have not a shadow of doubt. During the past two years I have been constant witness of experiments on a large scale, with several hundred tons of coal, which have convinced me that it is merely a question of developing engineering appliances to effect the carbonisation economically on a large scale. That the difficulties are considerable is beyond question—our knowledge of refractory materials and of oven technique is but in its infancy, and we have to make up for our past neglect of the subject.

The coming struggle is that between smokeless solid fuel and gas as heating agents for domestic use. The gas companies already occupy the field; they have powerful political backing, and their ware has long been puffed for all and far more than it is worth. On the ground of cleanliness, care of use and economy of labour, gaseous fuel has every advantage as a mere heating agent for kitchen use; it is even economical if burnt with forethought and thrift. But the open fire of solid smokeless fuel is greatly superior to the gas fire, not only more pleasing in appearance and less costly, but far more conducive to health. Even its variability is greatly in its favour. Dr. Leonard Hill, Prof. Bone and others have dealt with this subject so fully that I do not propose to say more.

The difficulty will be to secure the supply of a gas of suitable quality for domestic use. There is an insidious move on foot to legalise the supply on the basis of calorific power alone, without reference to quality, and quasi-Government support has been secured by referring the matter to the Fuel Research Board of the Department of Scientific and Industrial Research. The signatories of the report are not known as men conversant with the problems to be discussed, and there is no evidence in the report that the problem of quality has been taken into account, if at all in any comprehensive and adequate manner.

It would be to the public advantage if a richer gas were supplied This cannot be done, if the gas industry remains separate and self-contained. There can be little doubt that, in future, gas will be little used as a lighting agent: the electric light is so much more convenient, and the injury done by gas to internal decoration is so much greater, apart from the evils arising from the sulphurous fumes arising from its combustion in the open room; this argument now has an increased force owing to the greatly increased cost of whitewashing and painters' work.

The production of gaseous fuel should, therefore, be a function of the power station—not of the mere gas works. It may well be that the provision of 16 great electric power stations would serve to meet the needs of at least the more important industrial centres and industries—but not the general needs of the country. A broader, more generous scheme is required, one which will meet all requirements, those of the general public as well as those of industry. At least the larger towns would each have its fuel and power station. If and when this were not at the pit mouth, it would draw its supplies of coal from a convenient source. As far as possible, all the coal would be carbonised at a low temperature. The area assigned to the station would be supplied with the smokeless fuel required for domestic purposes—the use of raw coal being disallowed. Only a part of the coal carbonised would be distributed as smokeless fuel and a special quality of coal might be chosen for the purpose, in order that a standard fuel of guaranteed minimum ash content might be supplied. The greater part of the coal carbonised might be of inferior grade; this would be transferred to producers and converted into producer gas, in order to recover the nitrogen in the coal as ammonia. The scrubbed producer gas would, for the most part, be burnt under steam boilers, in order to develop the power required in generating electric current, maybe some of it would be consumed in gas engines.

The rich gas given off in carbonising the coal at a low temperature would bear dilution to a considerable extent with water gas and yet afford a fuel of relatively high calorific power for domestic use. If gas were also required for manufacturing purposes, probably a separate service conveying a weaker gas would be desirable—as in the South Staffordshire area supplied by the Mond Gas Company.

The condensable products obtained in carbonising the coal would afford various grades of liquid fuel.

The use of coal, under such a scheme, would be confined to the centres at which coal was carbonised and only the smokeless fuel required for domestic use would need to be delivered locally and in small quantities. Much expense both on carriage and handling might thus be saved; that considerable economy is possible must be clear when it is remembered that at least 40 per cent. of the weight of most coals is made up of ash and volatile matter; if only coals of high grade or washed coal were carbonised away from the pit mouth, this proportion of the cost of carriage should disappear.

It may also be pointed out that in burning smokeless fuel in the domestic grate, a further economy would be effected over coal, as heat is not used wastefully, probably at least a fifth of that given out in combustion, during the early stage, as it is in burning coal, while water and the volatile products are being distilled off. If properly used, the smokeless fuel soon becomes red hot and presents the glowing appearance of an ordinary fire which has burnt clear.

To carry so comprehensive a scheme as that I have sketched into execution it will be necessary to arrange for the fusion and consolidation of various interests; in fact, it would involve no less than the union of the electrical with the gas interests at power centres which would also be centres for the supply of solid smokeless fuel as well as of oil fuel, the main by-products of the carbonising process. If we will but use our intelligence to make such co-operation effective, taking into account the economies that might be introduced and the improvements that are in prospect in our methods of using fuels, it may well be possible at least to halve our coal bill at no distant date.

"Let us think together, work together, act together," was Mr. Lloyd George's recent exhortation, in his statement on the peace terms. This we must do, not only if we wish to conserve our coal, but if we are to retain a leading position in the world of industry and commerce, and in any way to recover from the ravages of war. The extreme gravity of the situation in which we are placed, the need of action without loss of time, must be brought home to all, to Labour especially. We are told that "A feeling of amazement, which quickly yielded to one of positive consternation, swept over the House of Commons when Sir Auckland Geddes announced that the Government had decided that the price of coal to the consumer must be raised by 6s a ton." It is well that there should be amazement at such a situation—but that this should occur only now is a striking illustration of the callous indifference to the problems of coal which the nation has shown hitherto, an indifference, which none of its political leaders has yet had the intelligence to bring home to the masses and to proclaim its inevitable consequence—our industrial downfall at an early date.

In the discussion Prof. W. A. Bone remarked that he did not believe in panaceas. The gas people, for instance, would say that the whole of the coal should be carbonised, and sold as gas, and the electrical people would probably say that coal should all be turned into electricity, but in his opinion we would not arrive at a solution by simply adopting exclusively or anything like exclusively one or other of these methods. For many purposes, and for power and lighting purposes, electricity was by far the best agent. For some heating purposes gas was undoubtedly superior. On the other hand he agreed with what was said as to the function of smokeless fuel for domestic purposes. He had had a great deal to do with the gas industry, and with the investigation of the improvement in the efficiency of gas fires. He remembered 12 years ago that the radiant heat efficiency of a gas fire was a little over 30 per cent., whereas now it was nearly 50 per cent. That was a great improvement, and yet he had never seen the gas fire becoming the universal domestic heating agent. He had always felt that provided we could obtain in bulk, and at a price not greater than raw coal, a smokeless fuel for the domestic fireplace, we should for the most part use it on grounds not only of economy and efficiency, but also of health. We were now going in for great building schemes, and there were many people who wanted to push a gas policy, gas fires, gas cookers and so on, but he thought it would be a great mistake to do so, and he hoped those responsible for the housing schemes would not listen to interested advice of that sort. The householder whose means were limited would find that if he heated the living rooms with gas fires instead of coal fires, the fuel bill would be at least twice as much as when coal fires were used. Gas fires were most excellent and economical for rooms which required occasional heating, but if the room had to be heated throughout the whole of the day, then from the point of view of cost the gas fire was very considerably behind raw coal. He agreed, of course, that the use of raw coal should be abolished if possible, but he was not prepared to abolish the use of raw coal in his own house, or to advocate it being abolished in other people's houses, in favour of gas fires at present. He would not do it himself on the ground of cost, if for no other reasons, and he welcomed the knowledge that Prof. Armstrong and others were going into this problem, and he hoped they would redouble their efforts to provide us with what was wanted on a large scale, and at as low a cost as possible. The use of a smokeless fuel such as that obtained from the low-temperature process of carbonisation would ultimately be the solution of the domestic heating problem. He urged the public to put its faith in disinterested scientific research, and to encourage and support it. He believed in science as he did in commerce, a free trade policy. He would support any investigator, no matter where he came from, who was both competent and enthusiastic. We did not know where new problems might be found, and in whose brains new ideas might spring, and he should always advocate that research upon this and other matters of national importance, should be on an absolutely Free-trade basis.

Correspondence.

THE DEVELOPMENT OF THE POULSEN ARC SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Under the heading of "Progress of Wireless Telegraphy" in the June 6 number of your paper is an article by Mr. C. F. Elwell. Up till now we have not been able to say much with regard to what has been done in connection with the Poulsen system in this country during the war, for reasons which will be obvious to you.

In all probability we should not take any notice here of Mr. Elwell's letter to your paper, had it not been for your Editorial in the same number. Owing to the latter, however, it has become necessary to make some reply to the letter referred to.

We are not aware that Mr. Elwell was the organiser of the American Company, but it is true that he reported on the Poulsen system to the Company, and that as a result of his favourable report the latter ultimately, by agreements dated Sept. 12, 1911, acquired the Poulsen-Pedersen patents for the United States.

I am quite certain that Mr. Elwell will acknowledge that every facility was given him during the periods when he was in Denmark in order to make himself acquainted with the Poulsen-Pedersen system, and when later in 1910 he asked for permission to visit the Knockroe Station in co. Kerry, he was also given permission and allowed to inspect the whole installation in that station, and to obtain any information he desired. The said station had been put into commission again with the object of giving demonstrations in high-speed wireless telegraphy between that point and the station at Lyngby, in Denmark. These demonstrations, we may mention incidentally, were highly successful, and were the first demonstrations of automatic high-speed transmission by wireless means over a considerable distance.

During Mr. Elwell's stay at Knockroe he made full use of the courtesy shown him, and nobody ought to know better than he that the 30-kw. Poulsen arc installed for the purpose named in that station was designed and made in Denmark and not in Germany, because he took most careful measurements of the arc.

It is highly gratifying, however, to learn that, presumably as a result of Mr. Elwell's visit to Knockroe, his experiments at Arlington in 1912 turned out so successfully, and that as a result thereof the American Company obtained a contract for a Poulsen installation at Arlington. Nevertheless, it is quite true that by means of the 100-kw. arc made in Copenhagen and lent by a British syndicate to the United States Naval Authorities and installed temporarily at Arlington, the first high-power demonstrations in United States took place. It has also been a source of gratification to the inventors of the Poulsen system that aerial systems similar to the system adopted at Knockroe station have since been adopted in the main by the American Poulsen Company and the United States Government.

It is obvious that if two organisations are operating the same system they can only gain by co-operation and by communicating to one another such improvements as may be made from time to time by either in the course of their operation, and it has always been the object of the writer to encourage such co-operation.

In the main, however, as Mr. Elwell points out, the Poulsen arc had practically all the merits when invented some 17 years ago that have made it the vogue to-day for high-power stations.

During the war this Syndicate's operations have been seriously hampered owing to the restrictions imposed upon wireless undertakings. Owing to this it has had to limit its work chiefly to the design of new types of arcs of a more compact kind, as it could obtain no priority licences, and, therefore, had to make use of other firms for manufacture according to its designs. In spite of these and many other difficulties a great many Poulsen installations have been furnished to British and Allied Governments, among these two high-power installations.

With regard to late and really important improvements in the construction of high-power arcs, a long series of experiments have lately been carried out by Prof. P. O. Pedersen, at the Royal College of Engineering in Copenhagen, and the result of these investigations will have a very far-reaching effect as regards the Poulsen system. The moment has, however, not yet arrived when the nature of these highly important improvements can be made public, for reasons which you will appreciate.

The benefit of these improvements will become the property of this Syndicate for its territory, and will become the property of the Company operating the United States Poulsen-Pedersen patents within the United States territory.—I am, &c.

For and on behalf of
The British & Oversaes Engineering Syndicate, Ltd.
Viggo Gandil Managing Director.

Aluminium in the Construction of Chemical Plant.

A booklet on the above subject issued by the British Aluminium Company, Ltd., refers to some interesting technical applications of aluminium in the chemical industries. Among the apparatus for which it seems specially suited are mentioned brewing vessels, varnish pots, and condensing stills, the two chief problems being first cost and constructional difficulties (except in the smallest sizes of vessels). Aluminium, it is stated, is suitable for practically all purposes, provided it is not brought in contact with hydrochloric acid, halogen solutions and caustic alkalis. Thus, in brewing, it has no effect whatever on the reproductive power of yeast cells, facilitates earlier "racking," and is more easily cleaned and lasts better than wooden vessels on account of its non-porous nature. Similarly, aluminium vessels have been very widely used in the varnish industry, for sugar refining, for storing foodstuffs, and for jam making. It is remarked that fruit acids met with in the latter process are apt to attack copper, but have no effect on aluminium. For all practical purposes aluminium is also unaffected by fatty and vegetable oils and can accordingly be used with success in the preparation of stearic and palmitic acids, and especially the edible oils and fats which were notoriously difficult to handle until aluminium was available in sufficient quantity.

British Scientific Products Exhibition.—I.

Electrical Exhibits.

Wireless Telegraphy and Telephony.—It may be premature to say that the demands of the war resulted in the most marked advances in this or that department of electrical engineering, but none have come into greater public prominence than wireless telegraphy and telephony. That such prominence is warranted by technical progress has been made known to the profession, especially by the lecture delivered to the I.E.E. by Lieut.-Col. Cusins, R.E., last April It is, therefore, natural that electrical visitors should find a great attraction in the wireless apparatus exhibits at the Exhibition.

The Marconi Company has a good display of apparatus for different purposes, notably a wireless telephone installation by which wireless conversation between two stations is demonstrated. The sets shown are intended for communication up to a distance of 10 miles, and are suitable for ship use. The primary generation is worked by hand power, showing that no great amount of motive power is needed. There are also shown wireless telegraph sets for ships and aircraft. These have spark transmitters. Compactness is a notable feature, and in the aircraft set lightness has been successfully aimed at. One set with a range of 30 miles weighs but 13 lb., and the other, for 60 miles range, only 25 lb. A continuous-wave transmitting set, with a range of 80 miles, weighs 32 lb., and a valve receiving set 17½ lb., in each case with all accessories. The audion valve is shown in several combinations, both for transmitting and receiving. A vacuum ampere gauge is shown in several sizes. No description was available, but it appears to be a bipolar thermal ammeter, in which the expansion of a pair of wires is taken up by a flat spiral spring connected to the pointer bar. The instruments are made with ranges suitable for the magnitudes of wireless currents, and should prove useful for other purposes in which the measurement of small currents is required.

Mr. Wm. Hamilton Wilson also shows some wireless apparatus. A spark generating set as used extensively for war purposes has some attractive features. The interrupter, driven by a small motor, is an insulating disc with a number of metallic segments let into it. Two brushes resting on the periphery are connected when on the metal, disconnected when on the insulator. The battery and coil primary are connected either in series or parallel with an oscillating circuit which can be tuned to the interruption frequency, so that the break on the interrupter takes place at the zero of the current waves, avoiding sparking; and, in addition, the oscillation characteristic leads to building up the condenser voltage until the secondary sparking commences. The sparking distance and energy may thus be several times as great as that which would be given by the battery voltage unaided. The oscillatory circuit stores the battery energy between the secondary sparks. As one result, a closed magnetic circuit transformer may take the place of the usual open circuit induction coil, which should result in some economy of material and weight. The absence of sparking at the interrupter is naturally conducive to long life. It is stated that the first disc made in 1913 has been in continuous use ever since, and is still serviceable. The favourite frequency is 650 per second, corresponding to a musical note to which the telephone and the ear are alike sensitive; but anything between 100 and 1,000 sparks per second can be arranged for, also any primary pressure between, say, 25 and 500 volts. The interrupter can also be used for X-ray tubes.

Another apparatus shown is an adjustable condenser combined with an inductance. The condenser is a glass tube silvered inside and out, the outer conductor being supplemented by a relatively substantial copper sheath. This sheathed tube is coiled up into a flat spiral; the inductance is given by the self-induction of this spiral. The capacity is adjusted by clamp terminals sliding on the sheath, so that any desired proportion of the condenser surfaces is included between them. Cable engineers will notice some analogy between this apparatus and the artificial cables used for duplexing, in which one condenser plate is made to reproduce the conductor resistance of the cable, and to have the same capacity resistance ratio in respect to the other plate as the cable conductor has to earth.

Another exhibit on the same stand, which has no apparent connection with wireless, will excite much curiosity and speculation. It consists of a number of thermopiles of various shapes and sizes made of wire which is apparently homogeneous, wound on to mica slips. If one edge of the strip, and of course the end bends of the wire turns, is heated, an E.M.F. is set up at the terminals of the continuous wire. In other words, the end bends take the place of junctions of different metals. How this can happen in a wire which is homogeneous in composition and structure is a puzzle on the ordinary principles of thermo-electricity. No explanation is offered by the exhibitor on the plea that a patent is involved, and that the patent is not yet due for publication. Meantime it can be said that, as the wire can be drawn down to 0·0002 in. thick, and a line of elements may be as little as 0·005 in. thickness, the pile lends itself well to spectrum thermo-analysis, and perhaps other uses where the measurement of radiation intensity over a small area can be utilised. No information was given as to the voltage per element for a given temperature difference, but the heat of the hand in contact with a small pile makes a big deflection on a micro-ammeter, so the voltage appears to be sufficient for measurement purposes.

The Edison Swan Company and some others showed audion valves of various sizes, from which the curious can ascertain the detailed construction.

Firth's Stainless Steel.

[Communicated.]

Stainless steel was first discovered in the Research Laboratories of Thos. Firth & Sons, Ltd., Sheffield. Its first outstanding feature of direct public interest is its remarkable property of resisting the corrosive action of atmosphere, water and many acids.

This steel is capable of attaining, by suitable heat-treatment, a wide variation of mechanical properties, from extreme hardness, downwards. Included in this range of mechanical properties are those suitable for table cutlery; hence an immediate demand was created for the steel for this purpose, in which form it is now well-known.

While the above mentioned properties of Firth's stainless steel are in themselves of great importance to the engineering industry, there are others which considerably increase its range of usefulness. Prominent among these is its ability to withstand the injurious effects of heat. Stainless steel will not scale appreciably under a temperature of 800°C., while its tensile strength is not materially reduced at half that temperature. This has been proved by the pulling of test pieces maintained, during the tests, at various temperatures. This property, combined with its marked resistance to erosion, led to the adoption of this steel in very large quantities, during the war, for the manufacture of valves for aero engines. We understand that tests of turbine blades have, for the same reasons, proved highly successful, and a large field is now open for the steel in this connection.

Of especial interest to the electrical world is the suitability of this steel for permanent magnets. Although its properties for this purpose are slightly inferior to those of the best tungsten permanent magnet steels, they are sufficiently high to warrant its adoption where the balancing factor is the ability of this steel to resist rust. Of many investigations on the magnetic properties of stainless steel at different heat-treatments, that which gave the best all-round result showed coercive force 63 and remanence 6,640.

A rapidly-growing industry, where stainless steel will undoubtedly prove of great value, is the manufacture of electric cooking stoves and utensils. Apart from the improvement in appearance and sanitary value, the advantages of permanently bright and clean surfaces in assisting the reflection of heat and consequent economy of current, are immediately apparent.

In general engineering, Firth's stainless steel is being largely adopted in places where bronze has been formerly used to resist corrosion. As a material for pump rods and valves, for instance, its superior strength and resistance to erosion and corrosion open in its favour a wide sphere of usefulness, while for marine purposes, its imperviousness to the action of sea air and water indicate many applications where it will be regarded in the near future as indispensable.

As an example of the wide range of uses to which this steel has been put, it may be mentioned that hypodermic needles have been successfully made therefrom. Stainless surgical instruments are also proving their advantages in retaining their pristine polish, freedom from stain and tarnish and hence the ease with which they may be kept clean and sanitary under the conditions which previously necessitated plating, with its attendant drawbacks.

Electrical Progress in Japan.

According to recent statistics, there are in Japan at present about 700 central generating stations, 530 power and electric light works, 42 electric tramways, 48 combined railway and lighting systems, 1,609 private electricity plants and 53 Government works. In 1915 over 3,050,000 families used electric light; and in 1918 there were 152,000 telephone subscribers. Though much progress has been made in the local production of apparatus and machinery, it was found necessary to import plant and apparatus valued at £800,000 per annum during the past few years. The general engineering industry has also made great progress during the war. A systematic survey of the water power available is being made at the instance of the Government, and credits have been voted for carrying out the work which will occupy two or three years to complete. There is a considerable amount of water power available and it is anticipated to effect substantial economies in coal and other fuel by its utilisation.

G.E.C. Measuring Instruments.

The G.E.C. "M" section catalogue of measuring instruments and testing sets, has just been thoroughly revised and brought up to date, as regards illustrations, descriptive matter and prices, the latter being subjected to an advance in accordance with a slip inserted over the title page. The section is arranged in a convenient manner, and has a well-ordered contents page, a numerical, or catalogue number index, and a portion devoted to dimension drawings and another to a general and technical description. Only those types have been included which experience has proved the most suited to the requirements of electrical engineers, central stations (with H.T., L.T. and C.C. systems) and general installation work. For general purposes very costly instruments of scientific accuracy are not considered absolutely necessary, but great care has been taken to produce commercially sound instruments, the construction and accuracy of which in every way comply with the British Engineering Standard specification.

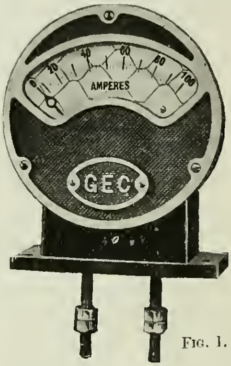


Fig. 1.

The first part of the catalogue is devoted to moving iron instruments, moving coil instruments, leakage detectors, power-factor meters, indicating wattmeters, synchroscopes, frequency indicators and recording voltmeters, ammeters, wattmeters and combined recording instruments. Then follow portable instruments of all kinds, including the G.P.O. detector (combined testing set), "Salford" combined testing set, cell-testing voltmeters, Sumpner combined voltmeter and wattmeter, photometers, transformers, shunts, meggers, lamp-testing instruments, miscellaneous testing equipments, and portable recording instruments. It will thus be appreciated that the new section catalogue is particularly comprehensive, and it is difficult to single out any instruments for special mention. We would, however, draw attention to the "Pedestal" pattern voltmeters and ammeters, shown in Fig. 1. These are specially designed for use under adverse conditions, and so that they are not damaged by any excessive current. They can be obtained with either gravity or spring control, and for use on C.C. or A.C. circuits.

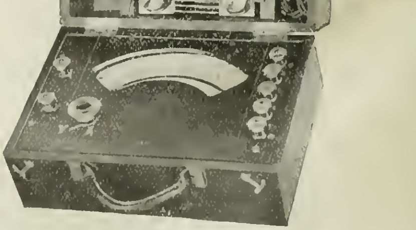


Fig. 2.

Fig. 2 shows the "Salford" testing set, which has been designed to meet the requirements of a highly accurate and reliable standard of minimum size, and weight, and of robust construction. The instrument's range of usefulness will be gathered from the fact that the current ranges of 0·0002 ampere to 600 amperes, and voltage ranges from 0·0005 volt to 600 volts can be obtained, together with resistance measurement.

Patents and Designs Bill.

A Bill to amend the Patents and Designs Act was introduced into the House of Commons and read a first time on the 15th inst. The following is an abstract of the principal clauses :—

1. For section 27 of the Patents and Designs Act, 1907 (hereinafter referred to as the principal Act), the following section shall be substituted.

"27.—(1) Any person interested may at any time apply to the Comptroller alleging in the case of any patent that there has been an abuse of the monopoly rights thereunder and asking for relief under this section.

(2) The monopoly rights under a patent shall be deemed to have been abused in any of the following circumstances :—

(*a*) If at any time after the expiration of four years from the date of the patent, the patented invention (being one capable of being worked in the United Kingdom), is not being worked within the United Kingdom on a commercial scale, and no satisfactory reason can be given.

Provided that if an application is presented to the Comptroller on this ground, and the Comptroller is of opinion that the time which has elapsed since the date of the patent has by reason of the nature of the invention or for any other cause been insufficient to enable the invention to be worked within the United Kingdom on a commercial scale, the Comptroller may adjourn the application for such period as will in his opinion be sufficient for that purpose.

(*b*) If the working of the invention within the United Kingdom on a commercial scale is being prevented or hindered by the importation from abroad of the patented article by the patentee or persons claiming under him, or by persons directly or indirectly purchasing from him, or by other persons against whom the patentee is not taking or has not taken any proceedings for infringement.

(*c*) If the demand for the patented article in the United Kingdom is not being met to an adequate extent and on reasonable terms.

(*d*) If, by reason of the refusal of the patentee to grant a licence or licences upon reasonable terms, the trade or industry of the United Kingdom or the trade of any person or class of persons trading in the United Kingdom, or the establishment of any new trade or industy in the United Kingdom, is prejudiced, and it is in the public interest that a licence or licences should be granted.

(*e*) If any trade or industry in the United Kingdom, or any person or class of persons engaged therein, is unfairly prejudiced by the conditions attached by the patentee, whether before or after the passing of this Act, to the purchase, hire, or use of the patented article, or to the using or working of the patented process.

Provided that for the purpose of determining whether there has been any abuse of the monopoly rights under a patent, it shall be taken that patents for new inventions are granted not only to encourage invention, but to secure that new inventions shall so far as possible be worked on a commercial scale in the United Kingdom without undue delay.

(3) On being satisfied that a case of abuse of the monopoly rights under a patent has been established, the Comptroller may exercise any of the following powers as he may deem expedient in the circumstances :

(*a*) He may order the patent to be indorsed with the words "licences of right," and thereupon the same rules shall apply as are provided in this Act in respect of patents so indorsed, and an exercise by the Comptroller of this power shall entitle every existing licensee to apply to the Comptroller for an order entitling him to surrender his licence in exchange to be settled by the Comptroller. ...

(*b*) He may order the grant to the applicant of a licence on such terms as the comptroller may think expedient, including a term precluding the licensee from importing into the United Kingdom any goods the importation of which, if made by persons other than the patentee or persons claiming under him, would be an infringement of the patent. A licensee under this paragraph shall be entitled to call upon the patentee to take proceedings to prevent infringement of the patent, and if the patentee refuses, or neglects to do so within two months after being so called upon, the licensee may institute proceedings for infringement in his own name.

(*c*) If the Comptroller is satisfied that the invention is not being worked on a commercial scale within the United Kingdom, and is such that it cannot be so worked without the expenditure of capital for the raising of which it will be necessary to rely on the patent monopoly, he may, unless the patentee or those claiming under him will undertake to find such capital, order the grant to the applicant, or any other person, or to the applicant and any other person or persons jointly, if able and willing to provide such capital, of an exclusive licence on such terms as the Comptroller may think just.

(*d*) If the Comptroller is satisfied that the objects of this section cannot be attained by the exercise of any of the foregoing powers, he may order the patent to be revoked.

(*e*) If the Comptroller is of opinion that the objects of this section will be best attained by making no order, he may refuse the application.

(4) In settling the terms of any such exclusive licence due regard shall be had to the risks undertaken by the licensee in providing the capital and working the invention, but subject thereto the licence shall be so framed as :

(*a*) to secure to the patentee the maximum royalty compatible with the licensee working the invention within the United Kingdom on a commercial scale and at a reasonable profit ;

(*b*) to guarantee to the patentee a minimum yearly sum by way of royalty, if and so far as it is reasonable so to do ;

and in addition to any other powers expressed in the licence or order the licence and the order granting the licence shall be made revocable at the discretion of the Comptroller if the licensee fails to expend the amount specified in the licence as being the amount which he is able and willing to provide for the purpose of working the invention on a commercial scale within the United Kingdom, or if he fails so to work the invention within the time specified in the order.

(5) In deciding to whom such an exclusive licence is to be granted the Comptroller shall, unless good reason is shown to the contrary, prefer an existing licensee to a person having no registered interest in the patent.

(6) The order granting an exclusive licence under this section shall operate to take away from the patentee any right which he may have as patentee to work or use the invention and to revoke all existing licences.

(11) All orders of the Comptroller under this section shall be subject to appeal to the Court.

(12) In any case where the Comptroller does not dismiss an application as hereinbefore provided, and (*a*) if the parties interested consent, or (*b*) if the proceedings require any prolonged examination of documents or any scientific or local investigation which cannot in the opinion of the Comptroller conveniently be made before him :
the Comptroller may at any time order the whole proceedings or any question or issue of fact arising thereunder to be tried before an arbitrator.

2. For section 24 of the principal Act the following section shall be substituted :—

"24.—(1) At any time after the sealing of a patent the Comptroller shall, if the patentee so requests, cause the patent to be indorsed with the words "licences of right," and a corresponding entry to be made in the register, and thereupon—

(*a*) Any person shall at any time thereafter be entitled as of right to a licence under the patent upon such terms as, in default of agreement, may be settled by the Comptroller on the application of either the patentee or the applicant.

Provided that any licence the terms of which are settled by agreement shall be deemed, unless otherwise expressly provided, to include the terms and conditions specified in paragraphs (*c*) and (*d*) of this subsection as if they had been imposed by the Comptroller thereunder

(*b*) In settling the terms of any such licence the Comptroller shall be guided by the following considerations : (i.) he shall, on the other hand, endeavour to secure the widest possible user of the invention in the United Kingdom consistent with the patentee deriving a reasonable advantage from his patent rights , (ii.) he shall, on the one hand, endeavour to secure to the patentee the maximum advantage consistent with the invention being worked by the licensee at a reasonable profit in the United Kingdom : (iii.) he shall also endeavour to secure equality of advantage among the several licensees.

(*c*) Any such licence the terms of which are settled by the Comptroller may be so framed as to preclude the licensee from importing into the United Kingdom any goods the importation of which, if made by persons other than the patentee or those claiming under him, would be an infringement of the patent.

(*d*) Every such licensee shall be entitled to call upon a patentee to take proceedings to prevent the infringement of the patent, and if the patentee refuses, or neglects to do so within two months after being so called upon, the licensee may institute proceedings in his own name.

(*e*) If in any action for infringement of a patent so indorsed the infringing defendant is ready and willing to take a licence upon terms to be settled by the Comptroller no injunction against him shall be awarded, and the amount recoverable against him by way of damages (if any) shall not exceed double the amount which would have been recoverable against him as licensee if the licence had been dated prior to the earliest infringement.

Provided that this paragraph shall not apply where the infringement consists of the importation of infringing goods.

(*f*) The renewal fees payable by the patentee of a patent so indorsed shall as from the date of the indorsement be one moiety only of the fees which would otherwise have been payable.

(3) Any person alleging that a request under this section has been made contrary to some contract in which he is interested may apply to the Comptroller within the prescribed time, and the Comptroller, if satisfied of the truth of such allegation, shall refuse to indorse the patent pursuant to the request or shall cause the indorsement, if already made, to be cancelled.

3. After section 27 of the principal Act the following section shall be inserted :—

"27A. Any order for the grant of a licence under this Act shall, without prejudice to any other method of enforcement, operate as if it were embodied in a deed granting a licence executed by the patentee and all other necessary parties."

4. For paragraph (*b*) of sub-section (1) section 11 of the principal Act, which relates to the opposition to grants of patents, the following paragraphs shall be substituted :—

"(*b*) That the invention has been published in any complete specification or in any provisional specification followed by a complete specification deposited pursuant to any application made in the United Kingdom within 50 years next before the date of the application for the patent the grant of which is being opposed, or in any document (other than a British specification) published in the United Kingdom prior to the application ; or

"(*bb*) that the invention has been claimed in any complete specification for a British patent which though not published at the date of the application for a patent the grant of which is opposed will be of prior date to such patent ; or "
and after paragraph (*d*) of the same sub-section the following paragraph shall be inserted :—

"(*e*) That in the case of an application under section 91 of this Act a specification describes or claims an invention other than that for which protection has been applied for in a foreign State or British possession and that such other invention forms the subject of an application made by the opponent in the interval between the leaving of the application in the foreign State or British possession and the leaving of the application in the United Kingdom."

5. Amends section 12 of principal Act as to grant and sealing of patents.

6.—(1) The term limiting the duration of patents shall be increased from 14 to 16 years.

(2) Any patent the original term of which had not expired at the date of the commencement of this Act shall have effect as if the term mentioned therein was 16 years instead of 14 years, subject to the following conditions :—

(*a*) Any licence existing at that date which has been granted for the term of patent shall be treated as having been granted for the term as so extended if the licensee so desires ;

(*b*) If the patent would apart from this section have expired on or before the first day of January, 1920, the patent shall during the period of extension be subject to all the provisions by this Act substituted for section 24 of the principal Act (except sub-section (5) thereof) as if the patent had been endorsed "licences as of right."

7.—(1) At the end of sub-section (1) of section 18 of the principal Act which relates to the extension of the term of a patent, the following proviso shall be inserted :—

"Provided that the court may in its discretion extend such period within which such a petition may be presented."

(2) At the end of sub-section (4) of the same section there shall be inserted the words "including in particular any loss or damage which may have been occasioned to the patentee, as such, by reason of hostilities between His Majesty and any foreign State, except in cases where the patentee is the subject of any such foreign State."

(3) In sub-section (5) of the same section, for the words "for a further term not exceeding seven years, or, in exceptional cases, 14 years," there shall be substituted the words "for a further term not exceeding five years, or, in exceptional cases, 10 years."

8. At the end of section 29 of the principal Act the following words shall be inserted :—

"And the terms of any agreement or licence concluded between the inventor or patentee and any person other than a Government Department, shall be inoperative so far as concerns the making use or exercise of the invention for the service of the Crown.

"Provided further, that where an invention which is the subject of any patent has, before the date of the patent, been duly recorded in a document by, or tried by on behalf of, any Government Department, such invention not having been communicated directly or indirectly by the applicant for the patent or the patentee, any Government Department, or such of their agents, contractors, or others, as may be authorised in writing by them, may make, use and exercise the invention so recorded or tried, for the service of the Crown, free of any royalty or other payment to the patentee, notwithstanding the existence of the patent. If in the opinion of the Department the disclosure to the applicant or the patentee, as the case may be, of the document recording the invention, or the evidence of the trial thereof, if required, would be detrimental to the public interest, it may be made confidentially to Counsel on behalf of the applicant or patentee, or to any independent expert mutually agreed upon."

9. After section 32 of the principal Act the following section shall be inserted :—

"32a. If the Court in any action for infringement of a patent finds that any one or more of the claims in the specification, in respect to its discretion as to costs and to such terms as to amendments as it may deem desirable, grant relief in respect of any of such claims which are infringed without regard to the invalidity of any other claim in the specification."

10. In section 34 of the principal Act, which relates to actions for infringement of a patent, after the words, "infringement of a patent" there shall be inserted the words "the plaintiff shall be entitled to relief by way of injunction and damages but not to an account of profits, but subject as aforesaid."

11.—(1) After section 38 of the principal Act the following section shall be inserted :—

"38a.—(1) In the case of inventions relating to substances prepared or produced by chemical processes or intended for food or medicine, the specification shall not include claims for the substance itself, except when prepared or produced by the special methods or processes of manufacture described and claimed or by their obvious chemical equivalents. Provided that in an action for infringement of a patent where the invention relates to the production of a new substance, any substance of the same chemical composition and constitution shall in the absence of proof to the contrary be deemed to have been produced by the patented process."

13. (1) At the end of sub-section (2) of section 41 of the principal Act (as to anticipation), the following proviso shall be added :—

"Provided that the protection afforded by this sub-section shall not extend to a patentee who has commercially worked his invention in the United Kingdom for more than six months prior to such publication as aforesaid."

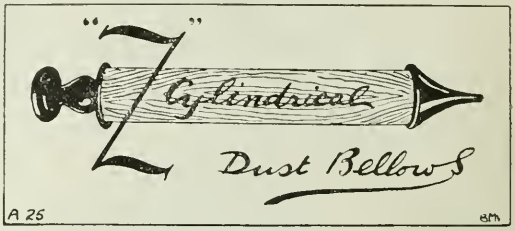
(2) This section shall not apply in the case of patents granted before the passing of this Act.

The Bill also deals with the registration of designs, of assignments and for the registration of patent agents, &c. There are also several minor amendments of the principal Act.

An Electrical Dust Bellows.

We have received from the "Z" Electric Lamp Mfg. Company, Ltd., an account of their electrical dust bellows, which is illustrated below.

This type of article has been very difficult to obtain during the war, but it is hoped that regular supplies will now be available. The device is specially useful for blowing dust out of motors and dynamos and other inaccessible parts of electrical apparatus. Being made entirely of wood, there is no possible chance of shorts occurring.



The "Railodok" Electrically Operated Freight Truck.

The "Railodok" truck, of which we have received particulars from Industrial Appliances, Ltd., is stated to be an essentially British production, with several special features in design and construction. The truck is supplied for loads of 2 tons, 1 ton and 5 cwt. Among other features may be mentioned : Two motor drive and solid drive from motor to wheel through worms and worm-gear, no differential gear, automatic braking from driver's seat, and brakes interlocked by electrical controllers, interchangeability of traction parts, detachable rims on wheels (which can be removed complete in one minute), four-wheel steering, specially designed loading platform and tractor attachments enabling trailers to be easily attached, &c. It is claimed that any intelligent labourer or porter can become proficient in the simple movements of these trucks involved in control and steering within an hour, and in many classes of work there are considerable opportunities for their use, it being claimed that one truck is equivalent to three or four men as regards labour saving.

Electricity (Supply) Bill.

On Tuesday, Standing Committee "B" resumed consideration of this Bill.

An amendment by Mr. Shortt providing that the Electricity Commissioners might, through a joint electricity authority or other competent body, conduct experiments for the improvements of methods of electric supply, as well as through a district electricity board, was agreed to.

Mr. W. Graham moved an amendment providing that the Electricity Commissioners might appoint more than one Advisory Committee. Mr. Shortt accepted the principle of the amendment and it was adopted

Mr. Shortt also accepted an amendment by Mr. Neville Chamberlain providing that an inquiry should always be held when any objection was taken to the proposed delimitation of an electricity area.

Considerable discussion arose on an amendment, proposed by Mr. Neville Chamberlain, to a practically new clause, moved by the Home Secretary, in substitution for clause 5 (constitution of District Electricity Boards) and ultimately the amendment was carried by 15 votes to 10. The new clause provided that the Electricity Commissioners should have the power to constitute separate electricity districts ; that authorised undertakers, local authorities, large consumers of electricity and other persons interested might submit schemes for the improvement of electricity supply ; that if the scheme submitted was not approved, or if no scheme was submitted, the Commissioners might propose a scheme for the constitution of the Joint Electricity Board for the district ; and that the scheme might provide for the establishment of a joint electricity authority representative of authorised undertakers within the district, either with or without representatives of local authorities and other persons interested. Mr. Chamberlain's amendment provides that "if objection is made to inclusion or exclusion from the proposed district of any area, a local inquiry shall be held."

In Pike County, Mississippi, many farmhouses and buildings are lighted electrically, and electrical energy is used for various agricultural purposes. It is reported that several farmers from adjoining districts have recently purchased farms and moved into the Pike County because of the advantages of the electric service. A contract has been made with the city of West Point for electricity on a 20-mile circuit running east and north, and there will then be an entire farming section electrically lighted and entirely linked with macadam roads.

Legal Intelligence.

The Marconi Arbitration.

Mr. Justice Lawrence concluded the taking of evidence in this case on Monday.

In cross-examination, Mr. Brown said that the object of the Government in erecting the stations was primarily strategic, and any commercial traffic that could have been received in diminution of the expenditure would have been welcome. If the stations had been erected when the war broke out they would have been extremely useful for strategic purposes, but as they were not then erected, and as it would have taken many months before they could be completed, it was considered that it would not be in the national interest to expedite the construction of the Imperial wireless stations. In a rough estimate of the cost and revenue of the six stations, prepared by an official of the Post Office in 1911, the working expenses were put down at £48,000, and the staff at 40 men per station. The company's estimate of 180 men on a three-way station was perfectly absurd. He was amazed at the company's estimate that the running of the English station would cost £98,352 a year—£12,988 for the transmitting and £85,364 for the receiving station. He always thought that wireless telegraphy could compete with cable, but he was absolutely convinced on those figures it could not. If the running expenses of the six wireless stations were £531,968 a year, wireless telegraphy could certainly not have competed with the cables, and they could not have afforded to reduce the rate below the cable rate. The Post Office official who prepared the rough estimate of the cost and revenue showed a profit of £178,450. Witness said that he was a member of the Imperial Communications Committee, but he had not appreciated that the offer of 1910 was now before the Government. He had not said that the stations would not eventually pay—say in 20 years.

In re-examination, Mr. Brown said that he did not think that Lord Parker's Committee "turned down" the Poulsen system. Since the date of that report a great advance had been made with that system. It was now being used at stations in France and in the United States. He understood they could work commercially.

Mr. Cyril E. Elwell said he had had 10 years' experience with the Poulsen arc system, and he considered it the best in existence. He formed the opinion in 1912 that the Poulsen arc was the best system.

Mr. E. H. Shaughnessy, staff engineer in the Post Office engineering department, said he thought the Poulsen arc was at present the best known system for wireless transmission. The development of the Poulsen arc had been very rapid, and large power arcs had been constructed in various parts of the world. The arc system was as good as any spark system. The alternative receiving system was perfectly free from any patent in existence at the end of 1918, and was as efficient as any other.

In cross-examination he admitted that the scheme for the alternative wireless system was worked out for the present inquiry. The Poulsen arc had been greatly improved since the report of the Parker Committee. They had tried to frame a scheme for working the masts which had been put up in this country and in Egypt, but it had not progressed to the trial stage. The alternative system would be as good as the Marconi, but he would not go beyond that.

Mr. H. A. Madge, civilian technical wireless telegraphy expert at the Admiralty, said he had been personally responsible for some hundreds of Poulsen stations. The Poulsn arc system, if properly designed, was more efficient than any spark system that he knew of.

Mr. Terrell here produced a large sealed packet containing a secret patent, by the use of which the Admiralty had for nine years dealt with "interference." The Admiralty's permission to open it had been obtained. The Admiralty would allow the document to be disclosed to an independent patent expert representing the "other side."

Captain C. R. Payne, R.N., said that in September, 1912, he saw experiments with the Poulsen system at the Federal Company's station near San Francisco. They communicated with Honolulu, a distance of 2,000 miles. Afterwards he went to Los Angeles, where he saw experiments in duplex working, messages being received from San Francisco, a distance of 600 miles, on two separate receivers. The results were very good. In 1914 he was in command of H.M.S. "Vindictive," and in November of that year he communicated with the Poulsen system from Madeira to Horsea, a distance of 1,800 miles. The signals were quite clear. On a passage to Ascension the signals were quite clear up to 2,500 miles. In 1918, when he was in command of H.M.S. "Suffolk," at Vladivosteck, Press messages of 300 words were sent from Honolulu, a distance of 4,000 miles. No difficulty was experienced in receiving the messages by the Poulsen system. In June, 1914, he reported to the Admiralty on the results of trials between the spark and arc sets which were fitted in H.M.S. "Vernon" at Portsmouth. The signals on the arc were strong during the day, whereas those on the spark were unreadable.

Commander J. Somerville, R.N., said that direct communication was arranged by the Poulsen arc system between H.M.S. "Europa," at Mudros, and the Admiralty station at Horsea—1,600 miles. Satisfactory communication was maintained from June 12, 1915, to December, 1916. From December, 1915, a daily Press message was sent from Horsea to the "Europa."

Mr. F. R. Yelland, officer in charge of the Leafield wireless station, said that he kept observation on the working of the wireless communications between the Marconi stations at Poldhu and Carnarvon and Madrid from May 28 onwards. Many messages had to be repeated owing to atmospheric disturbances and interference from other stations. He made reports in which he described the service as poor, slow and unsatisfactory.

Mr. James Swinburne, F.R.S., one of the consulting engineers who sat on the Parker Committee, said the Committee did not "turn down" thePoulsen arc. The position was that the Poulsen arc shown to them at Copenhagen was not large enough to do the service for which it was wanted. The Government was anxious to make a start with the wireless chain at once, and the Committee felt that they should recommend something that was absolutely at work. That was the Marconi apparatus as used at that date. They pointed out in their report that there were several other high-frequency transmitters coming along, particularly the Poulsen and the Goldschmidt, and that either of them might be developed, and that the Government should be free to use them later if they developed. The alternative system of the Crown would accomplish the purpose for which it was designed, and there was nothing in the specification produced that would involve a Marconi patent.

Sir William Peat said that a 10 years life was all that a purchaser would give for the royalties if things had been in working order.

The evidence for the Crown was concluded, and M. Emile Girardeau, radio-engineer to the French Government, gave evidence for the company to the effect that the Poulsen arc system had not been a success at stations in France where it had been installed. By changing or improving some of the apparatus originally installed, better results had been obtained. Very little was left of the original design. Neither the French Navy nor the French War Office had been satisfied with the Poulsen arc system. For commercial work the high-frequency alternator machines were better. The Marconi system was the only one which had given good and trustworthy results for commercial use.

Mr. Godfrey Isaacs said that the company had no special stations to carry on the Spanish service. All preparations were being made for the erection of such stations. The company had had considerable difficulty with the staff in Spain, and, in consequence, they had not made any attempt to encourage the service.

The Attorney-General addressed his Lordship on behalf of the Crown, and said the matter must be decided on the facts disclosed. He contended that the estimate of the Crown would be preferable to the estimate, or either of the estimates, put forward by the Marconi Company. The Marconi Company assumed that wireless telegraphy would attract 33⅓ per cent. of the cable traffic immediately the wireless chain of stations was established. That was an unfounded assumption and it rested on the most sanguine personal view of Mr. Godfrey Isaacs, based on a very shadowy foundation. Again, it was manifestly unfair to depend on the war years as the data years for the calculation of the claim. Nor was there any foundation for the assumption that the traffic would show a cumulative increase of 10 per cent. per annum. Dealing with the value of the Marconi patents, the Attorney-General said that it was idle to suggest in these days that wireless telegraphy and the Marconi Company were synonymous. The basic principles of wireless telegraphy were public property, and it was the view of the Post Office and of the Admiralty that after 10 years' experience they could have done as well as the Marconi Company.

Sir Edward Carson said that the Government had deliberately broken the contract for their own reasons. The Post Office seemed to have been doing their best to ruin the Marconi Company, but the result of the inquiry showed that the company was in a stronger position with regard to other wireless systems than it was when the contract was made. There was indisputable evidence of the enormous expansion of the Company's operations.

On the conclusion of Sir Edward's address, his Lordship said he would take time to consider his award.

Crown's Unsuccessful Claim Against Electrical Company.

In the King's Bench Division on the 21st inst. the Attorney-General on behalf of the Crown asked for a declaration that the issue by the South Wales Electrical Distribution Company of half-yearly deferred warrants to the holders of their 5 per cent. debenture stock were liable for duty under sec. 8 of the Finance Act, 1899.

The Attorney-General (Sir Gordon Hewart, K.C.), with whom were Mr. T. H. Parr and Mr. R. P. Hills, said that the company, instead of paying the half-yearly interest on their £200,000 of 5 per cent. Debenture Stock in cash, had for a period of about 10 years issued every half-year what were called deferred warrants for the amount of the interest, less income tax, the warrants themselves carrying 5 per cent. interest. The question was whether these issues were issues of loan capital within the meaning of the section, which said that loan capital meant debenture stock "or funded debt by whatever name known, or any capital raised by any company formed or established in the United Kingdom, which is borrowable or as the character of borrowed money." The company were incorporated by private Act in 1900 and by their 1906 Act took power to create Prior Lien Debenture Stock and in the event of doing so to satisfy the interest upon the £200,000 Debenture Stock for a period of years by the issue of half-yearly deferred warrants payable out of the first available funds of the company, subject to prior charges. The Prior Lien Stock was in fact issued, and from Jan. 1, 1906, to Jan. 1, 1916, no interest was paid in cash upon the 5 per cent. Debenture Stock, the deferred warrants being issued instead. Each warrant was stamped with a penny stamp and no stamp duty, except that had been paid upon them. The amount in question was considerable, about £95,000.

Mr. Holman Gregory said that for some years down to 1917 the question had caused the company a good deal of trouble, as they were being pressed to pay duty upon the warrants as marketable securities under sec. 4 of the Act. They struggled against that, and then in 1918 it was suggested that they came under sec. 8. It was rather interesting to notice that as marketable securities the warrants would have been excepted under sec. 8. The company were a statutory company with limited issuing and borrowing powers. They were the pioneer electrical company in South Wales, and, as often happened with pioneers, they did not succeed, and were unable to proceed with their works. In 1906 they borrowed £200,000 on mortgage and wanted to borrow £500,000 on mortgage, but could not unless the holders of the former agreed that the £500,000 should be a prior charge both as to capital and interest. The holders of the £200,000 Debenture Stock agreed not to ask for their interest in cash for 3 years, a period which was subsequently extended. Counsel submitted that this did not increase the company's capital, was not a loan, and created no new liability.

His Lordship, giving judgment, said it seemed to him that what had happened was merely to give an acknowledgment of interest unpaid, leaving the remedy for it exactly where it was, but adding the obligation to pay the interest. That, in his opinion, did not mean that it became funded debt, but that the stock-holder was given a warrant to show what his rights were. On the whole he came to the conclusion that judgment must be for defendants with costs.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following obstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1917 Specifications.

118,613 Smits. Electric heating element. (20 8 17.)
120,030 Bockman. Electric induction furnaces. (12 10 17.)
120,197 Automatic Telephone Mfg. Co. Automatic telephone systems. (13, 10, 17.)
128,231 Mazza. System of telephony. (27 2 17.)
128,234 Grylls & Heape. Electric arc lamps. (4 4 17.)
128,236 Barr & Stroud. Mechanical and electric relays. (10 5 17.)
128,241 Villeplee. (A.L.O. Fauchon.) Electric gun or apparatus for propelling projectiles. (5 8 16.)
128,254 Latour. Electromagnetic vibratory or oscillatory apparatus. (3,7 17.)
128,306 Midgley & Vandervell & Co. Starting magnetos for internal-combustion engines. (28 7 17.)
128,316 Antonoff. Electric batteries. (1 8 17.) (Cognate application 3,660/18.)
128,330 Lo-Thermo Patents, Ltd., Longbottom & Greenhalgh. Dynamo-electric machinery. (5 3 18.)
128,332 Jackson, Mellersh. (Burgess Battery Co.) Dry electric batteries and the method of making the same. (19 3/18.)
128,338 Woodhouse. Automatic delayed action electric switches. (4 5, 18.)
128,342 Heap. Electric relays or switching devices. (14 5 18.)
128,344 Oldham & Oldham. Miners' safety and other electric lamps. (15 5, 18.)
128,359 Tucker. Electric awitches. (12 6 18.)
128,383 Lea. Continuous electromagnetic wave syntonisers. (18 6 18.)

Relates to a device for measuring the lengths of electromagnetic waves and comprises a thermionic valve, the filament heating battery of which has its positive end connected through a resistance to the cathode of the valve and through the inductance of a tunable circuit to the anode, the grid of the valve being reactively coupled with the said inductance.

128,386 Peto. Electric storage batteries or accumulators. (18 6, 18.)
128,394 Morton. Process of and apparatus for electric welding. (19 6 18.)
128,410 Patterson. Electrical heating and cooking apparatus. (25 6 18.)
128,420 Mossay & Mossay & Co. Electrically-Opelled vehicles. (2 7 18.)
128,431 Boothroyd & Callender's Cable & Construction Co. Fixing and supporting devices for tubes, electric wires, and the like. (12 7 18.)
128,434 B.T.-H. Co. (G.E Co.) Electric locomotives or cars. (15 7 18.)
128,436 Marks. (Stuart, A. T.) Electrolytic cells. (17 7 18.)
128,443 Jackson, Mellersh. (Waterhouse & Prince.) Apparatus for electrically controlling air-brakes. (24 7 18.)
128,458 Fuller Accumulator Co. & Welch. Vents for electric accumulators. (17 8 18)
128,459 Breeze & West & Co. Vibrating decelerating relays for controlling electric motors. (20 8 18.)
128,463 Hyde. Means to be employed in the electric welding of iron or steel, or alloys thereof. (27 8 18.)
128,471 Price. Instruments for testing batteries, accumulators, motor dynamos, or other electrical apparatus. (12 9/18.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions*

May 30.

13,697 Harmer. Permutation switchlock for connecting or disconnecting electric currents.
13,738 Automatic Telephone Mfg., Co. Automatic or semi-automatic telephone systems.
13,739 Automatic Telephone Mfg., Co. Telephone and telegraph systems.
13,751 Quain. Electric radiators.
13,773 Relay Automatic Telephone Co., Bryant & Johnson & Ward. Telephone systems.

May 31, 1919.

13,795 Chantler. Insulators for overhead telegraph, telephone, &c., wires.
13,812 Norton. Electrical generators.
13,855 Wheeler. Incandescent lamp holders.
13,857 Sterling Telephone & Electric Co., & Cohen. Electro-magnetic timing or time-lag device.

June 2, 1919.

13,884 Ricardo. Generating sets.
13,909 Rochford. Electrical illumination for theatres, &c.
13,954 Sterling Telephone, &c., Co. Automatic telephone systems.
13,965 Samssonow. Transforming alternating current into continuous current.
13,968 Childs. Electric signal devices.
13,997 Fairless. Electric lamp fittings.
13,998 Bowman. Cable splices.

June 4, 1919.

14,029 Suchostawer. Electric turbine.
14,033 British Insulated & Helsby Cables & Lewis. Impregnation of cables, fibrous material, &c.
14,062 Meunier. Electric ironing, cooking, &c., apparatus. (4 6, 18, France.)
14,068 Turner. Electric relays, &c.
14,071 Bulpitt & Denholm. Brush holders for electric machines.
14,037 Scott-Taggart. Vacuum-tube detector, &c., of wireless waves.
14,110 Rutherford. Switches
14,163 Rippingille. Fittings for metallic conduits.
14,167 Ironclad Switchgear Co. & Morgan. Fuse holders.
14,163 Ironclad Switchgear Co. & Morgan. Switches.
14,191 Murray. Telephone receivers.
14,192 Barfield & Wild. Electric furnaces.

Commercial Topics.

The Australian Trade.

It is announced that the order recently made in Australia, laying down the conditions under which rubber-covered wire may be imported into the Commonwealth, will not come into operation until the 1st Jan., 1920.

A subscriber informs us that he has received a communication from one of his Australian friends asking for prices and particulars of all the parts necessary to build up watt-hour meters. It is stated that, owing to the rapid development of the electrical trades in Australia and the desire to introduce new manufactures, it will no longer be possible to export complete meters to advantage, but the parts may be exported and assembled in Australia.

Another aspect of the Australian trade connection is set out in a recent letter from New Zealand, which stated that, in spite of a preference for British goods of 12½ per cent. in the duty, American hardware had been selling there cheaper than British descriptions, and that the United States have dropped some metal manufactures as much as 33⅓ per cent. The correspondent thinks that "in view of the competition by the United States and Japan, Great Britain, in order to regain her lost trade, must make a wholesale reduction in prices."

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Trade with Czecho-Slovakia.

H.M. Representative at Prague desires to obtain catalogues of British export firms who are anxious to open up trade with Czecho-Slovakia. The catalogues should be printed, if possible, in the Czech language, or in French or German. Firms should forward the catalogues to H.M. Chargé d'Affaires, British Legation, Prague.

British firms who desire to establish an export trade with the Republic of Czecho-Slovakia are advised by H.M. Minister at Prague to send out at an early date fully qualified representatives. Englishmen knowing the Czech language are hardly likely to be available, but the representatives should at least have a knowledge of German. It is the exception to find business people in Czecho-Slovakia who can speak French, though a few of them know English. About one-third of the population is German speaking. Some important requirements will be copper, nickel, tin, zinc, rubber, machine tools, textile machinery, hardware, telephone and telegraph instruments, electric motors and dynamos, chemicals, &c.

* * * *

Electrical Supplies for Peru.

British electrical goods have hitherto proved very popular in Peru. So far only American, British and German manufacturers have been available in the country, but now the market should become wider as motive-power becomes more available, and as British manufacturers and exporters will have less competition, there should be greater opportunities for development. Where water-power is not available, internal-combustion engines are used. Wood, coal and petrol are all more expensive in Peru than oil. In some instances oil is burned underneath steam boilers. There should now be a market for electric motors and generators, accessories, batteries, carbons, fans, ventilators, insulators, lamps, meters, telegraph and telephone apparatus, wire and cable, electric light fixtures, bells, &c. In 1913 Germany increased the value of its electrical trade from £12,655 to £14,423, and the United States from £9,538 to £25,226, the trade of the United Kingdom only advanced from £699 to £1,847.

* * * *

The Chinese Market.

A luncheon was recently given by Sir Algernon Firth, a Member of the Federation of British Industries, to His Excellency Liang Chi-Chao and the Members of his Mission, and in reply to the toast of his health His Excellency enlarged upon the great possibilities that await British industrial enterprise in China in co-operation with the Chinese themselves. The enormous resources of China in raw material offered an illimitable field for development, but he considered that with the vast changes in trade and transport conditions throughout the world brought about by the war, the obvious solutions lay in working up these raw materials as far as possible in China itself. The desirability of such an economic policy has been quickly recognised by the Japanese, who at a time when Great Britain had her hands tied in Europe neglected no opportunity to establish industrial enterprises through the Republic. The Chinese had awakened to a realisation that foreign assistance was necessary to her social and economic well-being. They would be inclined particularly to welcome British co-operation during the period of their country's regeneration, for the name of Great Britain stood for efficiency and integrity, and in no circumstances implied a sinister political programme. Therefore he hoped British enterprise would bestir itself and take a hand in the industrial development of China. It was, however, of the greatest importance to act without delay.

Some corroboration of the above statements may be obtained from a recent report on the trade of the Port of Foochow, which states that the question whether British trade will be able to recover the position which it has lost during the past five years will depend to a great extent on industrial conditions in the United Kingdom. Japan has naturally taken full advantage of the opportunity offered her by the war to extend her trade in every possible direction, and her merchants have not only been able to replace enemy goods with Japanese wares, but have also cut very largely into our own trade. The Japanese import trade has an advantage in being handled and energetically pushed by Japanese merchants. Local British firms are not prepared to grant the long credits required by the native retailer, and recently a large order for British machinery was given by a local Chinese company to a Japanese firm because the latter agreed to payment in instalments over three years.

Electricity Supply.

Leeds electricity department has granted an additional 5s. a week on war wages to unskilled men employed in cable laying.

There was a profit of £895 on the working of the Walsall electricity department for the year ended March last. The accounts were approved by the Council last week.

An inquiry has been held into the application of Walthamstow Urban Council for sanction to borrow £32,975 for a 3,000-3,500 kw. turbo-alternator, condensing plant, pipework, &c., for the electricity works.

The shareholders of the Skibbereen Gas Company have passed a resolution empowering the directors to extend their company's operations so as to include the supply of electricity.

Coxhoe Parish Council has instructed Mr. Widdas, engineer of the Trimdon Grange and Kelloe Collieries, to prepare an electric lighting scheme for Coxhoe, Kelloe and Cassop parishes.

Wolverhampton Corporation has made an agreement with the Midland Electric Corporation for Power Distribution to take over the whole of the electric supply in the Heath Town district.

Owing to the increased price of coal and other increased costs Radcliffe Council has advanced the price of electricity by 75 per cent. over 1914 rates for private lighting, 85 per cent. for power and 50 per cent. tramways.

For the past year there was a deficit on the Heywood electricity department of £291, compared with £742 in 1917-18. The income increased by £1,571, but there have been greatly increased costs of production. On the tramways department the profit was £944

The past year's revenue of the Stalybridge, Hyde, Mossley and Dukinfield Joint Board was £9,000 more than in 1918. The electricity receipts showed an increase of £16,000, and the profit was £3,000 more than in the previous year.

Birmingham Electric Supply Committee recommends, in view of the 6s. a ton advance in the price of coal, to increase the charges for electric current by ½d. per unit for lighting, and ⅓d. for low-tension power consumers. In contracts with large consumers there is a coal clause.

Rochdale Corporation has been authorised to borrow £35,000 for mains extensions and £27,000 for transformers, &c. The Electricity Committee has finally approved the agreement between the Corporation and the D. R. Mills for a bulk supply of electricity. Last year 14½ million units were sold by the department, against 5½ million in 1913-14.

Duncan's Electricity Supply Company has notified the municipal authorities of several towns in the North-east of Scotland, including Buckie, Fraserburgh, Peterhead and Elgin, that it proposes to apply for powers to supply electricity throughout the area for light and power purposes.

At the meeting of the London County Council on Tuesday permission was accorded the Stepney Borough Council to borrow £21,212 on the instalment system in connection with its electric light undertaking—£3,712 for the acquisition of property, £10,000 for house services and £7,500 for meters.

The Board of Trade has extended for six months from July 8, 1919, the periods of two years and 18 months respectively limited by the Thornton Electric Lighting Order, 1914, and also the Hull Electric Lighting Extension Order, 1914, for laying mains in streets specified in the Orders and in the remainder of the area of supply.

The Court of Common Council has agreed to allow the City of London Electric Lighting Company to make a 50 per cent. increase on the pre-war contract prices of electric current, as from January 1 last, until twelve months after the declaration of Peace. Hitherto 35 per cent. increase has been charged.

An inquiry has been held at Londonderry into the application of the Corporation for authority to raise a supplemental loan of £6,700 for electric supply extensions. There is a greatly increased demand for light and power. It is proposed to instal coal-handling plant and mechanical stokers.

Since the removal of the embargo upon the wiring of private premises and the connection of new consumers, Glasgow Corporation Electricity Department has been inundated with applications for lighting facilities, and difficulty has been experienced in coping with them owing to the shortage of skilled labour and the necessary materials.

It is proposed to apply for a provisional order for supplying electricity in the district of Ware, and more particularly in the parishes of Broxbourne, St. Margarets and Stanstead Abbotts. It is proposed to form a local company for the purpose, and Messrs. Curwen and Carter are acting as solicitors for the promoters.

Matlock Urban Council is advised by Mr. H. D. Cook, consulting engineer, that there is sufficient water power available at the Bentley Brook for generating electricity for lighting the town. The Notts & Derby Electric Power Company has also notified the Council that it will apply for a Provisional Order, but under the circumstances it is probable that a municipal scheme will be adopted.

There was a deficit of £24,974 on the electricity undertaking at West Ham for the year ended March 31 last. The net capital expenditure is £683,432. The borough treasurer reports that the adverse result is due to the fact that the price charged per unit is not sufficient to cover the cost of production and capital charges. Apart from war allowances, the loss on the year is £20,892.

Representatives of the Dungannon, Cookstown and Magherafelt Urban Councils are conferring for the purpose of getting Ireland included in the Electricity (Supply) Bill. It is thought that sufficient power could be obtained from the falls of the Lower Bann to supply the towns and the adjoining districts with electricity for lighting and power.

Hull Electricity Committee has been asked to give a supply of 14 or 15 million units of electrical energy to new cement works which are to be established at Melton, near Ferriby. The committee has agreed that the firm be informed that the Corporation is to give the supply, subject to an agreement for a term of years, and subject also to the Corporation obtaining sanction to borrow the necessary money for additional plant which will be required.

Middlesbrough Gas and Electricity Committee has acceded to the application of the Cleveland & Durham Electric Power Company for a further increase of 15 per cent. in the price of electricity supplied in bulk to the Corporation. In turn, the Committee has made alterations in the charges for electricity to consumers. The 5 per cent. discount has been abolished and 5 per cent. will be charged on overdue accounts. Cables are to be laid in Smeaton-street and King's-road, North Ormesby, at a cost of £1,300.

An inquiry has been held at Derby into the Corporation's application or sanction to borrow £46,000 for the electric supply department. Of the sum required, £20,046 had been spent, £26,000 was for present and prospective requirements for mains, motors and transformers, and £660 for the purchase of land for a garage in Sowter-road for the highways and electricity departments. It was stated that the department had made rapid progress during the war. In 1913-14 the units generated were 7,000,000, and last year 19,300,000.

The city electrical engineer of Dundee (Major H. Richardson) reports that since the introduction of the Fuel Rationing Order last year several consumers had been unable to use the amount of electricity guaranteed by them owing to the amount being in excess of their ration. It appears that the Electricity Department has a number of consumers with contracts terminable on three months' notice, by which they get current for three months provided they guaranteed to take a specified minimum quantity. Under the Fuel Order these consumers were given a coal ration coupled with a specified quantity of electricity, which turned out to be less than the guaranteed consumption. Some of these consumers now refuse to pay for the whole guaranteed amount and plead the Fuel Order in defence. After discussion, the Committee decided to insist upon consumers complying with the terms of their contract.

Electric Traction.

Hove Corporation proposes to purchase four Edison electric vehicles for refuse collection.

Edinburgh Tramway Committee has instructed the Burgh engineer to prepare plans for the proposed extension of tramways on four routes.

The overhead equipment of the Dundee Corporation tramways is in an unsatisfactory state, and arrangements are to be made with the electric supply department for its repair and maintenance.

Hackney (London) Public Health Committee recommend the Borough Council to purchase, at a cost of £7,300, four electric motor vans for dust collection within the borough. It is estimated that a saving of 1s. 10d. a ton in the collection can be effected.

The West Ham tramway accounts for the year ended March show a deficit of £7,703, but there would have been a surplus of £7,739 but for the allowances to men on active service. The reserve and renewals fund of the undertaking is now exhausted.

The application to the Municipal Tramways Association for a further 12s. per week advance on wages for tramway workers all over the country is likely to meet with determined opposition in Lancashire, as managers of tramway undertakings think it time to make a definite stand against these repeated applications.

Sunderland Tramways Prize Band was represented in the local peace pageant in that town, and at night an illuminated tramcar, bearing no fewer than 860 coloured lamps and transformed to represent a castle, toured the principal routes. It was the design of the general manager, Mr. A. R. Dayson, M.I.E.E., and was given a popular ovation. Over 300 tramway employees took part in the peace celebrations on their own account. Each ex-service man was given a 10s. note and scroll by his fellow employees.

In a report to the London County Council on tramway fares, the Highways Committee states that the reinstatement of half-penny fares would mean a loss of revenue, and the present is not an opportune time for reinstating ordinary transfer and return fares. On workmen's cars and all-night services the annual loss is estimated at about £105,000 and £2,600 respectively. Careful observation is being kept of the results of the increases, and as to any inequalities which operate harshly on the travelling public, with a view to these matters being considered at the end of six months, when the whole question will be reviewed.

The Rural Transport (Scotland) Committee, which was appointed to consider and report upon the rural areas in Scotland which were most in need of transport facilities and the means of improving communication in such areas has issued a report. It is pointed out that defects in communication vary according to the nature of each of the regions in Scotland. A plea in favour of railways is urged in the coastal region founded upon circumstances created by the war. The Committee take the board view that there is a national duty to provide every community with reasonably convenient means of communication, and in considering what assistance is possible it would be too narrow a view to look merely for a direct pecuniary return on the capital expended. Among measures of relief, light railways are mentioned, and motor transport is also recommended where the roads are good.

Imperial and Foreign Notes.

Among the reconstruction proposals in the Island of Rodrigues is the erection of an electric supply station at Port Mathurin.

Arrangements have been made for the transmission of electric power from the Great Lake hydro-electric works to the north of Tasmania, the Government Hydro-Electric Department having agreed to supply 2,000 h.p. to Launceston Corporation.

The Ceylon Industries Commission is making investigations into the possibility of generating electrical energy by water power, and if, as the Commission anticipate, hydro-electric generation is found to be more economical than other means, the Government will be urged to take action in the matter.

A recent joint meeting of representatives of the Councils of the South African technical and scientific societies unanimously approved the principle of joint housing of technical societies and agreed that the various societies should be asked to appoint members of a joint committee to deal with the matter after the societies had approved the principle.

According to a statement of the chairman of the Hydro-Electric Commission of Toronto, Ontario will shortly double her present development of water-power, which now represents 750,000 h.p., and this will have the effect of decreasing power cost and increasing manufacturing. He believes that within 10 or 15 years, if hydro-electric development continues at its present progress, Ontario will have a population of 5.000.000. Canada has 18.000.000 h.p. capable of being developed, including over 6,000,000 h.p. in Ontario.

According to recent decisions, spare pieces for electric motors imported into Venezuela are subject to import duty of 0·078 bolwares per kilo.

The Greek Interests Bureau has been opened at Dorland House, 16, Regent-street, S.W. 1, for advancing the joint interests of Greece and Britain in commercial matters. The director is Mr. W. Hill.

The Norwegian Government is preparing a Bill which will regulate the distribution of electricity in the country. It is proposed to build a number of hydro-electric works, at a cost of £2,800,000, within four years. The country will be divided into six districts, each having its own power station.

Miscellaneous.

The late Sir William Crookes, who died on April 4, left estate of the value of £29,014.

The band of Messrs. Dick, Kerr & Company's electric works, Preston, carried off the first prize at a competition in Manchester, in which 17 bands took part.

On Wednesday a conference, organised by the Administrative Committee of the National Union of Manufacturers took place at the Cannon-street Hotel (London), for the purpose of discussing the inefficiency of the Telephone Service. The chair was taken by Col. Sir Fred Hall, K.B.E., M.P., and among those present were Capt. H. Newton Knights, M.B.E., J.P., M.P., Mr. Arthur Berkeley, Mr. H. Margetson, Dr. Henry T. Maw, and other business men.

On the 11th inst. the staff and works of Messrs. Hughes Johnson Stampings, Ltd., held their annual general outing. Leaving Langley Green they reached Worcester by train, where arrangements had been made to convey the party by steamboat as far as Tewkesbury. Luncheon was provided at the Bell Hotel, Mr. Tredgold taking the chair. During the afternoon various places of interest in the district were visited. About 230 members of the firm were present, and the valuable assistance of Messrs. Foster and Reynolds contributed towards making the outing a complete success.

The Court of Arbitration has issued its award on the recent claims concerning the Shipbuilding and Engineering Trades. On the ground that the cost of living was on the decline, the Shipbuilding Employers' Federation applied for a reduction of the war bonus by 5s. a week. The men counterclaimed for a 150 per cent. increase for time and piece workers and the consolidation of war bonus into standard wages. The Court found that the claim for the consolidation of the war bonus was not established, and that in view of the figures published in the "Labour Gazette," showing a decline in the cost of commodities during the last four months, the men's claim for an advance in wages also failed. On the ground that the outlook appeared to be one of much uncertainty, the claim of the Employers' Federation was also held not established.

The unprecedented demands of the Allied Governments for driving chains for all purposes during war made it necessary for the British Driving Chain Manufacturers to collaborate in order to use the whole of their resources to the best advantage. As a result, the needs were met, both as regards quantity of production and quality of products. The benefits accruing from co-operation were so marked that a permanent Association has now been formed. The main object of the Association is to foster and develop the use and application of chain gearing, the value of which is not yet fully appreciated by power users. In view of this, and in the face of competition with other forms of transmission, it is the policy of the Association to keep down the cost of chain driving to the user. It is anticipated that this will be attained by: (1) Standardisation of chains, wheels and chain wheel cutters to ensure interchangeability; (2) elimination of unnecessary sizes of chains; (3) the increase in output resulting from the above, and (4) the more comprehensive research made possible by co-operation. The address of the Association is Bassishaw House, Basinghall-street, London, E.C.2.

Educational.

Mr. T. Jones, A.R.C.Sc., B.Sc., of Keighley, has been appointed head of the physics department of Cardiff Technical College.

Mr. A. W. Stewart, M.A., D.Sc., has been appointed Professor of Chemistry at Queen's University, Belfast, in succession to the late Prof. Letts.

The Heriot-Watt College, Edinburgh, provides complete diploma courses of instruction in mechanical, electrical and mining engineering, chemistry, building construction, &c. Prospectuses may be obtained from the Principal.

Dr. H. R. Hasse and Dr. A. M. Tyndall have been appointed to the Henry Overton Wills chairs of mathematics and physics respectively at Bristol University, and Major A. Robertson to the chair of mechanical engineering. In the recent degree examinations in the Faculty of Engineering of the University, H. E. Sharp got first-class honours in mechanical engineering, and seven others secured a pass. The University Certificate in Engineering was granted J. A. L. Hooper.

The Merchant Venturers' Secondary School, which has been conducted for many years as a part of their technical college by the Society of Merchant Venturers, will at the end of the present term be transferred to the Bristol Education Committee, and will become a municipal school. The Merchant Venturers conduct in their college the faculty of engineering of the University of Bristol, and the need for additional space for this growing faculty has made it impossible for them to continue to house the secondary school.

At a recent meeting of old students of King's College the proposal to form an old students' association was cordially received, and a committee was elected to draw up a constitution, which will be submitted to a general meeting of old students in October. The principal (Dr. Burrows) presided, and pointed out that at present the Theological Society, King's College, for Women Old Students' Association, and the Engineering Society were the only organisations in touch with past students of the college. Dr. Relton and Mr. C. H. Wordingham spoke in support of the formation of the new association. Old students desirous of joining the new association should communicate with Mr. J. R. C. Bartlett, secretary, Union Society, King's College, London.

Tenders Invited and Accepted.

Dunedin (N.Z.) City Council require tenders by 5 p.m. Aug. 6 for the supply of a 3,500-volt three-phase regulator.

Tenders are invited for the supply and erection of three electric travelling gantry cranes at Belfast Harbour. Specification from the Harbour Engineer, and tenders to the Secretary by July 30.

Manchester Tramways Committee require tenders by 10 a.m. July 29 for the supply of tramcar motors. Specification, &c., from the General Manager.

Manchester Electricity Committee require tenders by Aug. 8 for the supply and erection of (*a*) 2,750 b.h.p. induction motor; (*b*) a 2,000 kw. induction motor-generator, with switchgear, &c. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Heston and Isleworth Council require tenders by July 28 for the supply and erection of a 500 kw. rotary converter, transformer, operating switchgear and l.t. feeder panel, cable, &c. Specifications from the Engineer, Electricity Works, Hounslow.

Durban (Natal) Corporation require tenders for the supply and delivery, c.i.f., of a quantity of Telephone Underground Cables. Specifications from Messrs. Webster, Steel & Company, 5, East India-avenue, London, E.C. 3, to whom tenders are to be sent by Aug. 1.

Grimsby Corporation invite tenders for high-pressure steam pipes, boiler feed and other pipes, circulating water pipes, electrically-driven centrifugal pumps and water storage tank. Specifications and drawings from the borough electrical engineer, Lieut.-Col. W. A. Vignoles, and tenders by Monday, Aug. 11.

Bradford Corporation invite tenders for the supply and erection of three water-tube boilers, superheaters, stokers, &c., and natural draught chimney-type cooling tower. Specifications, &c., from the city electrical engineer (Mr. Thos. Roles), and tenders to the Town Clerk (Mr. Frederick Stevens) by Aug. 15.

Redditch Urban District Council invite tenders for high-pressure steam, exhaust and water circulating piping. Specifications, &c., from the consulting engineers (Messrs. Handcock, Dykes & Trotter), 11, Victoria-street, London, S.W.1, and tenders to the clerk to the Council (Mr. G. W. Hobson) by noon July 28.

Stirling Corporation has accepted the tender of E. Deane & Beal, Ltd., for condensing plant at £4,124.

Battersea (London) Borough Council has accepted the tender of Babcock & Wilcox for the supply of additional boiler plant, and that of Musgrave & Sons for induced draught plant at the electricity station.

Eccles Corporation has placed an order for the supply and laying of three-way underground ducts and the supply and drawing into same of 2,733 yds. of 0·20 sq. in. e.h.t. 3-core cable, with the British Insulated & Helsby Cables, Ltd., at £5,785.

Tuam Electric Light & Power Company has accepted the following tenders: National Gas Engine Company, two 90 b.h.p. gas engines and suction gas plants, £2,980; English Electric Company, two dynamos, £1,458; Tudor Accumulator Company, batteries, £690; Whipp & Bourne, switchboard, £265.

Appointments Vacant and Filled.

Doncaster Corporation require an electrical engineer and tramways manager. Salary £700 per annum. Applications to Town Clerk by July 30.

Torquay Corporation require an electrical engineer and manager of their electricity undertaking. Salary £500 per annum. Applications to the Town Clerk by July 28.

The Council of Armstrong College, Newcastle-on-Tyne, invites applications for the post of professor of experimental physics. Salary £600, rising by biennial increments of £50 to £800 per annum. Applications to the Secretary by Aug. 30.

A demonstrator in physics is required at the Municipal Technical Institute, West Ham. Salary £150, rising by annual increments of £10 to £180 per annum. Applications to the Principal, Romford-road, Stratford, E. 15, by August 24.

Four assistant lecturers and demonstrators are required in the departments of engineering, electrical engineering and engineering design and drawing of the University of Liverpool. Salaries £250, £300, £250 and £250 respectively. Applications to the Registrar by Aug. 15.

An instructor in mathematics and physics is wanted for the electrical engineering department of the Northampton Polytechnic Institute. Salary £300 per annum. A demonstrator and assistant lecturer in mechanical engineering (salary £300) and a demonstrator and assistant lecturer in optics (salary £300) are also required. Applications to Dr. R. Mullineux Walmsley, St. John's-street, London, E.C. 1,by August 5.

Mr. Alfred Roberts has been appointed electrical engineer and inspector to the City of London Corporation in succession to the late Mr. H. R. Mott.

Major F. Barritt Hills, D.S.O., engineer, manager and secretary of the North of Scotland Electric Light & Power Company, of Montrose, Brechin and Inverness, has been appointed engineer and manager of the Guernsey Electric Light & Power Company.

South Shields Council received 44 applications for the position of borough electrical engineer, in succession to Mr. H. S. Ellis, and these were reduced to two, Mr. T. A. Kingham, borough electrical engineer, Kingston-on-Thames, and Mr. Edgar Moxon, deputy electrical engineer and manager, Blackburn. Mr. Moxon was unanimously appointed at £600 per annum, rising to £700.

Business Items.

Mr. P. W. Osborn, of Gordon Works, Hornsey, London, N.8, has resumed the manufacture of wooden electric fittings.

Messrs. Hills & de Lotbiniere (Brig.-General E. H. Hills, F.R.S., and Major-General A. C. J. de Lotbiniere, C.B.) have secured offices at 9, Victoria-street, Westminster, S.W. 1, and have commenced to practice as consulting engineers.

The partnership between James Briggs Russell and Thos. Wardrop, trading as Russell, Wardrop & Company, mechanical and electrical engineers, Pritchard-street, Chorlton-on-Medlock, Manchester, has been dissolved by the death of Mr. Russell. Debts by Mr. Wardrop.

Messrs. J. R. Parkinson, Sons & Heywood will sell by auction at the Temperance Hall, Bury (Lancs), on July 31, some modern chemical, electrical and scientific instruments and laboratory furnishings, stocks of chemicals, metals, &c. Catalogues from the auctioneers, 16, Market-street, Bury, or Messrs. Small, Woodcock & Sons, solicitors, Broad-street, Bury.

Bulletins 11 and 12 of the Alloy Welding Processes, Ltd. (149, Leadenhall-street, E.C.), which have just been issued, relate to the execution of repairs to permanent way, rolling stock and equipment by the A. W. P. system of electric welding, and to the electric supply conditions and apparatus for successful welding. The engineers and managers of tramways and light railways should procure copies of the pamphlets.

The Chloride Electrical Storage Company, Ltd., accumulator manufacturers, Clifton Junction, near Manchester, have appointed Mr. Donald Sinclair, A.M.I.E.E. (until recently resident engineer at Glasgow for the G.E.C.) as their representative for Scotland and the English border counties—the district previously covered by Mr. E. C. Hart. Mr. Sinclair's address is Box 15, Royal Exchange, Glasgow.

There is steadily growing demand for ELECTRIC VEHICLES for urban transport purposes, and in pamphlet 7,045 G, recently issued by Messrs. Mossay & Company, particulars are given of the "Orwell" electric lorries (Mossay system) which have already been adopted for a variety of commercial and industrial purposes by a number of local authorities, contractors, transport companies, &c. The lorries are built by Messrs. Ransomes, Sims & Jefferies, Ipswich, and in addition to particulars of construction, control, &c., the pamphlet contains abridged specifications of 2-$2\frac{1}{2}$-ton and $3\frac{1}{2}$-ton chassis.

Mr. Holbrook Gaskell, O.B.E., M.I.E.E., A.M.I.Mech.E., has resigned the position of chief engineer to the United Alkali Company, and has joined the board of Drake & Gorham, Ltd., as managing director, to take charge of industrial applications of electricity, the company's works and the vehicle business. Mr. Gaskell, who took a First in the Mechanical Science Tripos at Cambridge, has had a large experience during the 18 years he has been with the United Alkali Company in the equipment of their various works with power and chemical plant. Messrs. Drake & Gorham have been handling some big contracts during the last few years, including a complete generating station with an output of 10,000 kw., and arranged for extensions up to 20,000 kw., also another station with three geared turbine sets each of 1,000 kw.

Companies' Reports, &c.

The Electrical Utilities Corporation has declared a dividend of $1\frac{1}{4}$ per cent. on the preferred stock for the quarter ended June 30.

The directors of the Western Union Telegraph Company have declared a quarterly dividend of $1\frac{3}{4}$ per cent. (\$$1\frac{3}{4}$ per share).

Chadburns (Ship) Telegraph Company has declared a dividend on the ordinary shares of 6 per cent. per annum for the year ended March 31 last.

The Bournemouth & Poole Electricity Supply Company, Ltd., has declared an interim dividend on the ordinary shares at the rate of 5 per cent. per annum for the half-year ended June 30.

The directors of Mather & Platt, Ltd., have declared an interim dividend on the ordinary shares of 5 per cent. for the half-year ended June 30, being at the rate of 10 per cent. per annum.

The Adelaide Electric Supply Company is making an issue of 250,000 5 per cent. "A" cumulative preference shares of £1 each at par for the purpose of erecting a new power house at Osborne, Port Adelaide.

The directors of the Kensington & Knightsbridge Electric Lighting Company, Ltd., have declared a dividend on the ordinary shares for the half-year ended June 30 at the rate of 5 per cent. per annum, payable on the 14th prox.

The directors of the Lima Light, Power & Tramways Company have declared a dividend of $1\frac{1}{2}$ per cent. payable against coupon No. 21 in London by Messrs. Grace Brothers & Company, 144, Leadenhall-street, London, E.C.

The Liverpool Overhead Railway Company has declared interim dividends for the half-year ending June 30 at the rate of 5 per cent. per annum on the preference shares, and $2\frac{1}{2}$ per cent. per annum on the ordinary shares, payable Aug. 15.

The net profit of Veritys Limited for 1918, after meeting interest charges, &c., and writing £2,769 off for depreciation, was £11,250. A further dividend of $3\frac{1}{2}$ per cent. is proposed on the preferred ordinary shares, making 7 per cent. for the year, and carrying forward £3,239.

The Hydro-Electric Power & Metallurgical Company announces that the whole of the recent issue of 45,000 10 per cent. participating preference shares has been allotted. The electrode factory has now been completed and is turning out electrodes for use in the carbide works.

The directors of the St. James' & Pall Mall Electric Light Company, Ltd., have declared an interim dividend at the rate of 7 per cent. per annum on the preference shares, and 7 per cent. per annum on the ordinary shares for the half-year ended June 30. The transfer books will be closed from the 24th inst. to August 6 inclusive.

At the recent annual meeting of the Newcastle. Emlyn and District Electric Supply Company, a dividend at the rate of 5 per cent. per annum was declared. There are over 170 consumers, and the past year's revenue showed an increase of 20 over that of the previous year. The engineer (Mr. Parkinson) is to prepare a scheme for an extension of the plant and mains.

Mr. Edward Cowan, who presided over the annual meeting of the Arbroath Electric Light & Power Company last week, said the company was paying a dividend of 5 per cent. and carrying forward £1,000 to reserve and renewals fund. The past year had been a record one as regards trade, but, on the other hand, the cost of all materials had gone up enormously, with the result that the profit had been much the same as in the previous year. There was a large demand for current by new consumers, but it was exceedingly difficult to get the necessary plant.

At the recent annual meeting of the Woking Electric Supply Company, Ltd., the chairman (Mr. W. Ashby) said the directors and their friends owned rather more than half of the ordinary shares, and they felt it would not be wise to pay an ordinary dividend, but considered it would be a wiser policy to place £1,000 to depreciation. On capital account they had expended £8,278 on a new turbine. The receipts (£28,184) showed a satisfactory increase, but there had been large increases in coal and wages. Coal cost them £11,571, an increase of £2,057. The increased cost of coal and wages would compel them to increase the price of current. They were issuing more capital in the form of 7 per cent. "B" preference shares, which was to pay off bank loans and to provide capital which might be useful in the near future for expansion.

Presiding at the meeting of Edmundsons' Electricity Corporation on the 17th inst., Mr. P. Debell Tuckett said that increasingly difficult as had been the conditions affecting their business throughout the war, they had been infinitely more difficult during the past year, whilst at present they had reached a stage which he could only characterise as impossible. Their total wages increase amounted to over £26,000, compared with 1917, and to £42,000 compared with 1914, while this year there had been an increase of many thousands a year. The increased price of coal alone represented an increased cost of £21,400 compared with 1917, and £78,250 compared with 1914, and now they were faced with an additional cost of £35,000, if the threatened increase of 6s. a ton was imposed. Moreover, much of the coal was of markedly inferior quality. On the other hand, there had been a further shrinkage in lighting output, due to the summer-time arrangement and to lighting restrictions and to the rationing of consumers, which was still having a serious effect on consumption. Unless the Government were themselves prepared to shoulder the burden it was incumbent on them to recognise the necessity of sanctioning rates of charge which would enable the company to earn a fair return on its capital. The combined rise in wages and coal, compared with 1914, had added over £120,000 to their costs during the past year. The times were wholly unprecedented, and in the small towns their only means of meeting the crushing burden of those increased costs was to advance their rates of charge.

Mr. Herbert Allen, who presided over the ordinary general meeting of the Anglo-Portuguese Telephone Company last week, said the past year's business had not been wholly satisfactory. The greater part of the increased income had been absorbed by the higher cost of labour and material, and he did not look for much improvement until they were able to get better supplies of plant and material with which to complete the extensive construction work in hand. The Portuguese Government had recently authorised an advance of 30 per cent. in the tariff. They had met practically all the demands of their workmen and thereby had avoided strikes. Although they did their best to ameliorate the lot of those they employed, it was useless to expect immunity from labour troubles in Portugal any more than elsewhere. Owing to the great difficulty in obtaining cable and apparatus during the past few years, it had not been possible to join up all the subscribers desiring telephones, and the service given to the existing subscribers had suffered to some extent. They had now over 2,000 would-be subscribers on their waiting list, which meant a temporary loss of £15,000 to £20,000 per annum in income. There was no limit to the amount of telephone business to be done in Portugal; indeed, their technical advisers told them that in the next three or four years, if they were given charge of the Lisbon and Oporto trunk line and the dual service, they could spend between £300,000 and £400,000. The report was adopted, and a final dividend of 3 per cent. (making 6 per cent. for the year) was declared.

Mr. W. Gascoyne Dalziel, who presided over the meeting of the South Wales Electrical Power Distribution Company last week, said the results of the year's working showed that after payment of expenses the credit balance was £26,143, which enabled them to pay the interest on the debentures and prior lien debentures, place £8,070 to depreciation of new plant and to carry forward £51. It was disappointing to have to record that although there was a material increase in the number of consumers and the horse-power connected, there was a decrease of 365,146 in the number of units sold compared with the previous year. That was accounted for by the fact that a large proportion of the output was supplied to colliery undertakings, whose business was carried on under the most difficult conditions. During the year 1,539 additional horse-power had been connected, bringing up the total to 42,662. Since the last annual meeting contracts for supply had been entered into with several new consumers, including some important collieries. Negotiations indicated that other collieries, &c., would be served from the western main at no distant date. The new contracts also included Pontypridd Urban Council (with whom arrangements had been completed for the supply of electricity in bulk), tinplate and wagon works, &c. The questions of the nationalisation of the coal mines and the threatened increase in the price of coal vitally affected their interests. They were large consumers of coal, and they naturally expected that that consumption would go on increasing.

In the course of his speech to the shareholders of the Anglo-Argentine Tramways Company last week, Mr. W. F. Hamilton, K.C., said they had been badly affected by the war, and so far there had been no material reduction in the price of coal. Their supply company, being a German company, was blacklisted, and was unable to buy fuel from any part of the British Empire or from the United States of America. In vain they applied to be allowed to purchase British coal upon condition that it should be used only for generating the power to be supplied to their company. The name of the supply company was removed from the black list in April last, but sufficient time has not yet elapsed to feel any material benefit from the removal. The year's traffic receipts amounted to £2,909,375, or £209,131 in excess of those of 1917. They carried 349 million passengers, which was a record. The receipts from tolls and the exchange profit on remittances were £20,279 better than in 1917. The expenditure on maintenance (£243,408) was about the same as in the previous year, the increased cost of materials being compensated by strict economies and incessant supervision. The traffic expenses were slightly heavier, due to increased wages and shorter hours. The key of the whole situation was the cost of electric energy. The supply company mostly used hard wood, spoilt maize and grain as fuel. In 1913 the average cost of current per unit was 1·45d., and in 1918 the cost was 3·66d. With a car-mileage of 50,872,935, £346,500 was charged to revenue under the head of traction, whereas in 1918, with a car-mileage of 53,118,576, the amount was £891,632. They had thus now to pay for power about £545,000 more to earn the same traffic receipts. They were also heavily hit by the income tax. After providing for the annuity of £70,660 to the City of Buenos Aires Tramways Company, for the interest on the debenture stocks (£542,050), and the sinking funds for the redemption of both debenture and share capital (£52,514), the net profit was £15,052. The directors regretted that, having regard to the uncertain labour position and to the cost of current during the first five months of the year, they were unable to recommend the distribution of any part of £83,042 available by way of dividend on the first preference shares. The directors hoped to be able to induce the Municipal Council to allow them to increase the fares, so as to meet the increased charges for wages, &c. There was every prospect of improved receipts during the current half-year. They would have the advantage of some reduction in the price of current, and if there were no further labour troubles and they were allowed to increase fares, this year should show an improvement.

New Companies.

COUNTY MOTOR & ENGINEERING COMPANY (PRESTON), LTD (156,778). Private company. Reg. July 7, capital £6,000 in £1 shares, to acquire the business of letters on hire of motor cars, garage proprietors, motor and electrical engineers, carried on by Beesley & Carruthers, Preston. Reg. office: County Garage, Fishergate, Preston.

HATCHAM MANUFACTURING COMPANY, LTD. (156,393).—Private company. Reg. June 24, capital £3,000 in £1 shares, to take over the business of electrical and general engineers carried on by A. S. King, E. A. Endacott and F. W. Carpenter, &c. The first directors are A. S. King, E. A. Endacott and F. W. Carpenter (also secretary). Reg. office: 314, Gray's Inn-road, W.C.

MAGNET MOTOR GARAGE, LTD. (156,561.)—Private company: reg. June 30, capital £10,000 in £1 shares. Motor, general and electrical engineers, garage keepers, &c. Director, R. B. Gunner. Reg. office, 2, Shaftesbury-road, Hornsey.

METAL INDUSTRIES, LTD. (156,191.) Private company. Reg. June 18, capital £39,000 in 20,000 preference and 18,000 ordinary shares of £1 each, and 10,000 deferred shares of 2s. each. Mechanical and electrical engineers, founders, &c. Reg. office, 136, Aldersgate-street, E.C.1.

PATENTS MART & TRADE AGENCY, LTD. (156,496.)—Private company: reg. June 27, capital £10,000. To acquire the business carried on by Patents' Mart and Trade Agency, Ltd. (in liquidation). Directors: Major P. R. Thornton, A. C. Hutchinson and R. Spyers. Reg. office, 329, High Holborn, W.C.

RELIANCE TELEPHONE COMPANY, LTD. (156,948).—Private company. Reg. July 11. Capital £25,000 in £1 shares. Manufacturers of and dealers in electrical machinery and appliances, especially telephones, telephonic apparatus, &c. Directors: A. L. Collins, J. H. Smith and E. Silbermann.

STEWART & MOORE, LTD. (156,882)—Private company. Reg. July 8, capital £12,000 in £1 shares, to take over the business carried on as Stuart & Moore, and to carry on the buesiness of manufacturers of and dealers in scientific instruments, fire alarm apparatus, electrical and general engineers, &c. Permanent directors: J. Sutton and G. J. Sutton. Reg. office: 46, Packington-road, Acton, W.3.

Prices of Metals, Chemicals, &c.

		Price.	Inc.	Dec.
Copper—				Tuesday, July 22.
Best selected	per ton	£111 0 0	9 0 0	—
Electro wire bars ...	,,	£118 0 0	11 0 0	—
H.C. wire, basis ...	per lb.	1s. $3\frac{9}{16}$d.	$1\frac{4}{16}$d.	—
Sheet	,,	1s. 3d.	$0\frac{3}{4}$d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	per lb.	1s. $6\frac{9}{16}$d.	$0\frac{4}{16}$d.	—
Brass 60/40—				
Rod, basis	per lb.	6s. $10\frac{7}{8}$d.	$0\frac{4}{8}$d.	—
Sheet, basis	,,	1s. $2\frac{1}{4}$d.	1d.	—
Wire, basis	,,	1s. 2d.	1d.	—
Pig Iron—				
Cleveland warrants	per ton	£164 0 0	—	—
Galvanised steel wire, basis	,,	35 10 0	—	—
Lead Pig—				
English	,,	24 15 0	—	—
Foreign or colonial	,,	23 15 0	—	—
Tin—Ingot	,,	256 5 0	9 15 0	—
Wire, basis	per lb.	3s. $2\frac{1}{2}$d.	$0\frac{1}{2}$d.	—

Salammoniac.—Per cwt. 80s. and 75s.
Sulphur (Flowers).—Per ton £21.
,, (Roll Brimstone).—Per ton £20.
Sulphuric Acid (Pyrites, 168°).—Per ton, £7 17s. 6d. to £8.
Copper Sulphate.—Per ton £45–£46
Boric Acid (Crystals).—Per ton, £72.
Carbon Bisulphide.—Per ton £55.
Sodium Bichromate.—Per lb. 11d.
Sodium Chlorate.—Per lb. 7½d.–8d.
Shellac.—390s. October delivery at 396s. to 400s.
Rubber.—Para fine. 2s. 5½d.; plantation grades, 1s. 11d. to 1s. 11½d. lb.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W.T. Henley's Telegraph Works Company

Thirty-Seven Years Ago.

[From The Electrician, July 22, 1882.]

Electric Light at Worcester.—An exhibition of art and industry was opened in this city in the early part of this week under the title of the "Worcestershire Exhibition." It is partially lighted by Brush arc lamps supplied by the Hammond Company.

Electric Light at Windsor Castle.—The preparations for lighting portions of this castle by means of electric lights are progressing rapidly. This work is being done by Messrs. R. E. Crompton & Company, and the Maxim-Weston Electric Light Company.

An Electrical Target.—It is stated that a target has been made use of during the Wimbledon meeting, which closes with the present week, which registered each shot fired, or rather each shot that struck it, on a dummy target placed some distance away and electrically connected with it. This target is reported to have worked extremely well.

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Notes.

The Tramways and Light Railways Association.

THE Annual Congress of the Tramways and Light Railways Association, which was held last week, was rather a melancholy affair. There was by no means such varied interest as there used to be a few years ago, and there seemed to be a lack of enthusiasm, as shown by the comparatively small attendance. This is probably due to the troublous times in which such enterprises find themselves, and for this reason, no doubt, the two Papers that were presented dealt largely with questions of finance. We refer at some length to Mr. W. L. MADGEN's Paper in our leading article. The only other Paper was by Mr. H. ENGLAND, on "Post-War Problems," which are certainly numerous. The first problem considered by the author was that of finance, which comes down to the simple view that the income must be raised sufficiently to meet all necessary costs if tramway undertakings in this country are to fill properly the position assigned to them. One way to obtain the essential surplus is to raise the fares to a remunerative figure, as suggested by Mr. MADGEN. The other is to cut down expenses. The latter is by no means an easy process. A method suggested by Mr. ENGLAND, and one which is certainly well worthy of attention, is co-operative buying and the standardisation of parts. For example, there is no reason why gear wheels should not be purchased on a co-operative basis. If the various parts were standardised it would thenbe possible to place large orders, which would be satisfactory from the manufacturer's point of view, and would also serve to bring down the cost very materially.

Other Problems.

The second problem mentioned by Mr. ENGLAND was rolling stock. We agree with him that the present tramway cars fitted with roof covers are the "acme of ugliness," but we doubt if very much can be done in the way of improving tramway cars from a commercial point of view. The present cars have survived many years of evolution, and though they are unsatisfactory, it is very difficult to say how they can be improved. Another question is that of road maintenance, which is an old standing grievance of tramway undertakings, and which is very naturally closely connected with the problem of the motor-omnibus. We think it will be agreed by most people that the maintenance of roads should either be left completely to the rates or should depend to come extent on contributions from all public services. At present the tramways bear a serious charge, and in some cases where motor-omnibus undertakings have been forced to pay, exorbitant demands have been made. There should be some uniformity in these matters, and possibly this will come when the Ministry of Ways and Communications is in being. It is impracticable to have anything in the nature of a tax on all vehicles, though theoretically this would be the best course to adopt. Apart from these problems there are many others to which Mr. ENGLAND referred, and which will be found set out briefly in THE ELECTRICIAN next week.

The London Traffic Committee's Report.

AT times the proceedings of the Select Committee on London Traffic were as farcical as those of the recent Coal Commission, for the Committee obviously started out with the assumption that the raising of fares was an iniquitous procedure, and proceeded to prove their case as far as possible. In the report which has now been issued the existing congestion is stated to be a scandal, and the statement is made that the demoralisation of traffic in Greater London is fully explained by the absence of a supreme traffic authority for Greater London. Although we are quite in favour of a suitable traffic authority, it is absurd to look upon the existing conditions as a scandal for which certain people are responsible, or to suppose that it would have been any less of a scandal if a traffic board had been in existence. Considering that the traffic facilities were cut down during the war, and that very few steps could be taken to meet the normal growth of traffic, there must inevitably be congestion. In due time a traffic board would no doubt be in a position to do something to regulate the whole problem, but it is to be hoped that any such board will be careful in making edicts without considering the financial effect of their regulations. The present Committee appear to have very little idea of the financial problems involved. It is grudgingly admitted that some increase in fares was necessary so long, be it marked, "as it is accepted that actual capital is entitled to a reasonable return on its outlay." We wonder on what basis the Committee would run public services.

Overcrowding.

THE statement is made that transport agencies were aware of the evils of overcrowding, but such evils meant better receipts, and therefore steps were not taken to remedy them. We think it is scarcely necessary to go seriously into such an allegation. If the remedy could have been introduced the police would certainly have gone back to their old regulations. Everyone, except the Committee, however, is well aware that omnibuses and similar material were not obtainable during the war except with great difficulty, and are by no means easily obtainable even now. In order to make things better, we notice that the need for restriction of competitive services along the same routes is emphasised. We should have thought that if there was much overcrowding it would be an advantage to have competitive services. One interesting point is noted, namely, the coming of the eight-hour day means greater congestion at certain hours of the day, owing to the fact that the movements of different sections of the community will more nearly coincide. In order to overcome this difficulty it is suggested that the board should regulate the hours of labour! This is an impossible suggestion, and certainly would not be acceptable. Something is also made of the fact that fares vary according to the districts, being higher in well-to-do districts. We cannot see much objection to this, if it enables lower fares to be accepted in poorer districts, and presumably this is the case. The report is interesting, but it would have been much more valuable if it had been drawn up by a really capable committee.

Restrictions in the Fuel Order.

It will be remembered that the 1918 Household Fuel and Lighting Order contained a clause restricting new connections to electricity and gas undertakings, and that this was suspended on the urgent representations of those interested in the industries as soon as circumstances permitted after the cessation of hostilities. It is, therefore, a matter of surprise that this old clause has been introduced into the new Order of 1919. Obviously such a restriction is a very serious matter, not only to electricity undertakings, but to manufacturers and others occupying new premises. It also necessarily affects adversely the manufacturers of accessories required for this class of work, and it tends to unemployment. We are therefore glad to find that Mr. J. W. Beauchamp, the director of the Electrical Development Association, has secured a relaxation of this clause, to the effect that such connections may be made if the local Fuel Overseer is satisfied that the gas or electricity undertaking in his district is in a position to meet the increased demand which may arise. This relaxation may be withdrawn at any time if the undertaking experiences difficulty in meeting the demand. This is a most important concession, and we think that Mr. Beauchamp is to be congratulated upon his success. What it means is that in practice the electricity supply undertakings will do all they can to make possible an increase in connections, and will satisfy the local Fuel Overseer that they are not likely to get into difficulties by so doing. This is just the kind of occasion on which the Electrical Development Association can do very useful work.

The Coal Position.

Although the Miners' Federation has agreed with the Government in regard to the various points under dispute, and consequently a strike on a large scale may be avoided, the position in Yorkshire is still a matter for anxiety, and it appears that there are still a large number of miners who do not realise the extreme gravity of curtailing the output of coal in this country, with the consequent shutting down of various works. We are glad that the Government has at last realised the need for settlements based on true economic principles, though even now it may be feared that they have given way too far and that the industries of the country may be endangered. The present position, however, is only part of a larger problem. It was announced in "The Times" last Tuesday that the Government have decided not to nationalise the coal industry. If this is the case, everyone engaged in other industries in this country will feel greatly relieved. The nationalisation of the coal itself, as distinct from coal mining, is another matter, and there is much to be said in its favour. Also there is a great deal to be said in favour of some such scheme as that outlined by Sir Arthur Duckham, and on which it is understood the Government are preparing a scheme of their own. We only hope that the miners and others in the rank and file of labour will realise the paramount necessity of dealing with such questions on economic lines, and not as questions of politics or such as to be settled by "direct action." Any such application of force in the settlement of industrial and economic questions can only lead to a disaster of the first magnitude and that very swiftly.

Regulations for Automobile Headlights.—This subject has been studied with considerable care by a committee of the Illuminating Engineering Society in the United States, some of the conclusions of which are summarised in a recent issue of the "Transactions." In particular, the tests leading up to some regulations adopted by the State of New York are described. The great difficulty is to effect a compromise between the high beam illumination desirable for the driver and the elimination of glare, which this almost inevitably occasions to pedestrians and drivers of approaching vehicles. From these tests it is suggested that, in order that objects may be distinguished at 150 ft. and 250 ft. respectively, 1,000 c.p. and 1,300 c.p. are needed. Also that the intensity of light striking the observer's eye should not exceed 850 c.p., measured at a distance of 100 ft. and at 60 in. above the ground. The specification for testing headlights drawn up by the State of New York is printed in detail.

Science and Industry in Canada.—We have received from the Royal Society of Arts a reprint of a Paper on "Science and Industry in Canada," read before the society on March 4th by Prof. J. C. McLennan. Education has been well developed in Canada, and the proportion of students who proceed to the universities is considered high as compared with the older countries. One reason for this is the arrangement by which students can earn sufficient money to carry them through the university courses during the vacation period (June 1st to October 1st). A feature is the equipment of schools for special subjects, such as the School of Railway Engineering and the Forests Products Laboratory attached to the McGill University, which is an exceptionally well-equipped institution. Mention may also be made of the various agricultural colleges which are deservedly world famous. In common with other countries, Canada has formed a department for scientific and industrial research, and the list of problems set out in the Paper suggests that there is plenty of useful work before it.

Co-Operative Production.—In June a conference of employers and trade union officials was arranged by the Industrial Reconstruction Council, and was held, at the invitation of Sir Samuel Waring, at Footscray Place, Kent. The chair was taken by Mr. E. J. P. Benn, and there were 15 other members of the conference. The conclusions reached were that (1) works committees should be established wherever practicable; (2) effective machinery should be created to regulate automatically the rise and fall of general standard rates of wages; (3) some scheme of co-operative production should preferably be adopted in order to increase production; and (4) the principle of co-partnership or profit-sharing should also be adopted wherever possible. At the same time, the conference came to the conclusion that no one standard scheme was likely to be suitable for all the varying conditions of our industries. In the pamphlet that has been issued, the Priestman scheme is given in an appendix, together with a specimen sliding scale agreement, according to which the wages vary with the selling price of the product.

British Scientific Products Exhibition.—*Explosives in War and Peace.*—In a lecture on "Explosives," at the British Scientific Products Exhibition, Central Hall, Westminster, by Mr. James Young, O.B.E., of the Royal Military Academy, the lecturer said that explosives were equally essential in war and peace. In industry they were substitutes for man power, and, as this had become scarce, their use in the future was likely to increase. Nitrates were the foundation of all our military and most other explosives, and at present practically all our supplies came from overseas. A great "National Nitrate Factory" should be established in England without loss of time. We were already behindhand. The Germans made their own nitric acid for use in the war, and America had already established a national factory. Experience was necessary, but good returns should be a certainty. There was an enormous demand for nitrates as fertilisers, so the main product could be used for this purpose in peace and be immediately available in case of war. Such a factory would increase our security and our agricultural prosperity.

The Exhibition closes next Tuesday.

Choking Coils for Earthing.—W. Petersen has investigated the disturbances due to the earthing arc on high-tension networks. He considers that a large number of breakdowns in the continuity of supply are due to the earthing current and the grounding arc. The earthing choking coil may be used for a double purpose—viz., to reduce the earthing current to a minimum and to suppress the arc. This choking coil may be connected to the generators or transformers; alternatively, it may be connected to the artificial neutral point of the system. It absorbs that part of the earthing current which is due to capacity, and renders the remaining part of the earthing current incapable of generating an arc if it receives from the voltage of the phase a current of the same magnitude as that part of the earthing current due to capacity. The physical peculiarity of the coil lies in the fact that its property of extinguishing the arc depends essentially on the equality of the frequency in the network and that in the discharge wave. The author gives in the "Elektrotechnische Zeitschrift" an account of some tests and experiments which he has conducted on the network of the Laufenburg power station.

Institution of Electrical Engineers.—At the annual dinner of the Institution of Electrical Engineers the following telegram was sent to the corresponding institutions of America, Belgium, France, Italy and Japan: "Fraternal greetings to their brother electrical engineers, allies in war and peace, from members of British Institution of Electrical Engineers assembled at first festival since outbreak of war, 1914.—Wordingham, President." The following replies were received:

Brussels, July 2, 1919.

Deeply appreciative of your friendly courtesy, the members of the Société Belge des Electriciens join most heartily in the first celebration of their brothers, the British electrical engineers, and send them their most cordial greetings. Pierard, President.

Paris, July 1, 1919.

Deeply moved by the affectionate thoughtfulness on the part of their fellow-members of the British Institution of Electrical Engineers, the members of the Société Française des Electriciens send them fraternal greetings on the occasion of their first celebration, and rejoice with them over the fact that the Peace Treaty has been signed.

Mazen, President.

Milan, July 3, 1919.

The members of the Associazione Elettrotecnica Italiana return to their English colleagues their expression of warm friendship, already traditional, which the present Allied victory has happily sealed.

Ferraris, President.

Tokio, July 9, 1919.

Your cordial greetings heartily appreciated and reciprocated.

Namba, President, Denkigakkai.

Federation of Technical and Scientific Associations.—We are pleased to learn that a scheme has been formulated for the federation of the Electrical Power Engineers' Association, the National Association of Industrial Chemists and the National Union of Scientific Workers. The federation, which was decided upon at a recent meeting of representatives of the three associations in question, is the fulfilment of a policy that the respective associations were established to promote. It is intended that kindred associations established as trade unions shall be invited to join in the grand federation. The immediate object of the federation is to secure the adequate representation of such trade unions upon joint industrial councils and other bodies whose functions affect the interests of the scientific and technical works. Each of the above associations, along with similar associations, has been working for this object in the past, but the need for collective action has been realised. In addition, the many questions of common interest to the members of the constituent associations in the federation will also come within the scope of its activities. There will be a Federal Council, consisting of not more than five delegates from each association represented in the federation, whose hon. secretary (pro tem.) is Mr. W. A. Jones, 65-66, Chancery-lane, London, W.C.2.

Effect of Power Factor on Networks.—Franz Buckholz in the "Elektrotechnische Zeitschrift" considers the question of power-factor in distributing networks, the effect of which on the efficiency of supply is well known. There has lately been a decided tendency towards the idea that it is reasonable to regulate the charges to the consumer according to the nature of his average power-factor. But there has been no entirely satisfactory solution of the question of determining the mean power-factor, and this is possibly due to the fact that it has been insufficiently considered from the theoretical standpoint. Moreover, it is not possible to give any physical meaning to the conception of the mean power-factor, and at best it leaves out of account the regularity with which power is taken by the consumer. The first part of his paper is a theoretical investigation of the problem, which leads to the idea of an "energy-factor," which is the product of the mean power-factor, and the "correlation factor." The latter takes into account the regularity of demand, which is of great importance in some cases, such as the demand made by steel rolling mills. He explains in the second part of the paper methods by which his proposed system of charging can be carried into practice and the principles on which his tariff would be based. He proposes the use of a meter which shall determine the uniformity with which power is taken by the consumer, and also the power factor of the load. As the result of the readings he finds a factor which should be used in adjusting the consumer's account. The meter which he employs is a modification of the watt-hour meter. In place of the voltage coil, which produces a field proportional to the network voltage, he uses a driving element which carries a field proportional to the current taken by the installation. The practical methods of adjusting the accounts and fixing the tariffs are explained

Obituary.

We regret to record the death of Mr. James Conolly, retired electrical engineer and cable manufacturer, of Blackley, Lancs. Mr. Conolly was found dead in Lake Windermere on the 24th inst. Medical evidence was given at the inquest that deceased appeared to have had a seizure, during which he fell into the water. Mr. Conolly, who was 52 years of age, had been in indifferent health for some time.

We regret to record the death of Mr. Henri Armagnat, the well-known writer, who was closely associated with our contemporary the "Revue Générale de l'Electricité." During the war he devoted his energies to assisting General Ferrié in the organisation of the radio-telegraphic service.

Personal.

Mr. Anthony Hodgson, Superintendent of the Eastern Telegraph Company at Gibraltar, has received the M.B.E. for services rendered during the war.

Sir Evan Jones, Bart., M.P., has resigned his position as Chairman of the Road Transport Board. The main duties of the local organisation of the Road Transport Board are now concerned with transport for foodstuffs and it was therefore incorporated with the Divisional organisation of the Ministry of Food on July 21.

Arrangements for the Week.

FRIDAY, Aug. 1st (to-day).

British Scientific Products Exhibition.

5.30 p.m. At Central Hall, Westminster, London, S.W. Lecture on "Applications of Science to Military Mining," by Mr. H. Standish Ball.

Weagant's Anti-Static Method in Wireless Telegraphy.

(Continued from p. 85.)

UNDERGROUND AND SURFACE-GROUND HORIZONTAL AERIALS.

The low horizontal aerial for radio reception was first used by Marconi. An antenna of the same type employed by Weagant in the spring of 1914, at New Orleans, gave a distinctly better signal to static ratio than the large earthed aerial. Later comparisons with a loop aerial showed the two to be substantially identical in that respect.

One important deduction resulting from these tests was the fact that the long horizontal aerials laid under ground, on the surface of the ground, or suspended above the ground, may act as a loop aerial. Because of the capacity to earth a return path for the current exists between the ends, which effectively completes the circuit.

It has been noted particularly that, as the distance between the ground and the horizontal aerial is increased, its action becomes more nearly that of an ordinary antenna; and that, because it is then not in the most effective position relative to the incoming signal to collect the maximum of energy, the signals are less in strength than would be secured with less spacing.

The usually accepted explanation of the working of the horizontal aerial is that the wave front of the signal wave is tilted forward, and that consequently there is a component of electric force in the direction of its length. It is to be noted, however, that under some circumstances such an aerial may be acting equally well as a loop. This view will also account for one observed fact which the usual methods of explanation do not account for, namely, that when an aerial of this type is laid on the ground, or buried underneath it, its effectiveness as an aerial does not increase indefinitely with length, but rapidly reaches an optimum value dependent on the circumstances obtaining. This can readily be accounted for under the present hypothesis by the fact that as the length increases its capacity to earth increases and at some point becomes sufficient to close the loop.

As this capacity increases, however, the currents originating in this increased length have various paths in which to flow, one of which includes the receiving apparatus, but others are through the capacity to earth between the conductor and the receiving apparatus, and the larger this gets the greater is the proportion of the currents originating in the ends of this aerial, which are diverted and do not flow through the receiving apparatus. This method of considering such an aerial is further supported by the fact that the greater the capacity per unit of length which exists between the conductor and the true underlying earth, the shorter is the maximum length which can be used to advantage. This capacity is a maximum, of course, when the aerial is actually buried in the ground or under water, becoming less when the wire is run on the surface of the earth and still less when the wire is suspended at some height above the earth, tests having shown that wires suspended some 10 ft. above ground can be used up to some six miles in length, the signal increasing with length; that a length about one-half of this is effective when the wire is laid on the ground and of approximately 2,500 ft. when the wire is placed under brackish water.

Mr. Weagant has also found that as the distance of such an aerial above ground is increased, its action becomes more nearly that of an ordinary antenna, and that therefore on account of its position relative to the incoming signal, it becomes less effective in collecting this signal energy.

The Weagant aerial constitutes, as a whole, a uni-directional receiving antenna; that is, signals arriving from one end of the loop can be tuned in, while an interfering signal from the opposite end can, by proper phase adjustments, be tuned out.

Mr. Weagant pointed out that advantage can be taken of this property to eliminate static interference if the static waves happen to come from a direction other than that from which the signal arrives. This is of considerable help when a thunderstorm is gathering in the vicinity of the station. Although the most effective spacing of the loop to obtain this uni-directional characteristic is one-quarter length, a general order of the result is obtainable with any spacing between the loops.

Suppose that the two loops of the system are one-quarter wave length apart and that the desired signal arrives from right to left; then the currents in the left-hand loop are 90 deg. behind those of the right-hand loop, if the circuits are accurately tuned, and they will add in quadrature. Next, suppose a signal arrives from left to right; then the currents due to this signal in the left-hand loop are 90 deg. ahead of those in the right-hand loop, and therefore also combine in quadrature. Then currents due to both signals exist in the common receiving circuit.

Suppose, now, the phases of all currents in the left-hand loop are shifted forward 90 deg.; then the currents due to the desired signal in this loop are shifted around until they are in phase with those from the right-hand loop, while the phase of the currents due to the interfering signal in this loop, and which were previously 90 deg. ahead of those due to the right-hand loop, are now 190 deg. ahead of those in the right-hand loop, so that they oppose and neutralise. Because of the unusual characteristics of the aerial used, this shift in phase is readily accomplished by a small adjustment of the condenser in the loop circuit. If the interfering signal is not in line the right amount of phase shifting can be made to take care of it, and this general order of result is obtainable to some extent with any spacing between the loops, although one-quarter wave length is best. The reception of Carnarvon's signal, 14,200 metres, through the powerful interference of the 200 kw. Alexanderson alternator at New Brunswick, only 25 miles away, working at 13,600 metres, has been an everyday performance of the system, while at the same time preserving a good static balance. All forms of the arrangement described have capabilities of reception through interference, these capabilities varying with the type of aerial employed, the loop aerials and the horizontal aerials giving similar curves.

It has been mentioned in the original article that Mr. Weagant observed the necessity for local tuning of each loop in all arrangements employing two widely separated closed circuit loops or cages connected to a central receiving station by long low horizontal leads. This required placing an operator at each cage and informing him by telephone just what adjustments were to be made in order to change the wave length or to obtain a good static balance. Obviously, this was not a convenient arrangement, and an added objection previously mentioned, was that the long, low horizontal leads acted as aerials, picking up both static and signals. Although this particular structure gave a marked reduction in static currents while retaining useful amounts of the signal currents, it cannot be said to have fully satisfied the requirements of modern radio engineering and commercial practice.

In an effort to overcome the troubles incident to the use of the loops with long low leads, Mr. Weagant and Mr. Waterman, jointly, conceived the idea of making the loop and lead-in wires, one; and accordingly experiments were conducted with two loops, each of which consisted of a single turn of wire extending out from the station and back again. This arrangement was free from points where abrupt changes in the circuit constants took place, which was not the case with the cage aerials which made use of the long horizontal leads.

One of the first discoveries made in connection with the enlarged single-turn loops was that they could not be tuned to sharp resonance with any particular incoming frequency; in fact, the insertion of inductances and capacities in the loops to establish resonance at different wave lengths had seemingly no effect upon their frequency of oscillation.

It was believed that this result was due to a current distribution in the loops of such a nature that a current node existed at the point of insertion of the tuning devices. This distribution was successfully altered by the insertion of inductances at suitable points. A coil of 30 millihenries was inserted, successively, in the upper wire at points between the receiving station and the other end of the loop; it was found that the tuning improved constantly as the coil was moved from one end toward the middle, but it became poorer as the coil was moved from the middle toward the end.

It is interesting also to note that when an inductance was inserted in the lower wire it produced no result. When coils were inserted in the middle points of both lower and upper wire at the same time, the effect of the latter was annulled. Experiments showed that 30 millihenries was about right for a wave length of 12,000 metres and 5 millihenries for 6,000 metres, but either value was sufficiently acceptable for both wave lengths, with loops each three miles long.

After this definite method of tuning had been determined, the results secured in balancing out static and retaining the signal were most satisfactory. The over-all results obtained were better than those secured with smaller loops spaced far apart and connected to the receiving apparatus with long low horizontal lead wires, because in that arrangement the leads had acted as aerials and reduced the effective spacing of the two end loops or cages. The most effective spacing of two such loops was found to be one-half wave length between the centres, which is in agreement with the theory previously outlined.

An exhaustive series of experiments with enlarged loops of various types were carried on at Lakewood, N.J. Various modifications were put under observation.

Mr. Weagant states that his whole work has demonstrated that existing ideas of the mechanism by which the loop aerial extracts energy from a passing electromagnetic wave will have to be considerably modified.

Practical Circuits

Detailed working circuits of the Weagant two aerial system for static elimination may now prove of interest. Fig. 3 shows more fully the station house circuits, with the exception that the centrally located line inductances are not shown. Loading coils *L*-6 and *L*-7 are inserted in the lower lead of each loop and reversing switches *S*-1 and *S*-2 are placed between the loops and stationary goniometer coils, to obtain the most effective working. Variable condensers *C*-1, *C*-2 and *C*-3 are inserted in the centre of each goniometer coil. Another reversing switch *S*-3 is placed in the intermediate tuning circuit which includes the rotating coil of the goniometer *L*-3, the load inductance *L*-4 and the coupling coil *L*-5 acting upon *L*-6 which in turn actuates the oscillation detector *V*-3.

This particular diagram shows an oscillating vacuum tube, the plate circuit being shunted by an inductance and capacity in series, but any type of detector and circuit suitable for damped or undamped wave reception may be employed.

In all the arrangements, the general procedure to balance out static and retain the signal is, in brief, as follows: The rotary coil of the goniometer is placed in inductive relation to one of the two loops: the circuits are then tuned until the maximum signal strength is obtained. A similar procedure is carried out in respect to the other loop. Both loops are then connected to the goniometer, and the third coil is rotated to a position giving maximum signals and minimum static. A finer balance is then obtained by adjusting the inductance, capacity and resistance in both loops.

Commenting upon the results obtained with the two aerial system as installed at the Lakewood, N.J., station, Mr. Weagant said that the station was operated continuously from the middle of July until the end of September with a force of three operators, each working eight hours, copying messages sent out by Lyons, Carnarvon, and Nauen, regularly, and occasionally other stations. This continued operation was undertaken to determine the capabilities of the system in a practical, commercial way, during the worst period of the summer and at all hours of the day. The results secured were most gratifying, the total interruptions experienced being of no greater total duration than those of good cable working between the same points and at the same time of year. It was found that when the signal from the European stations was of normal intensity the heaviest static experienced at any time was unable to interfere in the slightest, but that on the contrary, it might have been very much more severe without causing trouble. Reception under this condition was almost invariably good enough for high speed automatic reception.

A few thunderstorms occurred during this time, and some, but not all of them, prevented reception while they lasted. There were also periods recurring regularly every day between four and six o'clock in the afternoon, and between twelve and two o'clock in the morning when the intensity of the received signals from Carnarvon and Nauen fell off enormously, on some occasions falling as low as 1/100th of their normal intensity. During a few of these fading periods, interruptions were experienced varying from five to ten minutes, to perhaps one hour. The worst of these periods was usually—but not always—the midnight to 2 a.m. period when, although the static was generally lighter than during the afternoon fading period, at which time its maximum intensity occurred, the decrease of signal strength was rather greater. A careful study of the conditions during these fading periods convinced Mr. Weagant that the difficulty was due to the fact that when the signal weakened greatly the click type of static was present in sufficient quantities to cause the trouble, and that when the signal intensity was greatly amplified in order to be heard, the amplification also brought up this disturbance with its ratio to the signal unaltered.

Continued experimenting eventually culminated in the perfection of a three serial system which eliminated most effectively both the grinders and the click type of static, and moreover gave signals of sufficient audibility for continuous reception from European stations of a much lower power than required to give response with the two aerial arrangement. The three aerial arrangement permitted reception through the worst fading periods without interruption.

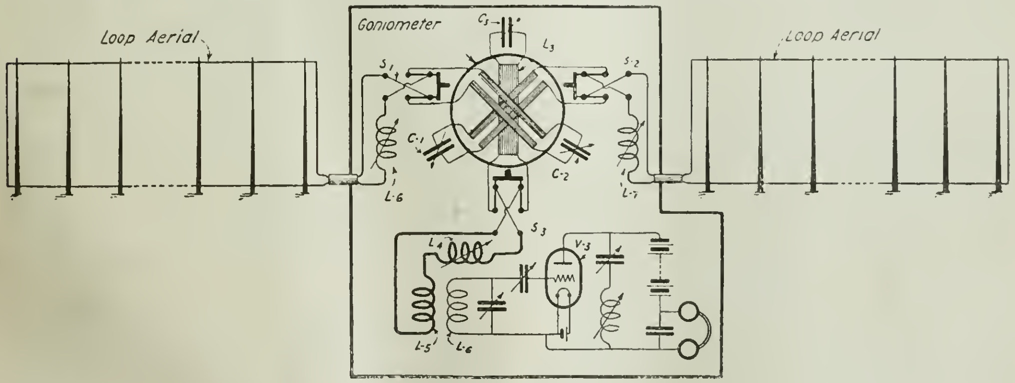

Fig 3.—Circuits of the Weagant Two-aerial System for Static Elimination showing the position of the Goniometer and the necessary Reversing Switches for obtaining a satisfactory Static Balance.

Characteristics of Static.

In support of his theory which classified "grinders" as a type of static which is propagated vertically, and the "clicks," a type which is propagated horizontally, Mr. Weagant declared that continuous experimenting had established beyond doubt that the characteristics of the two prevailing types of static were well defined. The "grinders" are most prevalent in the warm season, between the noon hours and sunrise of the following morning.

Grinders generally produce in the telephone a continuous rattle, with occasional heavier crashes. This type of static seems to be vertically propagated, and certainly affects aerials separated by considerable distances simultaneously. The two aerial system effectually excludes the grinders. The click type, however, which is apparently propagated horizontally, had to be dealt with in another manner.

Defining the clicks, Mr. Weagant said they are widely spaced crashes, and are most noticeable during the cooler periods of the year and day. They do not interfere, except on rare occasions, with signals equal to the normal strength of Carnarvon, Nauen, or Lyons, but during reception from stations of smaller power, such as Clifden, Ireland and Eiffel Tower, Paris, the clicks caused marked interference with the two aerial arrangement, and any adjustments that reduced the click type of static reduced the signal also.

By applying a principle hitherto unknown in radio-engineering, both clicks and grinders were eliminated while the full signal strength of foreign stations was retained. A description of the three-aerial arrangement follows.

(*To be concluded.*)

Tramways and Light Railways Association.

Annual Meeting and Conference.

The annual meeting and conference of the Tramways and Light Railways Association was held at Caxton Hall, Westminster, on July 25th, Mr. R. J. Howley presiding in the absence of the chairman of the Association, Sir Arthur Stanley.

Annual Meeting.

The Chairman, in his report on the work of the Association during the past year, said that the revenue for the year was £788 and the expenditure £750, leaving a balance to be carried forward of £38, which, added to the balance in hand from previous years, makes a total sum in hand of £646, of which £550 is invested in War Bonds. After congratulating the members on meeting under conditions of peace, the chairman said that there were still difficult times to face before matters become normal again. The outstanding features of the past year had undoubtedly been labour and wages. From January to November there had been an uninterrupted series of meetings and negotiations with the representatives of the employees. For the first time the unions put forward demands in the form of national demands, and after consultation with the Council of the Municipal Tramways Association, and at the request of the Ministry of Labour, it was decided to meet the employees on this basis. There were four applications to the Committee on Production, and four awards were given. The first, in March, 1918, gave the men a 20s. war bonus. In July a claim for an increase of $12\frac{1}{2}$ per cent. on total earnings resulted in a further award of 5s. per week. In August a claim by the unions that this should apply to women was successful, and in November a further claim of 10s. per week resulted in an award giving them 5s., bringing the total war bonus up to 30s. per week. Since the Association was not a trade union, able to bind its members, it became necessary to set up a separate body under the auspices of the Association which would be capable of dealing with questions of labour and wages affecting company undertakings. The representatives of the companies were called together at frequent intervals, and finally "The Conference of Tramway and Light Railway Companies" was set up, with an Executive Committee, to whom those matters were now referred. The Municipal Tramways Association had a similar organisation. The outstanding work done by the conference was the settlement of the famous terms of agreement of March 20, 1919, which set up a 48 hours week conditional upon the companies being given general powers to raise fares. Representations were made to the Ministry of Labour, without, he was sorry to say, any satisfactory results being obtained, and the matter was still under consideration. This brought him to the question of the National Joint Industrial Council, which was destined to become the body to deal with these matters in future. A great many meetings and conferences had been held, and a constitution was drafted, which was subsequently approved by all parties for settling up the Council, which was to consist of 44 members, 22 representatives of the employers and 22 representatives of the employees. The former were divided into 14 representatives of the municipal and eight representatives of company undertakings. The latter, who would serve for one year, were elected by ballot as follows: A. H. Beatty, E. H. Edwardes, R. J. Howley, C. G. Tegetmeier, W. G. Bond, H. England, C. J. Spencer and W. G. Verdon-Smith. Once the Joint Industrial Council got to work the Association would be at greater liberty to take up what might be called its legitimate functions—viz., to deal with problems of a technical nature. There was much to be done in the way of reconstruction, and he hoped the Association would be able to resume its pre-war work in setting up committees and experts to deal with pressing questions as they arose.

There was no discussion on the report and accounts, which were adopted.

The following retired from the Council: Sir A. Stanley, and Messrs. Beatty, Bulfin, Chivers, W. V. Edwards, Geod and Sayers, and a vote of thanks was accorded them for their work during the year

To fill the vacancies the following were elected: L. Harvey, general manager Ilford Corporation tramways; H. Holliday, Rhondda Tramways Company; W. B. Pickering, of Messrs. Hadfields (representing manufacturers); W. Shearer, of Balfour, Beatty & Company; R. E. Soames, representing the B.E.T. group; C. J. Spencer, representing the Metropolitan tramway companies; and the Hon. Sir A. Stanley.

Mr. A. W. Chambers was re-elected hon. auditor, and a hearty vote of thanks was accorded him for his services during the year.

CONFERENCE.

The first Paper was "Notes on Tramway Fares and Services," by Mr. W. L. Madgen.

Notes on Tramway Fares and Services.*

By WILLIAM I. MADGEN, M.I.E.E.

There are two criticisms which apply generally to tramways in the United Kingdom. The first of these is that they fail to produce an adequate financial return to their proprietors; the second is that in many respects they fail to give the community all the benefits of which they are capable.

A prosperous industry can accumulate funds available for the improvement and extension of its activities, or can attract the necessary capital for such purposes. A starved industry cannot do this. The effect of an industry being starved is felt in many other ways. The management and all in responsible positions are always conscious of a pinched feeling, deadening to enterprise and making them averse to trying changes which they know will have a temporarily adverse effect on the net receipts, although they believe that they would eventually give good results. This is particularly true of changes, the effect of which depends upon the education of the public, a process which inevitably takes time.

But it is not only the management and those in the more responsible positions who feel the pinch; it re-acts on all employees. In the long run it is impossible for a harassed and despondent industry to make its conditions of service as attractive as those of a healthy and prosperous one.

Some of the directions in which tramways have failed to achieve their possibilities involve improvements which may take some years to become remunerative. It is not to be expected that a starved undertaking can venture on these.

It has to be noted that whilst a number of the municipal tramway systems show good financial returns they are none the less starved, because the bulk of their net receipts are ruthlessly appropriated in aid of the rates, instead of being utilised in the improvement of the service.

It is clear that for a service to be remunerative the sums charged for it must cover the whole of the costs, including capital charges, and provide a reasonable margin. It is also clear that the charges made for the service ought to be equitable—*i.e.*, every passenger should pay his fair share of each of the items of cost involved in carrying him. In transport undertakings some of these items of the cost of service are proportional to the distance a passenger is carried. Some of them are more nearly represented by a fixed amount per passenger.

If, therefore, we can ascertain what these costs amount to *per passenger* in any given case, the result gives a sum which must be exceeded by the fares charged for the shortest journey. The fares for longer journeys should be increased over this minimum in proportion to the distances.

The results of such a scheme of fares are, first, that every passenger pays his fair share; secondly, that the longer journeys are relatively cheaper than the shorter ones; and, thirdly, that the travelling expenses consequent upon living at a greater distance from the place of employment are less than proportional to the greater distance. The last-named effect would be of immense importance in making tramways of greater service to the community.

Taking "standing charges" to include all the costs of having the system equipped and ready to meet the traffic, and the "running costs" as those proportional to the passenger miles, we distinguish a figure for standing charges which can, with entire fairness, be spread equally over the whole number of passengers. The equity of this as regards passengers at the minimum fares is made more apparent by the fact that, taking all the tramway systems collectively, a far larger number of passengers are carried at minimum fares than at any others.

As an example of a particular system Glasgow may be cited, where the minimum fare of one halfpenny was paid in the 1918-19 by 63 per cent. of the total number of passengers

An analysis of the figures in the Board of Trade returns for 1913-14 shows that the average cost per passenger (including depreciation at 4 per cent. and interest at 3·03 per cent.) was 1·105d., the standing charges being 0·544d. and the running costs 0·561d. It has to be observed that these figures are an allocation of the total receipts,

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* Abstract.

"depreciation" and "interest" being an allocation of the net receipts deduced from the returns. From this it appears that the tramway work in the United Kingdom is a starved industry, for a return of 3·03 per cent. is not sufficient to attract capital or to justify its expenditure, nor does it provide a margin for enterprise in improvements and extensions.

The figures show that the basic or fixed charge per passenger to which running expenses proportional to the length of journey have to be added should exceed 0·544d. at pre-war rates, or, in other words, that in 1913-14 every passenger carried should have paid 0·544d. plus an amount varied according to the distance travelled.

This fare would, however, have provided a yield of only 3·03 per cent. on the capital, which, of course, is quite insufficient. A moderate yield is 6 per cent., amounting to 0·340d. per passenger. Taking the depreciation, &c., at 4 per cent. as before, gives 0·227d. per passenger; rent, rates, &c., as before, gives 0·090d. per passenger; and, taking 100 per cent. increase over pre-war prices for the items mainly made up of labour and material belonging to this side of the account, gives 0·120d. per passenger, making a total of 0·777d. as the basic figure for standing charges, to which must be added in each case an amount per mile travelled to cover running costs.

The basic figure of 0·777d. per passenger is rather on the low side, and leaves something to be made up by the passenger-mile charge for depreciation and return on capital, and meets the criticism that a portion of these charges is in fairness proportional to the use made of the system by each passenger.

There are no statistics in the Board of Trade returns or the accounts published by tramway undertakings of the passenger-miles, so that the running expenses per passenger-mile can only be estimated. A fair estimate of the average distance each passenger was carried in 1913-14 for the average fare of 1·105d. is 2 miles, or a total of 6,853 million passenger-miles for running costs of £8,015,579, or 0·281d. per passenger-mile. At post-war prices of labour and material this cost will be doubled, but let us take it on the low side at 0·55d. per mile.

On the bases set out, then, a table of fares against distance would give the following figures:—

	Standing charges.	Running cost.	Total.	Rate per mile.
For 1 mile	0·77d.	0·55d.	1·32d.	1·32d.
„ 2 miles	0·77d.	1·10d.	1·87d.	0·935d.
„ 3 „	0·77d.	1·65d.	2·42d.	0·806d.
„ 4 „	0·77d.	2·20d.	2·97d.	0·742d.
„ 5 „	0·77d.	2·75d.	3·52d.	0·704d.

This table is an illustration of the plan on which an equitable fares table can be made up. It is believed to give fair average figures for United Kingdom tramways under post-war conditions. It is submitted that this is a sound method of settling fares, and that it will tend to raise the tramway industry, legislation permitting, from the position of being starved to one in which it will be moderately prosperous, and therefore able to attract and to expend capital in improvements and extensions. Although it is admitted that tramways have done something to spread the population of large towns, it is believed that the practice of giving very low fares for short distances, which militates against reasonable financial returns, has another very serious effect, in that it encourages people to continue to live at distances from their work within the radius of the minimum fares. The most serious social fault of the systems of very low fares for short distances is that they discourage families from moving outwards.

There are two obvious difficulties against setting up a rational fare system. The first is that tramway fares are generally limited to a maximum of one penny per mile, and any sound system—at present costs—must charge more than a penny for the first mile. Besides this general statutory obstacle, there are numerous provisions in special Acts and Orders, agreements between companies and local authorities, and the like, setting out scales of fares or maximum fares which cannot be reconciled with the principles laid down.

There is another difficulty about the application of rational ideas to tables of fares—viz., the coinage. The table already set out gives the following figure for distances from 1 to 5 miles:—

Distance.	Fares.	Nearest coin value.
1 mile	1·32d.	1¼d.
2 miles	1·87d.	1¾d. or 2d.
3 „	2·42d.	2½d.
4 „	2·97d.	3d.
5 „	3·52d.	3½d.

For the first 2 miles the nearest coins include farthings, and, even so, the difference between the theoretical fare and the nearest coin is a somewhat large percentage of the total. Farthings are not popular. An attempt to rationalise tramway fares by the use of them was made some years ago on a number of systems, and after patient trial was withdrawn.

The penny has too small a value for the minimum fare, because the standing charges item alone is nearly 0·8d., and the length of ride which could be given for the 0·2d. balance is too small for a stage. Therefore the minimum fare must exceed one penny, and it should be a single coin. The writer strongly advocates the adoption of the decimal system of coinage as approved by the Associated Chamber of Commerce, the Institute of Bankers, the Decimal Association and by numerous other bodies, including your Association. This system divides the £1 into 1,000 mils, and includes the provision of a 5 mil nickel coin of the value of 10 to the shilling. This is equivalent to 1·2d., and would suit a rational system of fares very well. The value is a little lower for the mile distance as set out above, but that table is only an illustration based on collective figures. The actual length of the stages will in every case have to be adjusted to the circumstances and costs of the particular system. There is no need to keep to even miles in making this adjustment. As it is, the lengths of fare stages are rarely based on even miles. The vary on different routes on the same system, as the stages are in practice defined by traffic points, junctions, &c. There is no more difficulty in fitting the stages to the coins of a decimal system than to the halfpennies and pennies now in use. Five mils is a better starting point than a penny or the nearly equivalent four mils, and there are very strong reasons in other directions for making the coin, which has probably the greatest use in retail transactions, of the slightly higher value.

There is not time to say much on the question of services. The author believes that the power of the tramway to give frequent service is not, perhaps, so generally recognised or utilised so fully as we may hope it will be under more encouraging conditions. Frequency of service has an extraordinary power of developing traffic. The aim of the tramway manager is to run every car-mile on every route which will pick up anything in excess of its standing charges and bare cost of running. This object cannot be attained by calculating from the number of people served and the minimum service which can suffice them. To attain the object calls for a continuous study of the habits and tendencies of the population, their working hours, shopping hours and places and times of recreation, entertainment and any other factors tending to induce them to travel. This means adapting not merely the daily normal service, but adding more cars at suitable hours in accordance with the local circumstances. The formation of the travelling habit in the people living along any route, and the attraction to living on that route of people who have the travelling habit or travelling needs is fostered by the appeal of a good service more effectively than by any other means. It is clearly better to have a car making only a small net revenue per mile than to be standing idle in the shed.

An enterprising manager will keep his services rather a little better than apparent necessities than a little below them. Experience shows that this policy pays. In some instances a route which has not paid during the dull hours of the day with a poor service has responded so well to a more frequent service during those hours that it has paid continuously.

DISCUSSION.

Mr. C. J. **Spencer** said there were many points raised in the Paper which deserved extended discussion. The first point, as to the allocation of the costs of tramway working under the headings of "standing charges" and "running costs" was a novel one, but it had received too little attention among tramway operators. He agreed with the author that the passengers should pay something which represented standing charges. If a passenger merely stepped on to a car and stepped off again after travelling only a few yards he should, at any rate, pay the standing charge, even if he might have incurred only a very small proportion of the running costs. On the calculation in the Paper, it was obvious that this standing charge was something like ¾d. under present circumstances, but he was inclined to think that the figure was a good deal larger than that. Taking it at ¾d., however, it meant that the ½d. fare was uneconomical and unsound, and could not under present circumstances be continued with safety. Mr. Dalrymple, of Glasgow, who had had many years' experience with ½d. fares, was present, and he hoped he would contribute to the discussion. Mr. Madgen's argument that running costs plus the standing charge per passenger were more than 1d. he thought the experience of all of them would uphold as absolutely sound. That meant that no passenger should be carried even for a penny. On his own system he had, like most other people, been faced with the problem of rising expenditure with practically a stationary income, and he took advantage of the powers he had to enforce a minimum fare of 1½d. He could have enforced a minimum of 2d., but the 1½d. fare immediately lifted the undertaking out of the financial morass in which it found itself, and he believed that that was the only sound and proper way of dealing with the position. Merely to shorten the stages was not right, because by doing that the burden was placed unequally on the shoulders of the passengers. A great proportion, perhaps 50 or 60 per cent., paid no increase at all, because they had been in the habit of riding a mile or less, and the shorter stage did not affect them. On the other hand, the long-distance passenger had to pay sometimes 100 per cent. more, and he naturally kicked. According to

Mr. Madgen—and he himself believed the argument was sound—the long-distance passenger should be carried at a cheaper rate than the short-distance passenger, whereas by shortening the stage the reverse took place. It was impossible to continue to operate tramways with present revenues. The last few months in London had been good months from the revenue point of view, but there were good reasons for believing that these months had been abnormal, and difficult times were ahead. Under the old system of setting aside 1d. per car-mile for track renewal—which was considered a handsome sum before the war—certain funds had accumulated; but, in view of present costs, they were totally inadequate, and ought to be at least double. Therefore, unless they got more revenue, he was afraid the outlook was serious. On the other hand, he was not sure that tramway managers had done all they might have done in working on scientific lines. At the same time, he was heartily in agreement with the suggestion to start a propaganda movement in order to educate the public to the need for higher fares, for until the public understood, the Government would never understand.

Mr. A. L. C. Fell said that the tramway managers who appeared before the Select Committee recently were treated more like criminals than tramway managers. He failed to see why newspapers, for instance, should be allowed to charge 100 per cent. more than they did before the war, whilst tramways were abused up hill and down dale for increasing fares by 33 per cent. in order to meet the abnormal conditions of the times. He personally was a great believer in charging the lowest possible fares in order to encourage traffic, and he was especially a believer in giving a long-distance passenger a cheap fare, because it encouraged him to settle down, and his family made use of the tramways for short distances, so that what was lost in one way was gained in the other. The London County Council had extraordinary burdens upon it, and it was necessary to take steps to get relief from them. The same applied to tramways generally in the metropolitan area, and to the company as well as the municipal undertakings. It was a most unfair thing, for instance, that the tramways should be made to pay for all the improvements which had had to be made when the tramway was built. The L.C.C. contributed enormous sums towards the widening of streets, and yet omnibuses and other vehicles also used the same streets without paying a penny towards the improvements. When a tramway was built the road surface was repaired and reconstructed, and immediately it was completed a competing service was put upon it. There was also the great burden of rates on permanent way, which ought to be considered by Parliament; whilst in regard to track maintenance, tramway undertakings had to look after half the street which they did not wear out. That condition was imposed in the distant days, when horses worked the trams, and had never been removed now that electric traction had been introduced. There were also the present extraordinary labour burdens, and a striking example was in connection with Peace Day, when, owing to the various agreements made with the Transport Workers' Federation, which included extra pay for Peace Day, the wages on that day on the L.C.C. tramways amounted to £18,000, whilst the takings were about £14,000. Peace Day was hardly an occasion for rejoicing on the part of the L.C.C. tramway management. In his opinion, tramways in this country had reached the saturation point, and unless some relief from the burdens to which he had referred was given, some other means of locomotion would have to be invented, because no tramway could exist except merely as a rate-aided concern. He hoped that the tramway undertakings would carefully consider the matter before giving anything further away which would damn the tramway industry.

Mr. James Dalrymple said his view was that tramway passengers should be carried at the lowest possible fare after meeting all expenses and fixed charges, and contributing a reasonable return on the capital invested. In Glasgow over 60 per cent. of the passengers paid ½d., which meant that the average revenue per passenger was extremely low, slightly over ¾d. It was many years ago since he tried to show that it would be a mistake to give the ½d. passenger too great value, because it took more than ½d. to put the car on the street. The Glasgow people thought otherwise, and extended the ½d. stage from half-a-mile to considerably over a mile. The result of the change, however, was that not only was the deficiency caused by the transfer of penny passengers made up, but so many more people were carried that the total revenue was greater. The cost was greater, as it took more cars, but the result was nevertheless remarkable. Before the change the cars were considered overcrowded, the average number of passengers carried per car-mile being 11 or 12, but now he had actually touched 20 per car-mile. The result was that the revenue was greater than it ever had been, and it was very difficult in these circumstances to persuade the travelling public that there was any need for an increase in fares. At the same time, he believed they would have no difficulty in obtaining an increased fare if they could show that the return to-day was not equivalent to what it was in 1914. That was the great difficulty, because very few of them could say that, owing to the increases that had lately been made in fares, even if the latter were below the statutory limit. He himself was not so anxious about the position to-day as he was with regard to what it was likely to be two or three years hence, when there would be less money to spend on tramway fares, and expenses would not be much less than they were to-day. It would then be imperative to increase the revenue, and how that was to be obtained was a difficult problem, because experience had shown that an increase in fares did not always mean an increase in revenue. In Glasgow every reduction in fare had resulted in increasing the gross revenue. In Glasgow in the past the present fare had not only enabled them to carry on the undertaking, but to wipe off the whole indebtedness, but last year, owing to the increased expenditure, there was only a sum of £17,000 to hand over to the Common Good, in spite of the fact that there was nothing to charge on the capital of £4,000,000, and not a penny was charged to sinking fund, because there was no necessity to do so. That was not as it should be, and he had now suggested to the Corporation that the fares should be increased, not so much to meet present conditions, but in order that the undertaking should be kept in the future, as it always had been, in a thoroughly efficient condition.

Mr. W. G. Verdon-Smith asked whether it was not a fact that the low fares in Glasgow had caused the congestion which existed in the centre of the city.

Mr. Dalrymple said the population was in the centre before the tramways were there, and he did not know that it could be that the tramways had caused the congestion. The low fare may have caused a number of people to stay near the centre. At the same time, it often happened that a man had to travel a considerable distance to his work, although he lived in the centre, whereas his family would be working as well as living near the centre, and to them the ½d. fare was a great advantage.

Mr. E. R. Soames asked how many times the Glasgow population was carried on the tramways in a year. Did the ½d. fare make people travel more frequently than in other towns?

Mr. Dalrymple said he had not the figures with him, but there was no town in the kingdom where so many people were riding on the trams as in Glasgow. The population was one million, but last year the trams carried 460 million passengers.

Mr. C. G. Stanley suggested that the very low fare encouraged the overcrowding of the long-distance cars for the first mile with short-distance passengers.

Mr. Dalrymple said that was undoubtedly the case.

Mr. Stanley thought that was a point which would have to be dealt with. Mr. Madgen's remedy was to give the long-distance passenger rather more for his money than the short-distance passenger—*i.e.*, a lower fare per mile. That was sound as far as it went, but it did not go far enough towards solving the problem, which would be very acute in the future. The Paper was entitled "Notes on Tramway Fares and Services," but seven-eighths of it was concerned with fares, and, having regard to the admirable way in which fares were dealt with, he wished similar attention had been given by the author to services. Unless there was an alteration in the present system, we should continue to have cars crowded with short-distance passengers for the first mile or so and then being half empty, whilst long-distance passengers were left behind at the start. Even encouraging the long-distance passengers would not keep the short-distance passengers out of the car. At the present time he was not at all sure that the long-distance passenger was being given what he wanted. Cars maintained a very low average during the first portion of the journey through the more crowded areas, and later the average speed was low on account of the numerous stops. What the long-distance passenger required was a car, which now made 20 or 30 stops and did a journey in three-quarters of an hour, should make half a dozen stops and get through in half the time. It might seem Utopian, but unless something of the sort could be done, then, he maintained in all seriousness, that tramway transport would not be the transport of the future, or even the near future. At the request of the Government, a large number of "request" stops had been abolished, and that was an unmitigated blessing, and that policy should be extended, because he failed to see why a tramcar should be called upon to stop every 150 yds. or so. If the stops were placed a quarter of a mile apart no one would have to walk more than 220 yds. to a stopping place, and that was not usually considered an unreasonable distance in the case of a railway. Many a man would walk several times that distance to a train. Another important matter in relation to service was acceleration. He would probably be told that that could not be done, but something should be done on the lines of non-stop cars. A few years ago to run non-stop trains on the District Railway from Sloane-square to West Kensington would probably have been characterised as impossible, but it was now a commonplace, and he was convinced that the question of running non-stop cars for the benefit of the long-distance passenger would have to be very seriously tackled in the near future if tramways were going to carry the traffic.

Mr. R. Hogg said he did not think the evidence showed that the public required any teaching in the manner suggested by the author. In the case of the underground railways in London, for instance, the fares had been increased by something like 50 per cent., and that had not been resented in the slightest degree. (Cries of "Oh.") In addition to that the passengers in the tubes were packed like herrings, and it was this which was grumbled at more than the fares. In his own town he had been able to raise the minimum fare to 2d. under powers which he already possessed, but which had not been exercised, but the people did not grumble. They crowded the cars just as much as formerly. What was wanted was better accommodation, and that could not be given unless the fares were raised.

Mr. E. R. Soames said he did not quite see eye to eye with the previous speaker. It had been announced in the papers that the House of Commons Traffic Committee would report that the increase of fares was unjustifiable, and that made it clearer than ever that propaganda was necessary for educating the public as to the true position of tramways. No impartial observer of the proceedings before that Committee could come to any other decision than that there was an overwhelming case for an increase in fares. Further than that, when the figures of the London General Omnibus Company were submitted to an impartial auditor, he expressed the opinion that the increased fares were absolutely justified up to the end of 1918, and yet in face of that the Committee was prepared to circulate to the public a recommendation that the fares were not justified. That was a very serious matter, and demanded that the education of the public should be taken thoroughly in hand. For that purpose money was needed, but he regarded a sum of £10,000 or more as a fleabite to the industry as a whole, having regard to the benefits which would be derived. He therefore hoped that steps would be taken to obtain the necessary funds. With regard to Mr. Dalrymple's remarks as to the effect of an increase in fares, his own experience, both in London and in Wales, was that an increase in fares had in every instance produced an increase in revenue.

Mr. J. M. McElroy said the one fact which all tramway managers had to face was that the cost of operating had gone up by 100 per cent. Someone had to pay for that, and that person must be the tramway rider. It was necessary not to draw wrong inferences through dividing the cost into standing charges and running costs. In Glasgow on one occasion the standing charges had been divided by the total number of passengers, and that revealed a figure of rather less than ½d., and the inference was drawn that the ½d. passenger was being carried at a loss. When the number of ½d. passengers increased, the prosperity of the Glasgow tramways increased, and this showed that the inference was not correct. The policy in Manchester was diametrically opposed to that of Glasgow, where the short-distance passenger was catered for. In Manchester the long-distance passenger was catered for on public health grounds. It was the desire to spread the population as much as possible, and a passenger was carried three miles for a penny. Statistics showed that that policy, during the past 10 or 12 years, had been absolutely successful in spreading the population. The question was how were the increased costs being met to-day. In some cases it had been possible to increase the fares within the statutory limit, and in others the distance carried had been reduced. In many other towns the statutory fare was being charged, and not only were they for the most part keeping their heads above water, but they were doing better than they were in pre-war days. An investigation had just been made of the municipal undertakings with a view to seeing whether a case for an increase in fares could be supported, and it was found that there was no case. Prosperity was going on, but at what expense? In Manchester and other large towns he ventured to say that the increased expenses were being met in a way which was not beneficial to the travelling public. The cars were overcrowded, and the travel was very much less comfortable than it used to be, and he agreed with Mr. Dalrymple in believing that the present prosperity would not exist in two or three years time. At the same time the public would have had enough of the overcrowding, and would want decent and reasonable travelling, and that must mean higher fares.

The Chairman thought the discussion had borne out the fact that it was the short-distance passenger who got the benefit of the cheap fares. Having regard to the need for spreading the population as much as possible in the interests of health, their aim should be to consider fares from the point of view of giving the best value to the long-distance passenger. The fact that the short-distance passenger crowded out the long-distance passenger was demonstrated in his own long-distance omnibus traffic, and there had been a minimum fare imposed on the 'buses of such a nature that the omnibuses would not interfere with the local tramway traffic. He welcomed that, as having the effect of preventing the 1d. or 2d. passenger crowding out the 6d. or 8d. passenger. He agreed with previous speakers that although there would be a great outcry and much grumbling at a suggested increase of fares, the average passenger would pay if he were satisfied that he was getting value for his money in the way of a reduction in overcrowding, and more comfort generally. There was a great necessity for bringing to the notice of Members of Parliament and the public the disadvantage in the national interest of allowing the tramways of the country to get into a bad state financially, and it was only by pegging away that they could bring this point of view to the notice of those who had to deal with these matters. Such propaganda was necessarily costly, but they need not be frightened by the suggested fund of £10,000. A great deal could be done at comparatively small expense by feeding news items to those who were willing to publish them, and by every person connected with the tramway industry taking the matter into his own local centre. It was in that way that he would ask them to consider the question of propaganda rather than that a large sum of money should be immediately subscribed. A fund was required, but it would grow gradually.

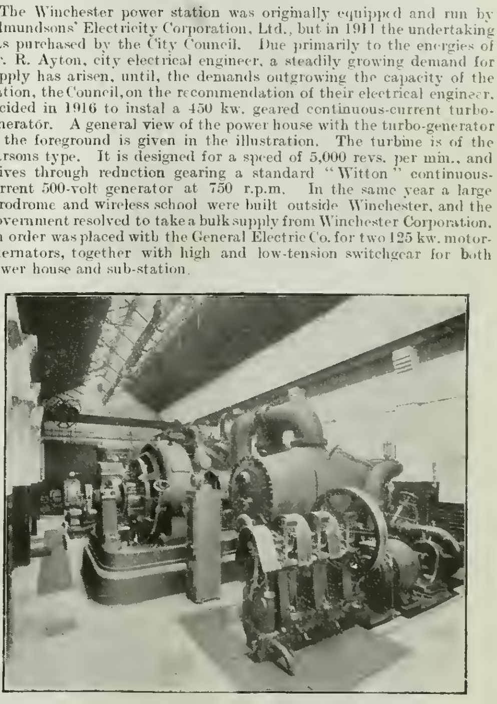
Mr. Madgen, replying to the discussion, agreed with Mr. Stanley that he ought to have dealt more fully with the question of services in the Paper, but he felt that the question of fares was so important that he had little space left to deal with services. Perhaps Mr. Stanley himself would present a Paper on that aspect. He was glad Mr. Fell had drawn attention to the hardships under which tramway undertakings suffered at the present time, and part of the propaganda which he had suggested should be directed towards getting the tramway industry emancipated from these troubles. It would be a great help if they could have the same principles of rating applied to tramways as were applied to light railways, which were only tramways, viz., that they should pay only one-quarter of the district rates. At present tramways were fully rated. Again, justice demanded that they should not have to pay for the upkeep of the track, seeing that they did not wear it out or even use it. He supposed it was too late to expect any retrospective justice with regard to street widenings, but many tramway undertakings had been most seriously handicapped from the start owing to the cost of street widenings. In America and on the Continent vestibules were allowed in the front and back of the cars for the use of smokers, and it would be an advantage if we were allowed to do that in this country. He believed that it was through some mistaken notion that horses were still in front of the car, and that on humanitarian reasons they ought to be considered. The application of the Tramway Act of 1870 to conditions to-day was most unreasonable, and he was very glad attention had been drawn to that. If he understood Mr. Dalrymple, what he was doing in stimulating the ½d. traffic was merely churning up the crowd within a certain zone, and he did not suppose Mr. Dalrymple would consider that a desirable thing to do, except in the interest of the undertaker or the cinema proprietor. He agreed with Mr. Hogg that there were a lot of reasonable people who would not complain of increased fares if they were made to understand the facts. Propaganda, however, as the Chairman had pointed out, did not mean thousands of pounds expenditure. A great deal could be done locally without much expense, and he would be glad if the Council of the Association would deal with the question, not only as regards fares, but also in regard to track maintenance, street widenings and means by which vestibules could be used in the front and back of cars.

A hearty vote of thanks was accorded Mr. Madgen at the conclusion of the discussion.

(*To be concluded.*)

New Plant at Winchester.

The Winchester power station was originally equipped and run by Edmundsons' Electricity Corporation, Ltd., but in 1911 the undertaking was purchased by the City Council. Due primarily to the energies of Mr. R. Ayton, city electrical engineer, a steadily growing demand for supply has arisen, until, the demands outgrowing the capacity of the station, the Council, on the recommendation of their electrical engineer, decided in 1916 to instal a 450 kw. geared continuous-current turbo-generator. A general view of the power house with the turbo-generator in the foreground is given in the illustration. The turbine is of the Parsons type. It is designed for a speed of 5,000 revs. per min., and drives through reduction gearing a standard "Witton" continuous-current 500-volt generator at 750 r.p.m. In the same year a large aerodrome and wireless school were built outside Winchester, and the Government resolved to take a bulk supply from Winchester Corporation. An order was placed with the General Electric Co. for two 125 kw. motor-alternators, together with high and low-tension switchgear for both power house and sub-station.



Engine Room at Winchester.

Each of the motor-alternator sets comprises a standard continuous-current interpole motor and a standard three-phase 500-volt 50-cycle alternator. The sets are started up by means of multiple switch starters; the three-phase energy from the alternators is transformed up from 500 to 6,600 volts and brought direct to the G.E.C. high-tension switchboard. The high-tension switchgear consists of two machine panels and a feeder panel. The machine panels are equipped only with oil switches and one ammeter each, and the feeder panel is equipped with oil switches and three ammeters, one for each phase. A synchroscope, power-factor meter and frequency meter, also main and synchronising voltmeters, are fitted on swinging brackets at the end on the board, which is of the G.E.C. standard boiler-plate cubicle type, with surge arresters mounted in cubicles at the top. The sub-station switchgear is similarly constructed, consisting of single high-tension transformer cubicle and low-tension alternating-current switchgear. The two generating sets run perfectly in parallel, and supply the whole of the current to the two depots.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Induction Coils in Theory and Practice." By F. E. Austin. (London: E. & F. N. Spon) Pp. 64. 5s. net.

"Senior Practical Chemistry." By H. W. Bausor, M.A. (London: University Tutorial Press.) Pp. viii.+217.

"Vergesellschaftung Industrieller Betriebe." By S. Herzog. (Zurich: Rascher & Company.) Pp. 97.

Electric Welding: Its Theory, Practice, Application and Economics.*

By H. S. MARQUAND.

(*Continued from page* 92.)

Summary.—In the present article the author deals with the preparation of welds and then passes on to certain properties of iron and mild steels which have a marked bearing on the methods adopted. The welding of copper and copper alloys has not received very much attention, but electric welding is nevertheless applicable to such work. Finally, examples are given of various types of welding.

The anchor (Fig. 55) had been welded up under the steam forge three times and failed to pass Lloyd's tests each time. The author's firm undertook to repair the anchor electrically, and chance that the metal in way of the fracture had not been perished. The fracture was cut out entirely by means of the electric arc, and welded up and slightly reinforced, as shown (Fig. 56), with great success. The anchor weighed over 7 tons. A large number of anchors are dealt with in this way. Sometimes a large or small piece breaks off one of the flutes, and a new piece can be forged or cast and welded on, so that it is very difficult to tell that any repair has been made. Again, often the eye,

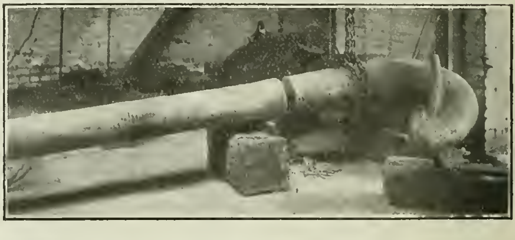


Fig. 55.

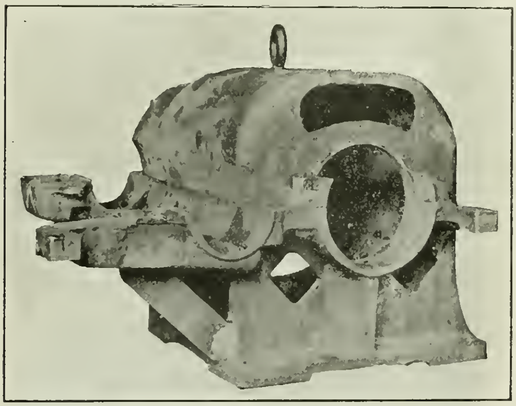


Fig. 57.

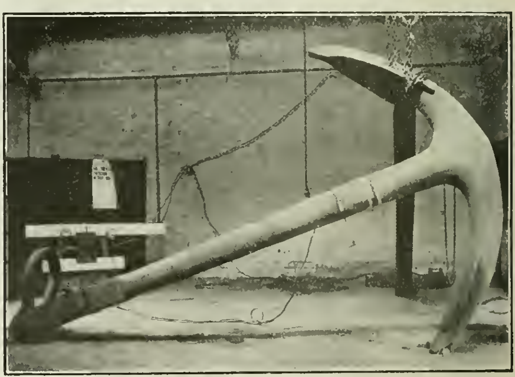


Fig. 56.

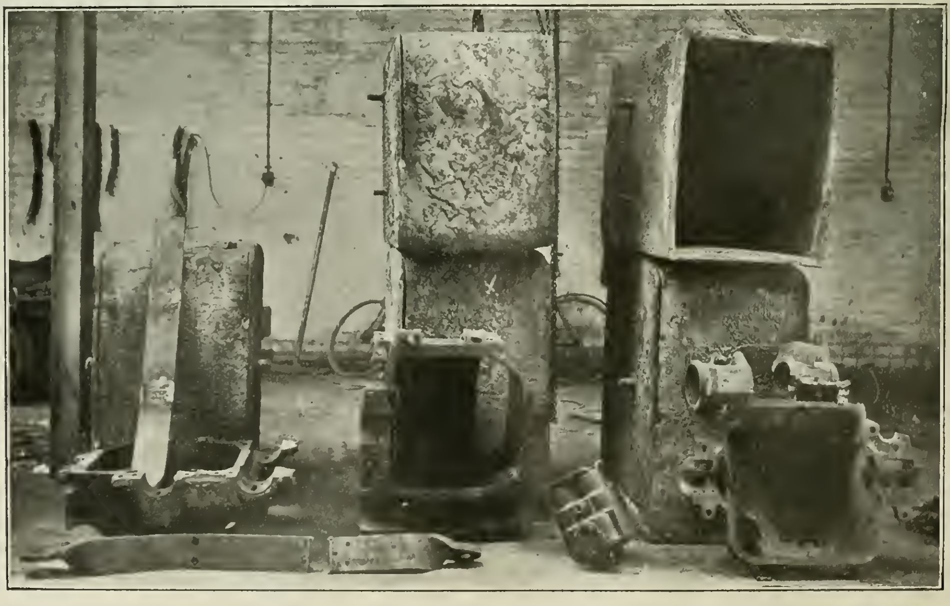


Fig. 58.

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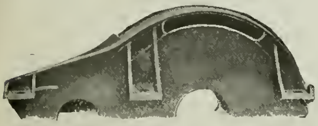
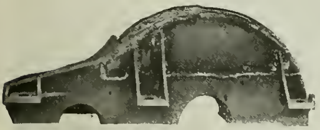
for the shackles give out; these can be cut out by the arcs welded up solid and even reinforced.

Again, the electric arc welding process has proved of the greatest value to tramway systems, especially during the war,



Tramway Gear Case with hole cut in side by gear wheel.



The same case repaired by the E. & E. Electric Arc Welding Plant.

Fig. 59.

as by its use it has been possible to repair badly worn sections of the track, and thus avoid the laying down of new rails. For building up hammered joints the process cannot be excelled, and a large saving in track maintenance is thus effected. Many corporations now bond their rails by means of arcwelding.

For these purposes a light portable motor-generator set can be used, the motor being run off the trolley wires. When the

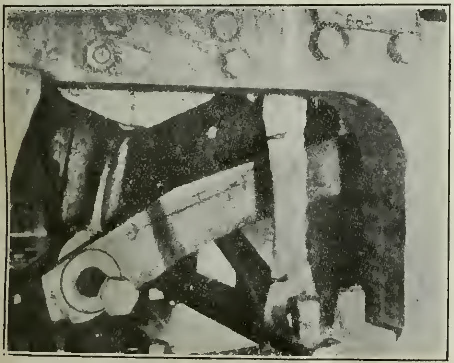


Fig. 61a.

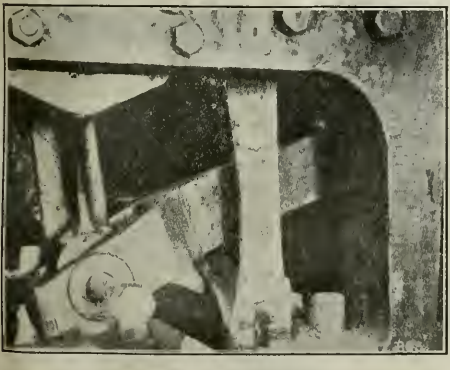


Fig. 61b.—Locomotive Repairs (also Fig. 61a).

plant is not required for track work it can be used in the tramway shops for carrying out all sorts of repairs, such as building up worn brake bars, cracked gear cases (Fig 59), motor frames (Fig. 57), flats on wheels, broken or cracked suspension bars, worn bolt holes, couplings, &c. (Fig. 58) can all be made good and put into commission again

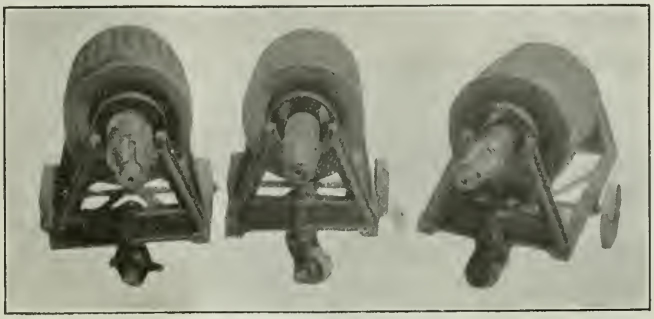


Fig. 60.

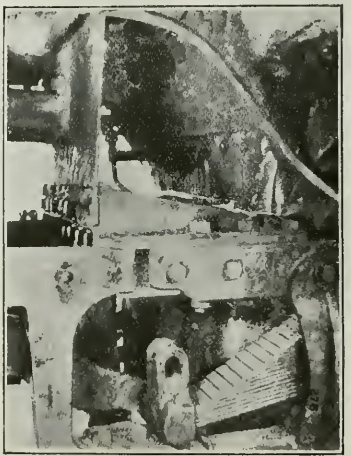


Fig. 62a.

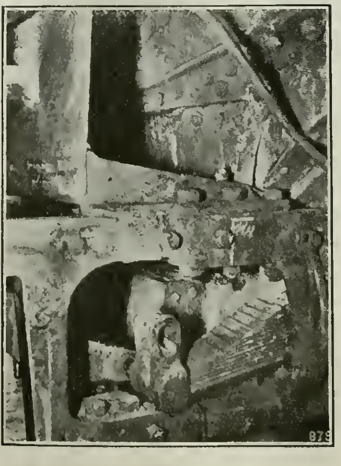


Fig. 62b. Locomotive Repairs (also Fig. 62a).

Armature or gear shafts can, when worn, be built up and returned to size (Fig. 60).

A common accident to motor yokes or frames is for the bearing brackets to break off, due to the gears fouling. These can be welded on again quite successfully (Fig. 58), thus saving time and valuable castings.

However, most of this work should only be performed by thoroughly experienced operators, as no doubt of reliability is permissible.

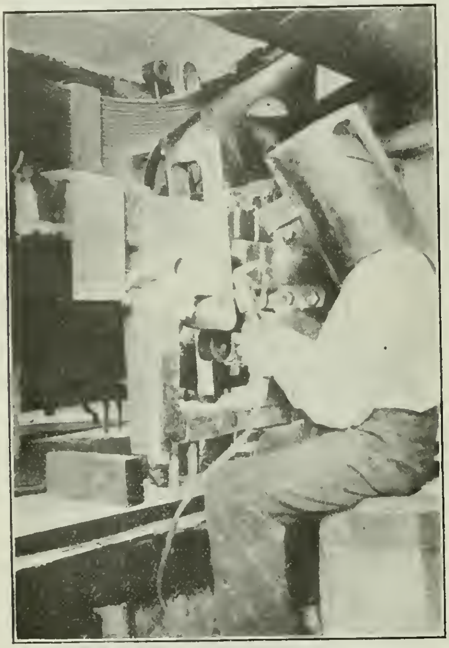


Fig. 62.—Carrying out Repairs to a Locomotive.

It can easily be seen that arc welding can be of great service in the railway shops.

Figs. 61, 62 and 63 illustrate repairs being effected to locomotive frames. Fractures in the main frames, horn cheeks, wheel rims and spokes, &c., can first be cut out by the graphite arc and afterwards welded; and, if convenient, reinforced by either the graphite arc system, if the parts are disassembled and can be turned about, or by the metallic arc in position.

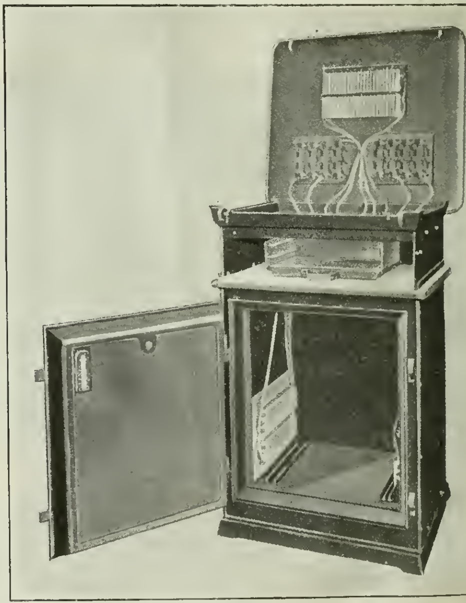
(*To be continued.*)

Heating and Cooking Notes.

The "Purser" Electric Oven.

"Creda" fires and irons have long since obtained an established reputation, and this year the Credenda Conduits Company, Ltd., have added the "Purser" electric oven to their list of heating and cooking apparatus. It was realised that the main source of wastage and inefficiency in connection with electric ovens was radiation losses, and therefore the main idea in designing this oven has been to provide as perfect heat retaining properties as possible. The walls of the oven are very heavily lagged, and a specially designed and patented type of door fits tightly into the oven doorway. The sides of the doorway and the sides of the door frame are wedge shaped, and when the door is closed the oven is practically sealed. The internal cooking space of the oven is 21 in. in height, 14 in. wide and 15 in. deep, and the loading is 3 kw. The elements are of the open radiant type, fixed at the bottom of the sides of the oven. Easy access can be obtained to the oven elements and connections by removing the sliding shelves and perforated protecting shields. A hot plate hob and a grill are mounted on the top of the oven. The hot plate is a one piece casting, with heating elements mounted on the underside, giving a variety of temperatures according to the position of the controlling switches and the position of the cooking utensils on the hob. By placing the utensil immediately above the element and using full heat quick boiling operations can be carried out, whilst the surrounding portions of the hob will give sufficient heat for simmering purposes. The grill is of the usual radiant type and consumes 1·5 kw. The two hot-plate or hob elements consume 1·5 kw. each at full heat, so that the cooker, all on, consumes 7·5 kw. The hot plate is hinged to the main casting, and can be conveniently lifted up when it is desired to obtain access to the connections. Four rotary-type switches, mounted on a separate switchboard, are employed for control purposes, the leads being carried from the cooker to the switchboard in flexible metallic tubing. Four fuses and pilot lamps are also provided. The illustration shows the cooker with hob lifted up and oven shelves removed, revealing the arrangement of the connections and internal wiring.

In a recent test the oven attained a cooking temperature of 350°F. in 23 minutes. A joint of beef weighing 10½ lb. was then placed in the oven and the current left on for a further 12 minutes, when the temperature was 394°F. All switches were then turned off, and the heat retained in the oven was sufficient to completely cook the joint. That is, 3 kw. were employed for 35 minutes, the consumption of electrical energy for cooking 10½ lb. of meat being just under 1¾ units. These figures undoubtedly show that the oven possesses particularly good heat retaining properties. A larger type of oven is made for restaurant uses, being loaded to 10 kw. and having a cooking space 44 in. in height, 23 in. in width and 24 in. in depth. The only essential difference in the design is that two doors are employed instead of one. In addition to "Creda" fires, this firm are now manufacturing a complete range of cooking appliances, comprising grills, boilers, steamers, fish fryers, carving tables, hot cupboards, stock pots, fish boilers and urns.



The "Purser" Electric Oven.

Simplex Conduits, Ltd., have just placed upon the market two new designs of lightly loaded heaters, suitable for portable and auxiliary heating. Both types are supplied complete with flexible cord and lamp-holder adapter ready for the customer. The reflector type, known as the Plexsim Firette, is loaded to 600 watts; but, the conical element being highly radiant, the effect of heat emitted along the lines of reflection is much greater than would be expected from so low a

loading, making this particular pattern suitable for use in cold rooms, where the heaters can be placed in near proximity to the person desiring warmth. In bedrooms, dressing rooms or for piano practice there is nothing less expensive or more satisfactory.

The cabin type, which is known as the Plexsim "Onebar" Fire, consists of a robust cylindrical iron case with open perforation on one side, in the interior of which is a Plexsim luminous fire bar, loaded to 500 watts. The heater is very strong, and will stand rough usage; the bar, being suspended on springs, is practically unbreakable through shock. It is particularly suitable for ships' cabins, small offices, cubicles, crane cabins and similar positions; and it is also very useful for domestic purposes, the position of the luminous bar being adjustable so that it can be arranged for fixing to the wall or floor.

Increased Production.

By Major E. A. PELLS, R.E.

There is hardly a newspaper or periodical one takes up that does not hold forth on the absolute necessity of increased production in this time of reconstruction that is now upon us, and when the matter is considered carefully every thinking person must come to the conclusion that unless we can obtain this much talked-of necessity, the era of peace and prosperity, which we are all looking forward to, now that the war is drawing to a close, will either not arrive or be very long deferred.

Politicians of all grades of thought, accepted leaders of all classes, have all joined the common outcry, and yet hardly are the signatures dry on the armistice terms, which apparently precede a definite peace, than a well-known trade union issues an ultimatum which practically demands limitation of output. There seems to be something wrong here, for only a week before a prominent labour leader had been urging the necessity of increased production. The why and wherefore of this does not enter into the scope of this short article, but it tends to prove that although practically everybody agrees with the importance of increasing our productive capacity, yet very few have any notion of what this means in the world of industry. Politicians and theorists may urge the idea with the power of fluent oratory, but it remains with the engineers, manufacturers, managers and operatives of the world of industry to provide the solution in practice.

Let us put it all in a nutshell. The operative wants less hours and increased pay. The employer wants increased production and lower production costs, and amazing as it may appear, the two apparently diametrically opposed demands go together and can be obtained by carefully calculated "Scientific Management" or "Efficiency Methods."

The term "scientific management" was first used by the eminent American engineer, Dr. F. Winslow Taylor, and was not, as it has been called, the emanation of an American quack. Dr. Taylor has had many followers in America, but I am sorry to say very few on this side of the Atlantic, and I submit that the day has arrived when we can ignore these methods no longer. Management, as such, can no longer be simply the triumph of mind over matter. For one thing matter is getting a mind of its own and can appreciate many things that it could not a few years ago, and also the day of haphazard methods are past and management must be studied as a science, embracing many side issues, which can only be authoritatively dealt with by specialists.

It is rather peculiar that the popular conception of American methods of management is that of a hustling bully of a manager speeding up his poor employees by driving them to the expenditure of their last atom of strength and energy, when actually it is the exact opposite and two of the principle points in the "Taylor System" is the sympathetic foreman instructor and the careful arrangement of correct rest periods. In fact, the whole trend of thought underlying the idea of scientific management is the conservation of energy, so as to secure a maximum output from a minimum of effort.

Many British manufacturers have already appreciated the value of the careful layout of their works so as to ensure a routing of the products without unnecessary double handling or cross traffic, but the "Taylor System" goes further and advocates motion study which is practically the study of routing as applied to the individual worker. By careful motion study of each element of a complete operation, it is often possible to eliminate as much as 50 per cent. of the energy expenditure and the operation being performed many times during the day, the consequent saving enables the worker to get through more and finish fresher.

Then, we have in the world of industry, as in the world of sport, men who excel at their particular job and might be spoken of as being of championship form, as in sport, these men's times can be taken and set up as standards and something for the weaker workers to aim at. Then these men of championship form can be placed in the position of instructor or coach. We never expect any man to excel in any kind of sport unless he is well coached and we pay the coach well for doing his part, whilst we pay the man he is training well if he succeeds. We do this in sport and why shouldn't we do it in industry, too?

This is provided for by cleverly arranged wage systems which, while encouraging the weaker worker to make the necessary effort to attain to the degree of efficiency set by the best worker, yet also gives the best worker his just and equitable reward. That is why the "Taylor System" has proved popular with the workers, wherever it has been installed. The workers find that they are getting full value for the work they put in; in other words, a square deal, and it is because of this fact that I consider that British workers have only to work under the system to appreciate it.

All the foregoing may give the results promised but they can easily be nullified by either lack of correct costing or a bad system of costing. Unless the manufacturer is able to arrive definitely at his actual cost of production it is most difficult for him to arrive at any sort of degree of efficiency, and he may be chasing some phantom inefficiency while all the time there are masses of waste crying out for his attention. The costs duly analysed are his gauge, or indicator, and it is only with their assistance that he can arrive at a real state of efficiency.

The real trouble at the present day appears to be the human element, and when one hears the great cry for increased production and yet sees haphazard and half-hearted attempts to eliminate the many obvious obstacles in the way, one is almost tempted to despair. It is no use taking the parts of scientific management which happen to appeal to you and applying them to your works and then expressing surprise when they fail. Every factor must be considered and by men who have studied the subject of management as a science. Then we should not have the sort of thing happening as has recently happened on the Tyne. There the platers in the shipyards are pieceworkers, but the men who are helpers are paid on a time rate, so that the obvious happens and the platers are prevented from showing their top form of output as their work depends upon the speed of the helpers.

This is so obvious that one wonders how it ever happened, as it is clearly common sense to pay all operatives whose ability to increase output depends upon each other's efforts, by the same system, giving the same incentive to increased production to all concerned.

It therefore behoves all who have made a study of scientific management to rouse their confrères in the world of industry to the importance of a careful and exhaustive study of the science of the efficient co-relation of men, machines and minutes, so that we may by means of definite accuracy, tempered by infinite sympathy, procure our increased production, and the consequent era of prosperity, for which we all long, by means of evolution and not by revolution.

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Tramway Fares.

Owing to the great increase in costs, both of labour and materials, all forms of transport are finding themselves in difficult circumstances at the present time. Notwithstanding the recent Parliamentary Committee, over which Mr. Kennedy Jones presided, and which evidently started out with the idea that to increase fares to meet increased costs is an iniquitous proceeding, it has been shown that the cost to the public of such services must be increased if they are to continue their existence. Later on, more normal conditions it is to be hoped, will return.

Even in pre-war days, however, the financial position of tramway undertakings was far from satisfactory. This fact was brought out clearly by Mr. W. L. Madgen, in a Paper which he read last week before the Tramways and Light Railways Association. The net return on the capital of such undertakings was only about 3 per cent., which is altogether unsatisfactory. Under these conditions it is quite impossible to attract capital for the purpose of extensions. Further, as Mr. Madgen remarks, the effect of an industry being starved is felt in many other ways. Under these conditions the management and those in responsible positions are always conscious of a pinched feeling, deadening to enterprise, and in due time this reacts on all the employees, as it is impossible for a harassed and despondent industry to make its conditions of service as attractive as those of a healthy and prosperous one.

The fixing of fares so as to produce a satisfactory financial position is a matter of some difficulty. In his Paper Mr. Madgen gives an analysis of average fares in so far as such figures are obtainable from statistics, and divides the costs per mile into standing charges and running costs. This is always an instructive method, but we do not remember seeing it applied previously to traction undertakings. The conclusion is reached that the pre-war standing charges per passenger were 0·544d., and that under present conditions (and allowing a yield of 6 per cent. on the capital) this figure would be 0·777d. Thus, every passenger should pay this latter figure, even if he only travels a few yards. The present running cost is about 0·55d. per mile, and from these two figures it is easy to arrive at a fare which should be charged per mile to place the undertaking on a satisfactory basis. It follows that the rate per mile should be 1·32d. for the first mile, and at a lower rate as the journey is extended.

There are certain difficulties, however, in applying this principle. The first is that the tramway fares are generally limited to a penny per mile, and consequently permission would have to be given by Parliament to increase the charge so as to reach the remunerative figure. Another difficulty is that a charge something like 1¼d. is extremely inconvenient. It is highly desirable that a fare should be adopted which can be given by means of a single coin in the greater number of cases, for the great majority of passengers pay only the lowest fare. In order to get over this difficulty, Mr. Madgen suggests that the decimal coinage should be adopted, as proposed by the Associated Chamber of Commerce, the Institute of Bankers and many other bodies, for 1 mil would meet the case.

Apart, however, from the difficulty of Parliamentary sanction we think it would be simpler not to aim so much at the ideal. In other words, it would be better to adhere to the penny, and to make the stage shorter. It may not be possible to limit the stage sufficiently to make it really remunerative for a penny fare, but in that case it would be necessary to make the double stage somewhat shorter than would otherwise be the case. In other words, what may be described as the curve connecting the rate of fare with the distance travelled would not fall so rapidly as it should theoretically.

There is one other difficulty with which the author does not deal. All such calculations assume that the number of passengers remains constant. This is not necessarily the case. If the short distance fare is raised considerably the chance is that the number of short distance passengers would fall, and it must be remembered that the great proportion of passengers consists of those who travel only short distances. It is for this reason that the half-penny fare is not necessarily a financial fallacy, because the number of half-penny passengers may be more than double the number of penny passengers which would otherwise take advantage of the service. A passenger who gets off a car in the middle of a stage and gets on again, paying two halfpenny fares, is not any less remunerative than the passenger who pays a penny for the whole distance. The only objection to the halfpenny passengers in such cases is that they may exclude certain penny passengers, who would be preferred. Nevertheless, the halfpenny fare in Glasgow has proved eminently successful. This question of extent of traffic is one of the difficulties which are speculative, and cannot be settled off-hand. Whatever course is adopted, however, it is abundantly clear that the present position is far from satisfactory, and it is well that a simple analysis of the position should be given on the lines adopted by Mr. Madgen.

Review.

Papers on the Design of Alternating-Current Machinery. By C. C. Hawkins, M.A., M.I.E.E., S. P. Smith, D.Sc., A.M.Inst.C.E., and S. Neville, B.Sc. (London: Sir Isaac Pitman & Sons, Ltd., 1919.) Pp. xv.+392. 18s. net.

The authors of these Papers form a very competent trio to deal with the subject: One the author of the best-used designer's book on the dynamo, past-master not only in dynamo design, but in the art of writing about it; the second having a wide experience of the very latest machinery, both as designer and as teacher; and the third a young man with all the enthusiastic grip of a well-trained student let loose among the problems of a modern factory. They have produced a book that deals skilfully with some advanced aspects of the design of alternating-current machinery in greater detail than hitherto attempted.

The first Paper, on "The Theory and Design of Alternating-current generators," by Dr. S. P. Smith, is already known in some measure to readers of The Electrician, and is remarkable for the complete statement of the laws of armature windings and the valuation of winding factors and armature ampere-turns. The rules for design are well illustrated in the working out of the complete design of a 750 kw. alternator running at 250 revs. per min., and of a 2,000 kw. turbo-generator running at 3,000 revs. per min. If we search for something to find fault with, we may take exception to the vector diagrams given in the book, which could be very much more readily followed by a student if Dr. Smith would look upon the vectors as quantities really existing on a two-pole machine and revolving in space as the machine revolves, giving at each instant of time the true position in space of the quantities under consideration. But against this conception of a vector diagram the author has definitely set his face; he prefers to regard the diagram as a pure abstract representation of quantities varying as sine functions of the time. This is apparent from his description of Fig. 2, and is very much emphasised in his treatment of the induction motor in the last Paper. But the main quarrel that the reader will have with Dr. Smith's Paper will be with respect to the names, or rather absence of names, of the different kinds of windings and parts of windings. Since the author is an acknowledged authority on armature windings, many of us are quite prepared to accept any reasonable new names for these things, so long as they have only one meaning and that meaning is clearly defined. It is obvious that the author has intentionally avoided using technical names that have become discredited on account of their ambiguity. In doing so he has confined himself to ordinary words, which can never be sufficiently precise in dealing with technical matters. It would not require more courage than Dr. Smith can easily take in one hand to make up a number of entirely new words and definitions so as to express himself exactly; but rather than do this he gives us many pages about "coil slides," "repetitions," "single-layer windings," "similar windings," and so forth, which are full of the most important matter for those who know exactly what meanings he attaches to these words. But for the student, who only knows the ordinary meaning of English words, the understanding of the text is unnecessarily difficult. Here, for instance, is a sentence from page 23: "In a three-phase winding the equivalent constant span of a single-layer winding is equal to a pole pitch with a whole number of slots per pole, and less than a pole pitch when the number of slots per pole is fractional." In order to understand this sentence it is necessary to know that by "single-layer winding" is meant a winding which is like those illustrated in Figs. 3 and 4, and virtually of full pitch. There are, of course, other windings in one layer which are short-chorded; but these are not included in the special meaning of the term. Suppose, now, that Dr. Smith had made up a new word, and said that the windings he has in view are to be called "monolamic"; that is not a nice word, but it would have this advantage, that if you knew what it meant you could understand a sentence in which it occurred, and if you did not know what it meant you would at least know why you did not understand the sentence. Armed with this new word, one might write the sentence quoted above as follows: "In a three-phase monolamic winding the equivalent constant span is equal to a pole pitch when there are a whole number of slots per pole, and is less than a pole pitch when the number of slots per pole is fractional."

The central feature of the book is the second Paper by Hawkins and Neville. This is a minute inquiry into the distribution of the magnetic field in a cylindrical turbo-rotor. The question may be raised whether it is necessary to make an inquiry so painstaking and exhaustive. The answer is that, when dealing with an important class of machinery it is worth while, now and again, to get full information down to the minutest detail. By so doing we check our bearings positively, and avoid errors into which the rapid dead-reckoning methods used in commercial design might sometimes lead us. The cost of a single turbo-generator may be several thousand pounds; the cost of all the machines built to one design may be reckoned in tens of thousands. An investigation of the kind found in this book throws a light not only upon one particular design but upon all the machines of the same type. Rather than criticise the Paper on account of its completeness, we should lament the fact that in dealing with the field distortion at full load the authors have been compelled to simplify the problem by assuming a sinusoidal distribution of the armature magnetomotive force. To have taken the actual distribution found on a three-phase armature would have made the problem enormously difficult, because of the discontinuities that occur in the magnetomotive force curve; these discontinuities, however, lead to some important considerations which are necessarily left out of account in the simpler solution. In Part III. of this Paper Mr. Neville develops a method by which the calculator can greatly simplify the work of finding the flux distribution from a magnet having a winding distributed in slots.

In the third Paper, on "The Magnetic Calculation for Taper Teeth," Mr. Neville reviews the various methods that can be employed for calculating the ampere-turns on taper teeth, including the graphical method, methods analogous to Simpson's rule and Hird's method; and then evolves a very convenient and accurate method based upon curves plotted in an original manner. Examples are worked out which show clearly the extent of the errors that may be made when employing the older rules, and the accuracy of the results obtained by using Mr. Neville's curves.

In the fourth Paper, on "The Theory and Design of Polyphase Induction Motors," Dr. Smith deals very comprehensively with the subject, and gives practically every formula that the designer requires. The Paper is unnecessarily irksome to the student on account of Dr. Smith's preference for the method that deals with all quantities as composed of horizontal and vertical components following sine functions of time, instead of dealing with quantities as we actually find them on a two-pole motor. The method is regarded by some engineers as giving a more rigid proof of the conclusions arrived at than the method that makes use of the revolving field. It appears to us, however, that it is just as rigidly correct to combine two magnetic fields at right angles and work with the vector sum as it is to work with the two fields independently and then add together the E.M.F.s induced by them. Perhaps it is hardly fair to complain of the method when the final practical results are so conveniently set out for use by the designer. Certainly one cannot find anywhere else so much important information upon the induction motor compressed into 80 pages. Another point of criticism which raises a question for discussion is dealt with in a letter to this journal upon zig-zag leakage.

The authors have made a great effort to get their system of symbols into some kind of order, and it is no fault of theirs if the result is unsatisfactory. The fault lies with the Sub-Committees upon Symbols of the I.E.C., who, after years of cogitation, published a list of about 30 symbols for use in general electrotechnical literature, in which we are told that M shall stand for mass, B shall stand for B; and a few other symbols are fixed which are either so obvious as to require no Commission or so bad that they will certainly never be adopted, being directly against the rules originally set down by the Commission itself. They leave every poor author to work out his own system of symbols, and every poor, poor reader to put up with changed symbols in each new book. Since it is impossible to get a proper system of symbols out of the I.E.C., it is to be hoped that the universities will come to some agreement as to the symbols that shall be used in teaching students. It has already been shown that if each symbol consisted of a letter and a subscript it is possible to write down 700 distinctive combinations, the name of each symbol being pronounceable in a single syllable. The method adopted by the authors of this book in using different founts of type is open to the objection that when we read the symbol aloud we require rather a long clause to express it, such as "capital clarendon B, subscript Roman numeral two, sub-subscript small italic *t*."

The points of criticism that we have raised are all upon minor matters; they do not to any extent detract from the great value of the work to the practical designer.

Miles Walker.

The Nile Project.—We have received a published summary, by Sir William Willcocks, K.C.M.G., of his criticism of the Blue and White Nile projects, reference to which was made in this journal some time ago. The publication also refers in detail to the findings of the committee appointed to investigate Sir William's charges. The matter appears to turn largely on the correctness of statistics presented for the Nile water discharges in past years, Sir William contending that the latter have been over-estimated in the important minimum years. The matter is obviously one for experts, who apparently differ. In view of the magnitude of the issues such differences of opinion are doubtless unfortunate, but perhaps hardly surprising. On reading the evidence one can only marvel at the complexity of the issues and the comparative success that has crowned human efforts to deal with the irregular and capricious waters of the Nile.

The British Scientific Products Exhibition.—II.

High Speed Telegraphy.

Messrs. Creed & Company, Ltd., have an installation of their high-speed printing telegraph, which has been described in various Papers and is in extensive use by newspapers. This system uses the Morse code, whereas most others use a code of the Baudot type, giving equal lengthed signals for each character. The transmission is effected by a Wheatstone transmitter from Wheatstone slip punched by a Kleinschmidt keyboard perforator, permitting a higher punching speed than the simple Wheatstone perforator. The receiver produces a similar punched slip, the receiving relay operating on the valves of a pneumatic perforator, and this punched slip on being run through an attachment to a typewriter produces a typewritten slip at a maximum rate of 200 words per minute. The punched slip can be used to re-transmit the message. For direct observation of the received signals—*e.g.*, to ascertain the highest speed at which good signals are received an "undulator" is employed. One feature of the Creed system is that exact synchronism between the transmitting and receiving instruments is not necessary; in fact, they may run at somewhat different speeds without any difficulty arising—one of the advantages of using the Morse code. The apparatus is shown in operation.

Instruments.

The display of electrical measuring instruments is large and varied. Most of the makers are represented, but there are few novelties. The B.E.A.M.A. has an exhibit of instruments by a number of well-known makers. It can be said that as a whole the display of instruments is worthy of the admittedly high reputation of this country for good workmanship and high finish. Messrs. Elliott Bros. show some gyroscopes of the type used in gyroscopic compasses and torpedo directors. These are shown in operation, one mounted on gimbals with pointers moving over divided circles, and one suspended as a pendulum. These show the curious responses made by a gyroscope to disturbance from outside, and seem well adapted for demonstration purposes. The speed of these instruments is about 20,000 revs. per min. The spinning part is a heavy steel flywheel carrying internally a squirrel-cage rotor of unusual design. The three-phase stator is placed inside the rotor, and is a laminated core-wound in open slots inclined to the axis. The rotor has a core of laminated iron with turned slots. The slot conductors and the end rings are of aluminium, which appears to be die-cast or pressed in so that the whole forms a single piece of metal, and the rotor turned on all surfaces is a hollow cylinder. The air gap between stator and rotor is of the order of 0·01 in. The rotor journals are of hardened steel pressed on to the spindle, running in ball bearings. The balls, it need hardly be said, have to be carefully selected for size. The flywheel and its spindle are machined out of a solid cylindrical steel forging. The complete article is a beautifully finished production.

The same firm shows a number of galvanometers and electrometers of usual types. One of these is a d'Arsonval galvanometer, with the very long period of ten seconds, which will be very useful for certain measurements. A small and handy Ayrton-Mather reflecting electrometer is an attractive instrument; its range is from 7 to 30 volts.

Messrs. Evershed & Vignoles show a number of instruments for the measurement of resistances, mostly variations of their well-known "Meggers." A "self-evident" resistance box used with a "bridge" megger, has four dials, for thousands, hundreds, tens and units, the value of the coil in circuit in each is shown by a figure read through a window. The row of figures thus give directly the resistance in circuit. Ratios of 1, 10 and 100 are obtainable by a movement of a switch on the megger. With ratio 1 it is possible to read to 1 ohm in 4,000. Another instrument of the megger type is a conductivity meter reading to 2,000 ohms. A "ducter," or deflectional ohmmeter reading directly up to 1,000 microhms, and an instrument of a similar type, but using a three-volt battery instead of a generator, has a range up to 100,000 ohms. With a set of these resistance-measuring instruments all commercial and workshop or inspection room insulation and conductivity measurements are reduced to very simple operations. The "Dionic" water tester must not be overlooked. This uses a conductivity meter to give the resistance of a column of water of definite dimensions, from which the presence of inorganic impurities can be inferred and their quantity estimated. The necessary connection for temperature variation is given by a thermometer which is immersed in the column of water, and carries a pointer on a scale. The thermometer reading is observed and the thermometer pulled up until the pointer is on the same reading on the scale, the alteration of the cross-section of the column due to the displacement of the thermometer then gives the temperature correction. The instrument is particularly adapted for detecting leakage in condenser tubes and contamination of water.

R. W. Paul shows an insulation and conductivity meter with a very wide range, from 0·00005 to 100 megohms. The generator gives 500 volts. There are three scales, and a pull switch with nine positions corresponding to various multipliers and the different scales. For the very low resistances, 0·00005 to 0·2 ohms, an auxiliary 2-volt accumulator has to be employed as well as the generator. This is a really marvellous boxful, highly attractive to anyone who requires a portable instrument to cover a very wide range of measurements. Another exhibit by the same firm is a dial-pattern Wheatstone bridge with precision contacts. The contacts are cased in, and the readings made through a glass window. Switch contacts are looked upon with some suspicion as to their constancy of resistance, but these, protected as they are, seem calculated to remain in good order for a long time.

The Cambridge Scientific Instrument Company shows a good many instruments of its usual high class. A six-string Einthoven galvanometer in conjunction with a photographic clock-driven chart will show the time relation between occurrences on six different circuits at as many different places, and has many obvious applications in scientific research. Various indicators are shown for use with thermo-couple pyrometers, for the control of furnace operations. The thread recorder is shown, connected to two pyrometers, the reading being shown in two colours—*e.g.*, red and blue on the same chart. This instrument can be made with a larger number of different coloured threads to record from a corresponding number of pyrometers, so that the working of several furnaces can be exhibited in the manager's office. This type of recorder gets over all inking difficulties by dispensing with ink. The pointer is sharp edged, and is brought down by a bar operated by a clock on to one of the threads which is impregnated with a coloured mixture, and pressed against the chart. The clockwork shifts the galvanometer connections and selects the thread, so that the dots of one colour always correspond to the one pyrometer. An optical pyrometer shown is for direct observation of a furnace or other source of visible radiation. A screen lit by a standardised lamp is compared with the luminous surface and equality obtained by the rotation of one of a pair of Nicol prisms. The amount of the rotation given on a divided circle indicates the temperature of the source.

The Foster Instrument Company also show some indicating and graphic thermometers and pyrometers, of the resistance type. The recorder shown uses a circular chart, which has some advantages in giving a general idea of what has happened throughout a day at a glance. The same firm shows a "cold junction" box for use with thermo-pile thermometers. The junction is contained in an iron box, oil-filled, provided with a thermometer, so that necessary corrections for this temperature can be applied to the readings. The box is arranged to fit into a run of steel conduit, and the pile connections are taken out of it as a flexible armoured cable. A convenient pyrometer indicator is shown by R. W. Paul in the form of a "Unipivot" milli-voltmeter with the scale divided in millivolts and temperatures.

Messrs. Everett, Edgcumbe show some graphic instruments which will run for eight days on one charge of ink. There is no pen, the ink being applied through a fine tube. A frequency meter, which indicates by deflection is useful for switchboard use, where all other instruments are deflectional, and it can be read at a greater distance than the more usual "reed" instruments, which are also shown. A paralleling voltmeter with a central zero, a synchronoscope, and a power factor meter, reading directly, not in degrees of lag or load, are other instruments suitable for alternating-current switchboard use with large boldly-marked scales. Photometers of the Trotter portable type, and Luxometers are shown. The latter is a particularly handy and useful instrument for determining illumination values, but has been described before, and should be in wide use. It ranges up to 2,000 ft.-candles.

Messrs. Crompton & Company show a considerable variety of measuring instruments, most of which can be classed as "special purpose" instruments. These include paired ammeters and voltmeters with shunts, &c., in cases, as portable testing sets; also for switchboards for battery charging and similar uses. A very neat flush pattern ammeter would be an ornament to any switchboard. This firm has developed the moving iron type of instrument for alternating-current work in a number of forms. It continues its practice of marking on instrument scales the actual pressure or current on the active coil required to give full scale deflection, most useful for checking the instrument constancy by the user.

This account by no means exhausts the electrical instrument exhibits. It is believed that it mentions the most important novelties, but it may be necessary to notice others.

Motor Control, &c.

The **Igranic Company** show several of their motor control sets. A remote control gear for machine tools has, at the operator's end, five press buttons, marked "Stop," "Faster," "Slower," "Inch." The controller contains contactors making the appropriate connections. The rheostat connections are controlled by a solenoid and dashpot, the time of cutting out can be regulated by dashpot adjustment. Another type controls the speed of cutting out rheostat sections by the armature current. This current passes through a magnet which opposes the action of the contactor magnet, consequently the latter will not act, although excited, until the armature current has fallen to a pre-determined value; a good arrangement where a motor has to start against variable loads. The same firm shows a lifting magnet for long articles. It is really two pot magnets carried at the ends of a bar, so that angles, rails, &c., are picked up at two points, saving the operator's time in finding a balancing position, and preventing swinging vertically. Battery changing units, which can be set up together and added to like a sectional book case, are very suitable for charging a number of vehicle batteries, the current for each is independently shown and controllable.

The testing of contactor and other coils which have to stand the making and breaking of circuit repeatedly is shown on a machine which automatically makes and breaks contact twice a second, so that an endurance test equal to years of normal operation in this respect, is made in the course of a few hours or days. Considering the importance of the reliability of such coils in motor controllers for lifts and other work where life and limb may be involved, this test seems very necessary as a workshop process. Coils of various kinds wound by the "Leesona" machines are shown.

The **Watford Electric & Mfg. Company** shows several automatic starters. The details show some novelties. A solenoid is used to cut out the rheostat sections at a speed controlled by the armature current. This current energises a magnet in the airgap of which a copper disc runs. The disc is geared to the solenoid plunger through a train of wheels. It is, therefore, a Foucalt current brake on the plunger movement, which is the slower the heavier the current. The airgap can be varied to alter the amount of the braking. The cutting-out of the rheostat sections is effected by a bar which is pivotted on a link and has a sliding movement as well as a direct thrust on the contacts. The contacts are carbon block with springs behind them, so that they yield gradually and the contact pressure increases. Finally, the contact bar brings up against a copper jaw contact cutting out the whole resistance. The arrangement gives a very smooth sparkless action, unequal wear of the contact surfaces does not interfere with the due order, and any worn block can be readily replaced. This controller is shown connected to a ball float, as it would be used for the automatic maintenance of water level in a tank, or with pressure control for maintenance of air pressure. A press button lift controller on the same lines is shown.

Messrs. **A. Graham & Company** show a fine assortment of Norval control sets; these are mainly used for giving steering and firing indications from the conning tower to the various positions in a warship. A very imposing commutator is exhibited which permits all the control apparatus to be connected to alternative sources of supply by the movement of a single handle. The workmanship is very good.

Lighting.

The **Westminster Engineering Company** shows a number of its very useful arc lamps and accessories for projection purposes. The smallest of these working with from $2\frac{1}{2}$ to $4\frac{1}{2}$ amperes is an exceedingly useful source of light, available wherever a supply at usual pressures is laid on, for optical lanterns, enlarging cameras, photo-micrography, &c. Supply-authority canvassers might find a surprising amount of interest from private consumers of photographic and scientific tastes in such lamps. Several other patterns suitable for photographic studios, photo-engraving, &c., are on view. There are various exhibits of incandescent lamps, a show case of the B.T.H. "Mazda" gives in small space a good idea of the range now available, from the "pea" lamps for instrument lighting, and surgical purposes, up to the 1,500 watt, gas-filled lamp of 3,000 c.p. An alleged exhibit, the "Pointolite" tungsten arc lamp could not be found. The **Edison Swan Company**, who make it, seem unduly modest in pushing it. This is rather a pity, as for many purposes it takes the place of and excels the now unobtainable Nernst lamps. It is understood that the National Physical Laboratory uses it extensively for instrument and photographic work.

A rather interesting device is shown by Mr. **Lionel Pearce** under the name of "Artificial Daylight." This is a bottomless box of metal, in the top of which is placed a glow lamp over certain coloured screens. An opening in the front gives a view of any object under the box, illuminated by the screened light, which is adjusted to be a visual match to daylight.

Correspondence.

ZIG-ZAG LEAKAGE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The zig-zag leakage of induction motors is a subject upon which the views of designers and writers differ very widely. In the Paper on induction motors in the new work, "Papers on the Design of Alternating-current Machinery" (Sir Isaac Pitman & Sons), there is given a method of calculating the zig-zag leakage founded on Arnold's method, in which a serious error appears. The reader will not quarrel with the general formula for estimating the zig-zag leakage due to the magnetomotive force of the stator currents and depending on the dimensions of the teeth and the length of the air-gap. Such a formula is necessarily approximate if it is to be simple. But the reader will notice that the formula is taken twice over, once for the stator and again for the rotor, and the zig-zag leakage is said to be obtained from the sum of the two results. In order to see that this is wrong, we have only to take the simple case where the number of slots in the rotor is equal to the number of slots in the stator, and to consider the teeth in the position shown in Fig. 1. Let the length of the air-gap be 0·1 cm., and the magnetomotive force due to the current in each slot be equal to 400 and in the direction indicated. The zig-zag leakage would then take the path shown by the dotted line, the arrow heads giving the direction in which a North pole would travel. It will be seen that the flux density in the centre of the dotted path will be about 2,000 c.g.s. lines per square centimetre, this figure being obtained by dividing the magnetomotive force 400 by the double length of the gap. This flux-density produces a drop in magnetic potential equal to 200 at each point where the flux crosses the gap; and it will be seen that the crossing of the gap by flux produced by the stator magnetomotive forces serves to set up a difference of magnetic potential between successive rotor teeth, which balances the rotor magnetomotive forces. If the rotor magnetomotive forces were not there at all, the leakage would, of course, be very much greater, because the flux would go through the whole body of the rotor. The formula should, therefore, be taken only once—say for the stator; but it should be constructed so as to take account of the differences in the stator and rotor pitch.—I am, &c.,

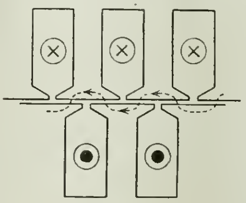


Fig. 1.

Manchester, July 18. Miles Walker.

OVERHEAD v. UNDERGROUND TRANSMISSION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Mr. Pearce's Paper emphasises rather prominently the troubles of voltage drop in overhead lines, and dwells complacently on the great virtues of the capacity current in cables; but it quite overlooks the fact that the latter may be a slightly unwelcome asset, because it is a *distributed* capacity, and therefore has the effect of over-nullifying the self-induction at the near end of the line, and leaving the distant end still in trouble. The real remedy for every trouble is increase in the voltage. If he had taken 90,000 volts instead of 30,000, the showing would have been altogether different. The copper "resistance" drop is the governing factor in the situation, rather than the reactance drop.

In his 10-mile 30,000-volt scheme, the copper resistance drop is roughly 2·5 per cent., the main line current per circuit is 200 amperes, the reactive drop 2,070 volts, the equivalent lagging current due to this drop is roughly 13·7 amperes per circuit, and the condenser leading current roughly 0·9 ampere.

By raising the voltage to 90,000 the copper resistance drop (with one-third the copper section) becomes 0·83 per cent., the main line current per circuit is 66 amperes, the reactive drop is 690 volts (0·76 per cent.), the equivalent lagging current due to this drop is roughly only 1·53 amperes, but the condenser leading current rises to 2·7 amperes per circuit.

Therefore, although a "distributed" capacity, and, therefore, not fully effective, the condenser current practically wipes out the self-induction, on a line having no tappings.

The voltage variation being now reduced to 0·83 per cent., we can extend the radius of transmission to 30 miles; and, if we dare venture 5 per cent. rise, to 60 miles. The 0·76 per cent. reactance drop is, of course, in quadrature with the current, and on unity P.F. would be quite negligible.

With cables, on the other hand, the dielectric losses would run up enormously, and be a very serious item; even were the cables forthcoming, which they are not. Then, again, the difficulty of the heating of cables in clusters, when underground, disappears when put overhead; and to those who have studied the dielectric loss question and know how supremely important it is that the temperature should be kept low if cables are not to break down, the importance of this point will appeal strongly.

It would be interesting to know whether the replacing of the individual overhead conductors by squirrel-cage "shell" conductors, on the lines of wireless "*aerials*," has ever been tried. I should expect from theory that the reactance drop could be halved and the condenser current doubled—a six-fold improvement.

It will be realised that, if the purely copper losses can be brought down in the manner indicated, by raising the pressure, the whole economical aspect requires re-consideration.

It is perhaps worth pointing out that the lagging component of the main line current due to the reactance of the line diminishes in proportion to the *square* of the increase in voltage; and that the proportion which the leading component of the current bears to the main line current (for a given kilowatt transmitted) increases also as the square of the increase of voltage.—I am, &c.,

Ashford, July 24. A. M. Taylor.

London Traffic Report.

The Select Committee of the House of Commons on London traffic conditions has issued its report, and makes a number of important recommendations. The report attributes the demoralisation of traffic in Greater London to the absence of a supreme traffic authority for Greater London, possessing executive powers to control, co-ordinate and initiate, and to safeguard and further public interests. Owing to the absence of such an authority, not a single important recommendation made in the past for the improvement of London traffic, for the avoidance of congestion, or for the benefit of the public has had the slightest chance of being carried into effect. The immediate creation by Parliament of a London traffic authority can alone remedy the present intolerable conditions. An immediate solution of the problem is imperative, since it has reached the dimensions of a public scandal.

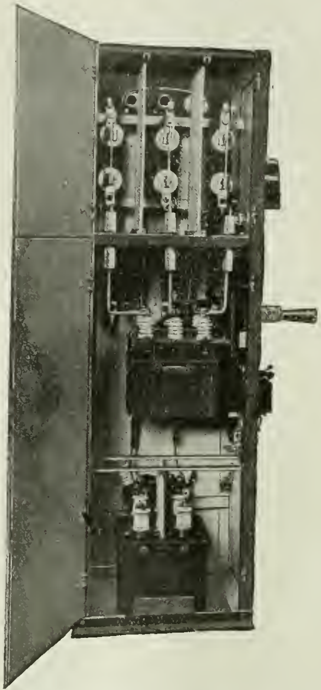
It is pointed out that the London County Council possesses the right to operate tramways, but cannot develop its system without express Parliamentary sanction, and it finds that while there is no traffic authority to co-ordinate or direct, and few authorities willing to put forth individual energy in the provision of public transport, there are many always ready to take up a position which might be helpful, but which is usually the reverse—first the City, with its right of veto; then the London and Greater London boroughs, who have the same rights conferred on them; the outer urban bodies have also to be considered. Of these local authorities it is estimated, according to the radius taken, there are some 172 to 204. They do not originate, but they can veto or exact specific conditions from those who provide transport.

On the question of fares the Committee say: "While some increase was inevitable in view of post-war conditions, the new fares are in cases excessive, in others unjust, and too manipulated to be understood by the public. Greater uniformity is essential and anomalies must be eliminated."

The Committee summarise their recommendations as follows:—

The immediate creation of a supreme traffic board (five as a maximum) for Greater London, which would have all powers now possessed by Government departments or conferable by statute. Its special functions would be to co-ordinate routes and services of all systems of transport, regulate all traffic and street repairs, be responsible for the comfort and convenience of the public, provide for future developments and promote legislation to desired ends.

Westinghouse Control Units and Measuring Instruments.



The British Westinghouse Electric & Mfg. Company, Ltd., have issued several new leaflets, dealing respectively with Oil-immersed Motor-control Units for Slip-ring type motors, Consumers' Oil-switch Cubicles and D.C. ammeters and voltmeters. The control units comprise automatic oil switch with no-voltage and overload trips, the latter fitted with time limits if required. Starter and oil switch are interlocked, and the former is started with slow motion operating gear. The whole is completely enclosed and oil-immersed. The oil-switch cubicles are intended for the control of simple feeders or for main switch panels for step-down transformers or large motors. Standard sizes go up to 300 amperes for 6,600 volts (max.) and 500 amperes for 3,300 volts (max.). Simple overload trips or both no-voltage and overload trips can be provided. A feature is the use of an isolating switch connected to the live side of the oil switch in a separate upper chamber. The D.C. ammeter and volt-meters (moving coils) are well adapted for switchboard use, a valuable feature being the possibility of removing the movement without any alteration to the air-gap.

Patents and Trade Marks Bills.

Both these Bills were read a second time in the House of Commons on Monday. A full abstract of the Patents and Designs Bill was given in our last issue, and in moving the second reading Sir A. Geddes said that clause 2 of the Bill instituted quite a new form of patent protection, for it proposed that, after the sealing of a patent, the Comptroller should, if the patentee so requested, cause it to be endorsed with the words "licences of rights." It was hoped that in that way the poor inventor, who had difficulty in getting the capital to work a valuable invention, would be able to get his invention taken up. In clause 1 they had a series of provisions which, it was hoped, would have the effect of controlling better the monopoly which the granting of a patent gave. It was proposed to extend the period of protection from 14 to 16 years, partly for the reason that during the war it had been quite impossible to get many patents working, and inventors had lost some years which might have been fruitful. There were also certain provisions which would enable, on cause shown, a further extension—beyond the increase of two years—to be obtained. Speaking broadly, the Bill proposed to improve the position of the inventor so far as it was right and proper to do so; to make it easier for the man without capital who was an inventor to get the fruits of his invention, and to relieve him from the position in which so many poor inventors had found themselves, of having to part, far below the real value of their inventions, with their right in it in order that it might be worked. In clause 18 there was a whole series of provisions for dealing with classification. The Bill required careful study, but he believed it would effect substantial improvements in the patent law.

In the discussion which ensued the opinion was expressed that the Bill did not go far enough to check monopolies, and in reply Sir E. Pollock said what was proposed by clause 1 was that, in addition to the power of revocation, there should be a power to enable a licence as of right to be granted in cases in which the privilege given under the patent had been abused. It was proposed under clause 1 to introduce a new section for clause 27 of the Act of 1907. The question of the restraint of trade through patents was a matter which must be dealt with, not under a mere Patent Bill, but under a Bill dealing with the question of trusts. He understood that such a Bill would be introduced in the autumn.

By the first part of the Trade Marks Bill it is intended to have a list or register of trade marks which had Common Law existence. It is also proposed to have a part (B) of the register of trade marks, and it will be much easier for anyone to register marks in part (B) than in part (A). The second part of the Bill deals with the abuse of the words "trade marks," and it is hoped to effect a considerable improvement in the legislation governing the use and protection of trade marks.

Electricity Supply Bill.

During the week Standing Committee B of the House of Commons made some progress with this Bill. To the new clause authorising the Electricity Commissioners to establish joint electricity authorities as well as district boards, an amendment by Mr. Shortt was agreed to in order to ensure that the Electricity Commissioners (if it became necessary) might, after a local inquiry, adjust the boundaries of the electricity districts, so as to secure that the best scheme should be chosen.

An amendment to include railway companies using electricity for traction purposes among the bodies which might submit schemes to the Commissioners, was also adopted, as was a proposal by Mr. N. Chamberlain that no scheme should provide for the transfer of other than the generating stations and main transmission lines, except with the consent of the owners.

Mr. **Chamberlain** proposed that a scheme for the establishment of a district electricity board should provide for the election of the members of the board by the local authorities. The Government proposal was that the members of the board should be nominated by the Commissioners, and should be representative of local authorities, companies, large consumers and labour.

Mr. **Shortt**, who opposed the amendment, stated that it would really exclude power companies, railway companies and local associations.

Lieut.-Commander N. **Craig** said the local authorities throughout the history of electrical undertakings had adopted a petty and parochial attitude. If municipalities were allowed to interfere with the composition of the boards they would inevitably control them, with the result that instead of having a board of experts they would have a board of Bumbles.

On a division the amendment was negatived by 19 votes to 11.

The Committee adopted an amendment by Mr. Mallalieu providing that there should be on the joint electricity authority representatives of the Council of any county situate wholly or partly within the district.

Major **Barnes** moved an amendment to omit the words applying to the joint electricity authorities any of the provisions of the measure relating to district electricity boards, including those as to borrowing, lending, and giving financial assistance by and to those boards.

After discussion the amendment was rejected, as was one by Mr. Trevelyan Thompson, providing that section 33, giving power to Electricity Commissioners to lend money to district electricity boards and authorised undertakers, should not be applied to a joint electricity authority where the representatives of private interests constituted the majority of the members of the joint electricity authority.

Mr. J. **Johnstone** moved an amendment providing that representatives of local authorities should constitute at least a majority of the members of a district electricity board.

Mr. **Shortt** could not accept the amendment, as it was too rigid, and would tie the hands of local people, and it was rejected by 18 votes to 12.

Clause 5, as amended, was agreed to, and added to the Bill.

On Tuesday Mr. Geo. **Balfour** moved an amendment to clause 6, providing that no direction should be given to any district authority or board by the Electricity Commissioners which would involve such authorities in financial loss. He said the introduction of electricity into rural districts was not going to be a paying industry, and if there was a loss it should be met by the State and not by the locality.

Mr. **Bridgeman** said such cases would naturally be met by grants from the Development Commissioners who had the power to make them. There should be some safeguard and he desired that the Government should have an opportunity of considering the point and bring up their own proposal.

The amendment on this understanding was withdrawn.

An amendment by Mr. **Bridgeman** was agreed to, providing that a district electricity board might establish or join with any other such body in establishing a scheme for the payment of superannuation allowances and gratuities to infirm or aged officers and servants.

On clause 7, which provides for the acquisition of existing generating stations, Mr. **Marshall Stevens** moved to exempt dock generating stations. After discussion the amendment was carried by 14 to 13 votes. A proposal by Capt. **Rupert Guinness** to exempt from control main transmission lines belonging to or leased to railway companies was agreed to.

Lieut.-Commander **Norman Craig** moved to provide that where the generating station was vested in or acquired by a District Electricity Board it should be lawful for the company to give notice to holders of mortgage debentures or debenture stock to pay the same in whole or in part out of the proceeds of such sale. The amendment was modified so as to provide that debentures could be repaid at the same rate as if the company were being wound up, and was then agreed to.

Legal Intelligence.

The Marconi Claim.

Mr. Justice A. T. Lawrence on Friday delivered his award as arbitrator in the proceedings between the Marconi Wireless Telegraph Company and the Postmaster-General upon the Company's claim for damages for breach of contract in connection with the construction of an Empire chain of wireless stations. The Company claimed £7,181,000 based on the contract provision that they should receive royalties amounting to 10 per cent. of the gross receipts from the stations for the full contract period of 28 years. The Crown, on the other hand, contended that the damage payable to the Company amounted to only about £50,000.

Mr. Justice Lawrence said that he found the amount of damages to be £590,000. That was his estimate of the present worth of all the royalties the Company would have received under the contract. He had excluded from consideration, as by order directed, the letter of Jan. 1, 1915, and he had not diminished the amount by any consideration of the probability or otherwise of Marconi patents being employed in commercial wireless in the future.

Judgment was then entered for the amount awarded.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1919 Specifications.

116,716 Friendly. Telephone systems. (11/6/17.)
117,450 Zorzi. Electrode for an electrolytic cell. (9/10/16.)
121,280 Larsen. Method of and apparatus for utilising the thermic effect of cathode rays. (7/12/17.)

Consists in collecting the rays by some well-known means, so as to form a narrow pencil of greater or less extension.

121,460 Norsk Alkali Aktieselskabet. Apparatus and process for the electrolysis of chlorides of the alkaline metals. (13/12/17.)
127,837 Graham. Electrical apparatus for transmitting and indicating orders, numerical data and the like. (11/1/17.)
127,846 Pilkington. Telephone transmitters. (29/5/17.)
127,884 Western Electric Co. (Material Telephonique Soc. Anon). Telephone apparatus particularly for use on aeroplanes. (13/6/17.)
127,914 Hutchins. Electrolytic cells for the production of chlorine. (27/6/17.)
127,915 Hutchins. Electrolytic cells for the production of chlorine. (27/6/17.)
127,937 Levin. Electrolytic gas generators. (22/5/17.)
127,946 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Electric battery charging apparatus. (3/6/18.)
127,967 Hellyar & Hellyar. Electric connections. (7/6/18.)
127,987 Alexander, Vint & Imbery. Method of and means for heating oils, fats, and other liquids or compounds by electricity for distillation or other purposes. (12/6/18.)
127,992 Edison Accumulators, Ltd., Monnot & Lewis. Electric switches. (12/6/18.)
128,012 Harrop. Portable electric batteries or cells. (15/6/18.)
128,051 Allen. Trolley heads for electric traction. (27/7/18.)
128,057 Heape & Grylls. Carbons for electric arc lamps. (2/8/18.)
128,082 B. T.-H. Co. (G.E. Co.) Electric motor control systems. (12/9/18.)
128,102 Barwell, Judd & Eastern Telegraph Co. Electrical relays. (10/10/18.) (Addition to 22,868/14.)
128,106 B. T.-H. Co. & Carter. High-speed electric or other locomotives. (23/10/18.)
128,116 Siemens Bros. & Co., Hewitson & Siemens. Means for supporting electric cables, and for like purposes. (11/11/18.)
128,117 Siemens Bros. & Co. & Perry. Galvanic cells. (12/11/18.)
128,118 Hill. Electric transformers. (13/11/18.)
128,119 Low. Electric relays. (21/11/18.)
128,143 Oxspring. Electric cable sockets. (22/1/19.)
128,148 Shenton. Electric bells. (3/2/19.)
128,152 Palmer. Electric storage battery separators and insulators, and process of making same. (19/2/19.)
128,527 B.T.-H. Co. (G.E. Co.) Control of electric currents. (15/3/19.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions*

June 4, 1919.

14,205 Baldock. Selective signalling, &c.
14,213 Elliott Bros. & Phillips. Securing permanent magnets of electrical instruments.
14,224 Automatic Telephone Mfg. Co. Automatic or semi-automatic telephone systems. (5/9/18. U.S.)
14,225 Automatic Telephone Mfg. Co. Automatic or semi-automatic telephone systems. (23/10/18. U.S.)

June 5, 1919.

14,205 International Electric Co. Selective signalling, &c.
14,251 Barker. Arc gap wireless telegraphy.
14,305 Shillito. Direct current dynamos.
14,309 B. T.-H. Co. (G. E. Co.) Wireless signalling.
14,315 Nobbs & Railing. Electric heating apparatus.
14,318 Vandervell & Midgliz. Electric starters for engines.
14,325 Meyrick. Insulators for conductor rails, &c.
14,348 Vickers Ltd. & Greenley. Secondary batteries.
14,350 Vickers Ltd. & Bairlocher. Transformers.
14,354 Tower. Generating h.-t. impulses with or without l.-t. current for battery charging, &c.

June 6, 1919.

14,374 Deakin. Insulating and anchoring device for lamp-holders, &c.
14,409 Western Electric Co. & Deakin. Mixed manual and machine telephone systems.
14,422 Winn. Electric condensers.
14,427 British Westinghouse Electric & Mfg. Co. Electric railways. (10/7/18. U.S.)
14,428 Hymas. Electric lighting of cycles, &c.
14,462 Pouchain. Negative plate for accumulators.
14,464 Johansson. Incandescent lamp-holder.
14,471 Crochat. Control of electric installations.
14,477 Muller. Electric heaters. (26/3/19. Switzerland.)

June 7, 1919.

14,559 Houston. Electrically and mechanically connecting accumulator cells, &c.

June 10, 1919.

14,578 Stewart. Determining directions of signals in wireless telegraphy.
14,583 Hewitt. Electro-therapeutic appliances.
14,614 Hope. Electric lamp-holders.
14,618 Coleman. Electric switch device for securing railway carriage doors.
14,632 Bygrave. Switches for automatic and semi-automatic telephone systems.
14,633 Bygrave. Automatic and semi-automatic telephone systems.
14,657 London Electric Supply Corporation. Furnaces.
14,668 Stephenson. Control of dynamos. (20/6/18. U.S.)
14,675 Le Tall. (Westinghouse Electric & Mfg. Co.) Electrical insulators.
14,680 Telephone Mfg. Co. & Murray. Electric Switches
14,682 & 14,683 Highfield & Calverley. Apparatus for transforming electrical energy.
14,684 Rushmores, Ltd. & Henn. Electrical engine-starting devices.

Commercial Topics.

Coal Mining Machinery for Brazil.

H.M. Consul at Porto Alegre reports that the Secretary of Public Works, on behalf of the President of the State, wishes to obtain catalogues of coal-mining machinery of every class, from coal-boring to briquetting. Catalogues should be addressed to Exmo. Snr. Dr. Ildefonso Soares Pinto, D.D., Secretario de Estado dos Negocios das Obras Publicas, Porto Alegre, Rio Grande do Sul, Brazil.

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International Congress on Patents.

An International Congress of Allies and Neutrals to discuss the question of Patents and Trade Marks will take place at Brussels between Sept. 2nd and 6th. The arrangements are being made by certain Belgian societies—the Chamber for the Protection of Inventions and Mechanical Arts (Technical and Scientific Committee), the Mechanical Arts Section of the Brussels Chamber of Commerce, and the International Committee of the Federation of the Associations of Invention and Mechanical Arts of Allied and Neutral Countries. The congress will deal chiefly with the protection and development of industrial property in various countries.

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New French Customs Duties.

By a French Presidential Decree of July 8 the Customs duties leviable on a large number of manufactured goods on importation into France and Algeria were increased. For this purpose, for each category of goods specified in the tariff, a coefficient or multiplier was fixed, representing the relation between the values of the goods in 1913 and in 1918, according to the official valuations laid down for those years by the Permanent Commission on Customs Values. The present rates of duty are, therefore, the specific rates contained in the pre-war tariff multiplied by the coefficient (varying from 1·1 to 3) attributed to the class of article concerned.

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U.S.A. Electrical Exports.

The exports of American electrical goods continue to increase at a rapid rate. The total value of the goods exported in April was $7,709,138 compared with $4,572,953 in April 1918. Only in carbons and fans was there a drop, but there were big increases in batteries, dynamos, motors, transformers, heating and cooking apparatus, telephone and telegraph apparatus, magnetos and lamps. For the 10 months ended April the value of the electrical exports was nearly $62,000,000, compared with $44,500,000 for the same period of the previous year and $41,730,000 in 1917.

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The Importance of the Overseas Trade.

The development of the export trade of the country has not received, and we are afraid is not receiving, from the Government that attention which its great importance demands. It is gratifying, however, to find that Mr. Charles B. Crisp delivered a long and interesting speech on the subject at the recent meeting of the British Bank for Foreign Trade, and in view of the urgency of the matter we have reproduced a few extracts from it. Mr. Crisp lamented the disorganised condition of British export trade and emphasised the importance of developing the overseas connections. He pointed out that the Continent of Europe was impoverished to an extent which could not be calculated. In order the more directly to participate in the work of reconstruction his own bank had opened a branch at Brussels. The "export of capital abroad" was still subject to control and he urged that the restriction should be removed as soon as possible. The export of capital, apart from gold, could only take the form of shipments of goods, or by rendering services to foreigners or colonials. Until the London market was reopened to foreign States a rise in our export returns was improbable. Our manufacturers could not ship to the newly constituted States of Poland, Finland and Serbia, or to Belgium and Rumania, except against payment in sterling or its equivalent. In pre-war days shipments were very largely financed by bankers and others, who granted acceptance credits which could not now be given because there was no certainty that the foreign importer would find means to buy sterling with his own depreciated paper money. The placing of foreign or colonial loans upon the London market, subject to a proviso that the proceeds or the bulk thereof should be applied to the purchase of goods in these islands, would to the extent that such loans were subscribed reduce the temptation to spend money upon luxuries. As a result of the war and British Government buying during the past four years many traders and individuals had accumulated large free credits at their bankers. Those credits were frequently drawn upon to pay for land or other property at ever-soaring prices. The purchase of a foreign Government bond might spell an order for a British manufacturer and give a London or Manchester merchant a turn. No money would necessarily leave this country. The American, and the Canadian also, said that a country which produces crops or goods beyond its own power of absorption should sell its surplus as against an acknowledgment of indebtedness rather than lose an oversea customer who could not pay cash down. The capitalist could risk temporary default upon a bond, but the manufacturer, who must pay cash for raw materials and wages and rent, could not deal except on a cash basis. Our situation was such that all proposals involving national expenditure should be scrutinised carefully. If labour be diverted to work not conducive to the production of goods for export we should be unable to pay interest upon the National Debt or obtain from abroad necessary food supplies.

Electricity Supply.

The Chiswick Electricity Supply Corpn. has increased the charge for electric power to 2½d. per unit.

SILSDEN Urban Council has decided to oppose the application of Electrical Distribution of Yorkshire, Ltd., for a provisional order to supply electrical energy in the district

Owing to the increased cost of coal BURY (Lancs.) Electricity Committee has put up the charge for electricity by 10 per cent. for traction and lighting, and by 20 per cent. for power, from Oct. 1.

BEDFORD Corporation proposes to lay a 6,600-volt feeder to Offa-road, and to erect a sub-station to meet the increased demands for current by manufacturers. The estimated cost is £2,000, but an extra £2,600 per annum in revenue is anticipated.

TISBURY ratepayers have appointed a committee to deal with a proposal for the supply of electrical energy from the power station at Fovant Camp. Many residents have already agreed to take a supply as soon as it is available.

BRADFORD Electricity Committee proposes to put on an additional 30 per cent. for electric current, making, with the last increase, 50 per cent. over pre-war rates. The necessity for the increase arises chiefly from the recent increase in the price of coal.

During last quarter the applications from new consumers to BURNLEY electricity department were above all previous records, and as the demand has recently increased it is anticipated that the current quarter's applications will break last quarter's record.

LEICESTER Tramways and Electricity Committee estimate that, owing to the recent increase in the price of coal, the advances in wages and the extra cost of raw materials, the Aylestone works will cost an additional sum of £9,175 per annum and the Lero station £4,914, and it is therefore proposed to increase the charges by a further 25 per cent., making a total increase of 75 per cent. on pre-war rates.

The increase of 6s. per ton in the cost of coal would entail a deficit of £10,000 on annual working of EDINBURGH electric supply department, and it is therefore proposed to increase, as from Oct. 1, the rate for lighting by ¼d. per unit, making the charge 4d. per unit and that for power by ⅛d., making it 1⅜d. There will also be a slight increase in the charge for traction and for public lighting.

The output of the Blackpool electricity works during June was 421,170 units, an increase of 77,420 units on the corresponding month last year. The tariffs were advanced from 25 to 33 per cent. above pre-war rates on July 1, and it has been decided to advance them to 40 per cent. from Oct. 1. The Staff Salaries Committee recommend that the salary of Mr. Charles Furness, the borough electrical engineer and tramways manager, be increased from £900 to £1,250 per year as from April 1 last.

In order to provide for the continuity of the supply of electricity at BATH, the Electric Light Committee reports that it will be necessary to put down a 1,500 kw. Ljungstrom turbo-generator, rotary converters, transformers, pumps and switchgear at an estimated cost of £24,441. Building extensions, cables, &c., will increase the cost to £30,405. The question of erecting a new generating station is also under consideration.

An inquiry has been held at DUNDALK into the application of the Urban Council to borrow £3,000 for mains extensions and to provide a new battery. It was reported that the effect of the restricted shopping hours was to reduce by 40 per cent. the shop consumption, and the Summer Time Act reduced the total sales to 17 per cent. less than they were three years ago, although some hundreds of extra consumers have been connected in the meantime.

Owing to an unfortunate dispute between ILFORD Urban Council and its employees as to the rate for overtime pay since the introduction of the 47-hour week in May, there has been a strike of the men engaged on the tramways and electricity works and the district has been without tramways or electricity for some days. The dispute, which involved only £100, has been settled, but it is to be regretted that such a small matter could not be settled in an amicable way by arbitration.

The accounts of the electric supply department, which were submitted to BRISTOL Corporation on Tuesday, show a net deficit on the past year's working of £3,416. With the credit balance from 1918 and the amount recoverable on the adjustment of income tax from the previous two years, there was a balance of £2,006 to carry forward. There is an excess of assets over liabilities of £177,176. The use of electricity for power, heating and cooking is about double that for private and public lighting.

HULL Electricity Committee finds that the recent increase of 6s. a ton in the price of coal will entail an extra annual expenditure of £17,000. The 47-hour week and other awards will require a further £5,000 per annum, and contingencies due to the present coal strike a sum of £1,565, making a total of £23,539. It is, therefore, proposed to increase the tariff by a penny per unit for flat rate lighting and by an additional 32½ per cent. for other units, an increase of 68 per cent. over pre-war rates for flat rate lighting and 100 per cent. for other purposes. For the year ended March 31 1919, the revenue was £144,369 and after providing for working and general expenses and special charges the gross profit was £39,110. Interest, loan instalments and income tax required £41,645, so that the net deficit for the year was £2,534. Working expenses were 1·32d. (1·02d.) per unit and loan charges 1·79d. (1·46d.). Total maximum demand was 8,850 kw. (9,150 kw.). Units generated were 25,964,370 (26,443,170) and sold 19,538,090 (20,125,652).

Peterborough Electricity Committee have decided that the amount to be charged to the street lighting department for the electrical energy used by the lamps shall, for each year, be an amount per kilowatt-hour to be ascertained by the following formula :—

$$P = A(0{\cdot}7F + 0{\cdot}3),$$

in which P is the required amount in pence per unit ; A is the average overall cost in pence per unit ; and F is the ratio which the general load factor of the whole of the output bears to the street lighting load factor.

Birmingham Electric Supply Committee reports that the increase of 6s. per ton in the price of coal will represent about £93,000 per annum on fuel account, and the consequential advances in the cost of other materials will bring the total extra expenditure to £110,000. In order to provide for this, an average increase in the low-tension scale of charges of approximately 14 per cent. is required, which mean additions varying, according to class of supply and quantity, from ½d. to ⅓d. per unit. An amended scale of charges was approved by the Council on Tuesday.

Heston & Isleworth Council has arranged with the Twickenham & Teddington Electric Supply Company for a bulk supply of high-tension electrical energy. The Council will take a minimum quantity of 400,000 units per annum for three years at £4 per kilowatt of maximum demand and 0·9d. per unit supplied, in addition to 10 per cent. per annum on the cost of the feeder cable between the company's generating station and the point where it enters the Council's district. The price per unit is based on coal at £1 5s. per ton, and is subject to a sliding scale in respect of the cost of coal and labour.

Presteign Urban Council is negotiating with the Bishop's Castle Electric Light Company and Hereford Corporation for a supply of electricity. The Corporation scheme is to supply the rural area of Hereford with electricity from the Hereford station. It is proposed to erect lines to supply Kington, Leominster and Lyonshall at a cost of approximately £25,000. Overhead high-tension transmission lines would commence at Holmer Cross Roads. One overhead line will pass through the parishes of Burghill, Tillington, Pipe and Lyde, Willington, Canon Pyon, Dilwyn to Pembridge (12 miles). At this point a sub-station would be erected, a line branching off to Leominster, via Eardisland, Kingsland and Monkland (6½ miles), another back from Pembridge to Titley quarries (4 miles), and from Titley one line to Presteign (3 miles), and one to Kington and Lyonshall (4 miles), a total of 29½ miles, with a population of 20,710 en route.

The accounts of the Aylestone electricity department of **Leicester** Corporation for the year ended December, 1918, show receipts £60,084 (compared with £57,205 in the previous year) and after providing for interest, sinking fund, war allowance, &c., the net balance was £3,317. Units generated were 6,673,750 and sold 5,210,014. Total maximum supply demanded was 3,278 kw. The accounts of the tramways and electric power supply department show revenue £294,916 (compared with £243,648 in previous year), cost of electrical energy generated at Lero station was £54,172 (£47,042), or £65,006 (£57,766), including capital charges, &c., while the units purchased from Aylestone station (917,990) cost £3,771 (£3,923). Total revenue was £294,916, working expenses were £218,506 and the net balance, after providing for capital charges, was £16,497. Units used for traction were 6,882,288, used at power station, depots, &c., 2,107,282 and sold for power purposes 11,531,620. Passengers carried were 50,983,223 and car-miles run 3,726,462.

Last week **Northants County Council** agreed to allow the Northampton Electric Light & Power Company to lay mains for supplying electricity to various places in Wellingborough, Rushden, Higham Ferrers and Irthlingborough district, but the mains must be laid in the grass roadside borders or in the footpaths and no mains shall be in the carriage way, except where it is necessary to cross the roads. Ald. F. H. Thornton, chairman of the Northampton Company, said that terms were arranged with the Roads Committee pending the application for a Provisional Order, and he complained that a clause had been inserted in the conditions which would deprive the company of powers it already possessed. They were generating power on the most economical lines at Northampton and wanted to serve the whole county, but they seemed to get the opposition of the Council instead of its support. Notwithstanding Ald. Thornton's protest the members of the Council insisted upon the conditions.

Stoke-on-Trent Electricity Supply Committee has informed the Coal Controller that in its opinion "the price of coal is much too high, and that the quality is so bad that an excessive amount has to be consumed compared with pre-war conditions."

Application has been made to the Ministry of Health for sanction to borrow £16,351, to cover various amounts which had been expended on works in excess of the sanction received. It has been decided to give a supply to Messrs. Harrison & Son on condition that they pay a minimum of £1,000 a year, the charge to be made on the Merz demand system with a demand charge of £4 per kilowatt per annum, and a consumption charge of ½d. per unit, with a coal clause of 0·03d. per unit increase for each shilling per ton above 27s. 3d. per ton.

In view of the proposal to raise the price of coal by 6s. per ton, it is proposed to make a further advance of 25 per cent. (or 125 per cent. over pre-war rates) upon all supply and other charges payable to the department. The supply to Newcastle-under-Lyme was commenced on July 11.

Electric Traction.

East Ham Corporation has been authorised to borrow £10,230 for the purchase of six tramcars.

Bolton Corporation has ordered eight new tramcars and proposes to carry out repairs of the permanent way.

Bradford Tramways Committee has abandoned the system of collecting tram-fares for the upper deck of cars as passengers enter.

York City Council has applied to the Board of Trade for sanction to borrow £17,000 for the purchase of additional tramcars and an extension of the tramways.

Barrow Corporation decided on Monday to acquire the local tramway undertaking from the British Electric Traction Company, which has run it for a number of years.

Leeds Corporation have sold eight tramcars to the Yorkshire (West Riding) Electric Tramway Company, at £900 per car ; and negotiations are proceeding with Walthamstow Urban Council for the sale of six cars.

The Commissioner of Police has notified **Walthamstow** Municipal tramways department that in future open-deck tramcars will not be licensed unless upper-deck seats are provided with suitable waterproof knee-aprons.

The extension of the Central London Railway from Wood-lane to Ealing Broadway is practically completed, but the line cannot be opened until the electrification of the G.W.R. line and the delivery of the rolling stock, which it is hoped will be supplied before the end of the year.

The Unopposed Bills Committee of the House of Commons have passed the Middlesbrough Corporation and the Stockton-on-Tees Corporation Bills, which confer powers for the purchase of the local tramways, the extension of the system, &c. Both Bills have already been passed by the House of Lords.

Wolverhampton Corporation have approved the annual accounts of the tramways department. The gross profit on the tramways was £31,992, and on motor omnibuses £1,609. A sum of £10,000 was allocated to the borough rate. The reserve and renewals fund is £56,685, with £19,427 in the maintenance and repairs suspense account. The traffic receipts were £88,787 (against £75,593 in 1917-18), the car miles run 1,115,139 (1,096,868) and 20,003,302 passengers (17,126,210) were carried.

An inquiry by an inspector of the Ministry of Health has been held at **Nottingham** into the application of the Corporation for sanction to borrow £13,340 for the erection of a motor garage. The Corporation has 20 motor vehicles, but it is anticipated that before long there will be about 40, and it is proposed to erect a garage at the Eastcroft to accommodate 30 electric and 10 steam vehicles, with a repair shed, stores and offices. The city engineer (Mr. A. Brown) stated that motor vehicles only involved about half the cost of horse vehicles.

On Tuesday the **London County Council** considered a long report by the Highways Committee making suggestions for the removal of certain financial burdens on the tramways. The Committee recommended that application be made to Parliament in the 1920 Session for the Council to be relieved of the liability for the maintenance of roadways in thoroughfares where tramcars run, and that no part of the cost of street improvements be charged to the tramways account, except where improvements are solely required for working the system. Consideration of the report was, howevr, adjourned.

The order for the second reading of the London County Council (Tramways and Improvements) Bill was discharged in the House of Commons on Friday and the bill was withdrawn.

The Salvage, Stables and Lighting Committee reported to **Birmingham** Corporation on Tuesday that, after exhaustive inquiries, they had come to the conclusion that electric vehicles were admirably adapted for the removal of house refuse. These vehicles are being used in a number of towns and it had been clearly demonstrated that they are more efficient and economical than horse haulage. The vehicles do not deteriorate by the repeated stops necessary for house-to-house collection of refuse, a factor which rules out entirely the petrol and steam vehicle for the work ; also electric vehicles cause no nuisance from dirt, noise or smell. Some properties from which refuse is collected were four miles away from the depots. It had always been assumed that three horse-loads should constitute a day's work for the men, and this could be done with a 54-hour week. With a 47-hour week overtime work would be necessary on many of those long rounds unless a speeding-up took place and they therefore recommended the purchase of 25 electric vehicles for the longer journeys, horses for the present being retained for the shorter journeys. Tenders had been obtained for the supply of 25 vehicles, and the Committee recommended that the tender of Edison Accumulators, Ltd., be accepted at £32,000. Each electric vehicle will displace two horses, and the Committee have every confidence that the cost of the vehicles will be more than repaid by their economical use. The prices asked for the two kinds of vehicles were : £1,155 with the lead battery, and £1,280 with the Edison battery. The lead battery was only guaranteed for two years, against the Edison battery of 60,000 miles, to be run in a maximum period of 10 years. The cost of renewing each of the lead batteries every two years is £245.

Six of the electric vehicles are intended for Lifford Destructor, where the stud of 13 horses will be dispensed with. There is sufficient steam at this destructor now being blown into the atmosphere to produce the current required for charging the vehicles, but there is no generating set for producing such current. The Committee recommend that they be empowered to instal a generating set at a cost of £2,000.

After discussion the recommendations were adopted by the Council.

Imperial and Foreign Notes.

Telephone communication has been established between CAWNPORE and LUCKNOW, and other long distance trunk lines are projected.

A scheme for supplying Ootacamund with electrical energy was recently discussed by MADRAS Government officials with Mr. Gibbs, electrical engineer of Messrs. Tata & Sons, and there is hope that a satisfactory scheme will soon be worked out.

The Treasurer of TASMANIA (Sir E. Lewis) states that every investigation is being made as to the water-power available, so that the Government can go ahead harnessing power as fast as customers can be found. He hopes to see £5,000,000 expended on the hydro-electric scheme on the same lines as the money already spent. A 45,000 H.P. scheme is ready to be developed at King River, and it is hoped to link up the west coast with the other power schemes. Mr. J. H. Butters, chief engineer and general manager of the State hydro-electric works, is on his way to England in connection with the purchase of machinery.

The SWISS FEDERAL GOVERNMENT has been requested by the electricity supply works and the Swiss Electrotechnical Institute to allow of a greater use being made in future of Swiss water power for industrial purposes.

The Secretary of the U.S.A. Navy (Mr. Daniels) has asked Congress to enact legislation to enable the Navy Department to handle commercial wireless messages on the ground that "an intolerable situation in the business world is threatened because of the inadequacy of other systems of international communication."

In order to place the CHILEAN State Railway system on a satisfactory basis it is proposed to raise a loan of 160,000,000 pesos, including 18,500,000 pesos for the electrification of the first section (Valparaiso to Santiago) and 12,000,000 for electric locomotives, 9,100,000 for cost of double lines, 5,000,000 for new branch lines and sidings, 15,500,000 for workshops, 26,000,000 for the purchase of equipment and 7,500,000 for signalling system and points service, 5,600,000 for automatic brakes and 4,000,000 pesos for mechanical coalers, bunkers, &c.

Miscellaneous.

The BRITISH INDUSTRIES FAIR, which was to have been held in Glasgow in September, has been postponed until the spring of 1920.

The Post Office has recently installed the BAUDOT PRINTING TELEGRAPH on the London-Dublin telegraph service, and at present there are about 20 circuits working on the system in this country.

At St. David's, Pontypridd, on July 29, the marriage took place of Mr. E. W. Jones, engineer and general manager of the Mountain Ash Urban Council, and Miss L. J. Evans, daughter of Mr. and Mrs. E. Evans, Ynysybwl.

The Government have allocated an additional sum of £170,000 for completing the GOVERNMENT WIRELESS STATIONS at Leafield (near Orford) and Abu-Zabal (near Cairo), thereby establishing direct wireless communication between England and Egypt.

It is announced that a Government cable is now in operation between this country and Canada. All telegrams for Australia and New Zealand handed in at post offices are forwarded by this cable to Canada for transmission by the Pacific cable, unless they are specially marked by the senders to be sent by another route. Telegrams for Cansda and the West Indies which are handed in at post offices marked with the words "*via* Imperial" are also sent by the cable. The charges are the same as those of the other Atlantic cables.

In reply to a question in the House of Commons as to whether the American Telephone and Telegraph Company had been granted LANDING RIGHTS for the five ATLANTIC CABLES which they took over from British companies before the war, Mr. Pike Pease stated that the Western Union Telegraph Company were promised landing rights under certain conditions when they took over the five cables. Owing to various causes there had been considerable delay in issuing a formal licence embodying those landing rights, but such a licence had recently been completed.

The Merchant Shipping (Wireless Telegraphy) Bill, which makes compulsory the use of wireless apparatus on passenger steamers and ships over 1,500 tons, has been passed by Committee "D" of the House of Commons. An amendment has been made substituting one for two operators, excepting where required by the Merchant Shipping Act of 1914, and some minor amendments were also introduced to give Post Office inspectors the same powers as Board of Trade surveyors to inspect wireless installations. The clause of the Bill relating to foreign ships will come into operation three months after it has been passed.

In a communication to "The Times" of the 26th ult., Mr. J. W. Dugdale-Bradley, M.I.C.E., states that "no improvement (in the output of coal) will result until the underground men are worked on much shorter shifts and a reduction is made in the weekly hours. Electrically-driven machinery employed to a much fuller extent, the working places in many pits brought nearer the surface by the provision of additional shafts and better transport facilities, when a higher grade of more intensive labour working under brighter conditions, with the fullest aid of machinery, will be available. Comparisons between the output per man in America and Britain are inadmissible, as the seams are thicker and shallower seams in America, and uneducated, low-type, mid-European labour is largely employed, long hours are worked, genius is displayed in the use of machinery, and there are safer natural conditions of working than in Britain.

Educational.

Mr. J. W. Thomas has been appointed lecturer in the electrical engineering department at the Birmingham Municipal Technical School.

The Council of MANCHESTER University has instituted a second chair of mathematics, and has appointed Mr. Sydney Chapman, M.A., D.Sc., to the chair.

Mr. E. Rawson, B.Sc., late head of the Newcastle Training Centre, has been appointed Head of the Mechanical and Civil Engineering Department at the Portsmouth Municipal College.

The council of Armstrong College, Newcastle-on-Tyne, has appointed Lieut.-Col. Sir Theodore Morison, K.C.I.E., K.C.S.I., Principal of the College, and Captain J. F. T. Greig has been elected Registrar.

In the July Examinations for the Associateship of the Institute of Chemistry Lieut. Cecil Wm. Wood passed in Branch (*a*), Mineral Chemistry; Lewis G. Peirson, B.A., and John E. Pollock, B.Sc., passed in Branch (*d*), Organic Chemistry; and Percy E. Stanhope in Branch (*g*), Chemical Technology, with Textile Chemistry as special subject.

The 1919-20 Session of the MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY begins on Oct. 8 and the matriculation and entrance examinations will be held in September. In addition to the degree courses in technology (electrical, mechanical and sanitary and municiapl engineering, the chemical industries, &c.), there are good facilities for advanced study and research.

Tenders Invited and Accepted.

ATHY Urban Council invites tenders by Aug. 18 for public electric lighting for three years. About 50 lamps will be required, and permission will be given for the use of overhead wires and poles.

Tenders are invited by the VICTORIAN RAILWAY COMMISSIONERS for the supply of an electric capstan for the Newport (Victoria) power house Tenders to the Secretary for Railways, Melbourne, by 11 a.m. Aug. 27.

MANCHESTER Tramways Committee require tenders for the supply of 5-ton Motor Tip Wagons and Tramway-pole Sleeves. Tenders to the Chairman, 55, Piccadilly, Manchester, by Aug. 5.

MANCHESTER Electricity Committee require tenders by Aug. 8 for th supply and erection of (*a*) 2,750 B.H.P. induction motor; (*b*) a 2,000 kw. induction motor-generator, with switchgear, &c. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

BRADFORD Corporation invite tenders for the supply and erection of three water-tube boilers, superheaters, stokers, &c., and natural draught chimney-type cooling tower. Specifications, &c., from the city electrical engineer (Mr. Thos. Roles), and tenders to the Town Clerk (Mr. Frederick Stevens) by Aug. 15.

GRIMSBY Corporation invite tenders for high-pressure steam pipes, boiler feed and other pipes, circulating water pipes, electrically-driven centrifugal pumps and water storage tank. Specifications and drawings from the borough electrical engineer, Lieut.-Col. W. A. Vignoles, and tenders by Monday, Aug. 11.

On Tuesday BIRMINGHAM Corporation accepted the tender of the Edison Accumulators, Ltd., for the supply of 25 electric vehicles for use in the Salvage Department at £32,000.

NUNEATON Council has accepted the tender of the Pirelli-General Cable Works for the supply of 1,350 yds. of three-core paper-insulated lead-sheathed armoured and served feeder cable at £2,042. 10s.

MANCHESTER Corporation has accepted the following tenders: W. Grice & Sons, Ltd., air filter for Stuart-street station; Western Electric Company and Callender's Cable & Construction Company, cable; British Westinghouse Electric & Mfg. Company, two 4,000 k.v.a. static transformers.

STOKE NEWINGTON (London) Borough Council has accepted the tender of the General Electric Company for additional electrical plant at £3,450. Orders have been placed with the Electrical Apparatus Company for 3, 5, 10, 15 and 25 ampere meters, and with Chamberlain & Hookham for 40, 50 and 100 ampere meters, and with Pirelli General Cable Works for cables.

SALFORD Corporation has accepted the following tenders:—W. T. Glover & Company, l.-t. electric cable, £254; I. Frankenburg & Sons, india-rubber insulated electric cable, £277 0s. 9d.; Hadfields Ltd., eight pairs of "Era" manganese steel points, £528; J. G. Brill Company, four Brill standard 21-E trucks, £427; J. Russell & Sons, 40 medium tramway poles, £824 10s.

Appointments Vacant and Filled.

A Principal is required for Bradford Municipal Technical College. Particulars from the Director of Education, Town Hall, Bradford.

Belfast Corporation invite applications for the position of Principal of the Municipal Technical Institute. Applications to Town Clerk by Aug. 7.

An assistant lecturer in electrical engineering is required at Leeds University. Salary £300. Particulars from the Secretary and applications by Aug 11.

Applications are invited for the University Professorship of Physics in the Benares Hindu University. Salary Rs. 500-50-750. Applications to the Pro-Vice-Chancellor, Benares, India, by Oct. 15.

The Council of Armstrong College, Newcastle-on-Tyne, invites applications for the post of professor of experimental physics. Salary £600, rising by biennial increments of £50 to £800 per annum. Applications to the Secretary by Aug. 30.

A demonstrator in physics is required at the Municipal Technical Institute, West Ham. Salary £150, rising by annual increments of £10 to £180 per annum. Applications to the Principal, Romford-road, Stratford, E. 15, by August 24.

Four assistant lecturers and demonstrators are required in the departments of engineering, electrical engineering and engineering design and drawing of the University of Liverpool. Salaries £250, £300, £250 and £250 respectively. Applications to the Registrar by Aug. 15.

An instructor in mathematics and physics is wanted for the electrical engineering department of the Northampton Polytechnic Institute. Salary £300 per annum. A demonstrator and assistant lecturer in mechanical engineering (salary £300) and a demonstrator and assistant lecturer in optics (salary £300) are also required. Applications to Dr. R. Mullineux Walmsley, St. John's-street, London, E.C. 1, by August 5.

An assistant lecturer and demonstrator in metallurgical and engineering chemistry and applied electro-chemistry is also required for the Northampton Polytechnic Institute. Salary £240 plus £39 war allowance. Application forms from the Principal,

Mr. F. French, of Bridlington, has been appointed electrical engineer to Horsham Urban Council.

Mr. G. T. Henzell has been appointed repair superintendent at the L.C.C. power station, Greenwich.

Mr. W. D. Fisher, assistant mains superintendent at Barrow, has been appointed assistant electricity distribution engineer at Bury, Lancs.

The directors of the Clyde Valley Electrical Power Company have appointed Mr. Archibald Page general manager of the Company, in place of the late Mr. D. A. Starr.

Bradford Electricity Committee has selected Mr. Johnstone Wright (out of 139 applicants) for the position of Chief Assistant Electrical Engineer, at a salary of £750 per annum. Mr. Wright is at present chief engineer and superintendent of power stations of the Cleveland & Durham Electric Power, Ltd., with which company he has served in various capacities for close upon 13 years. Mr. Joseph Smith, Chief Accountancy Clerk in the West Ham Corporation Electricity Department, has been appointed Managerial Assistant, at £500 per annum. There were 247 applicants. Mr. Smith has occupied his present position for 13 years, and was previously employed at Barking and Nelson.

Business Items.

The Accessories Mfg. Company (Mr. James Douglas) has removed to 4, South-street, Finsbury, London, E.C.

The offices of the Imperial Mineral Resources Bureau have been moved to 2, Queen Anne's-gate Buildings, S.W. 1.

The works of the Benjamin Electric, Ltd., will be closed during August Bank Holiday week (Aug. 4 to Aug. 9 inclusive) for the annual holiday.

Messrs. Higgin, Ltd., 265, Deansgate, Manchester, are district agents of the Ironclad Switchgear Company, and of Accumulators, Ltd.

Messrs. Renshaw & Marsden are opening premises in Penny-street, Blackburn, as electrical engineers and general hardware dealers.

The offices of the Industrial Publicity Service, Ltd., have been removed to 4-7, Red Lion-court, London, E.C. 4. Telephone: Central 2422.

Messrs. Broom & Wade, Ltd., High Wycombe, have issued a pamphlet which sets out particulars of Hyatt roller bearings and the power economies effected by their use.

The owner of British patent No. 28,409, of 1903, dealing with "improvements in and relating to telegraphy," desires to dispose of same or to grant working licences. Particulars from Messrs. Marks & Clerk, 57-58, Lincoln's Inn Fields, London, W.C.2.

The Automatic & Electric Furnaces, Ltd., of Gray's Inn-road, W.C.1, has issued an illustrated pamphlet which gives particulars of the Wild-Barfield electric furnace equipments. A description of the furnace recently appeared in The Electrician.

Offers are invited by the Disposal Board of the Ministry of Munitions for quantities of electrical plant and apparatus. Some information is given in an advertisement, and fuller particulars may be obtained from the Controller of the Electrical Section of the Disposal Board, Caxton House, Westminster, S.W.1.

Mr. James E. Naismith, district engineer in the construction department at the Birmingham office of the Western Electric Company, has been appointed Scottish representative for the Company with headquarters at 49, West Campbell-street, Glasgow. For many years Mr. Naismith was in the electrical department of the Corporation tramways at Glasgow, and no doubt his many friends in that city will welcome him upon entering a commercial career.

In a pamphlet recently issued by Erith's Engineering Company, Ltd., particulars are given of the mechanism and action of the Erith-Riley Self-cleaning Underfeed Stokers. In these days when coal economies are so essential the use of any labour-saving appliances will appeal to the station engineer, and therefore the present pamphlet should interest him. Several of the stokers have already been installed in electric power stations, and the pamphlet contains illustrations of typical plants. With the Erith-Riley stoker the coal is fed, the fire cleaned and the ash discharged continuously and automatically.

Liquidations.

A meeting will be held at 12, Lime-street, London, E.C., on Aug. 9 to receive an account of the winding-up of Portable Electric Motors, Ltd.

A meeting to receive an account of the winding-up of Pitter's Patents, Ltd., will be held on Aug. 9, at 23, Austin Friars, London, E.C. 2.

Companies' Reports, &c.

The directors of the North London Railway Company have declared an interim dividend of 2¼ per cent. for the half-year to June 30.

An interim dividend at the rate of 7 per cent. per annum has been declared by the Lanarkshire Tramways Company for the half year ended June 30.

The London Electric Railway Company has declared an interim dividend of 2 per cent. on the preference stock, and of 1 per cent. on the ordinary shares.

The directors of the Chelsea Electricity Supply Company announce an interim dividend of 3 per cent. per annum, less tax, on the ordinary shares for the half-year ended June 30.

The directors of the Metropolitan Electric Supply Company have declared a dividend of 2 per cent. per annum (1s. per share), less tax, on the ordinary shares for half-year ended June 30.

The directors of the Chatham & District Light Railway Company announce a dividend of 8 per cent. per annum (8s. per share), less tax, on the ordinary shares for the past half-year.

An interim dividend of 2 per cent. has been declared by the Central London Railway Company for the six months ended June 30 on the undivided ordinary and dreferred ordinary stocks.

The City & South London Railway Company has declared interim dividends of 2½ per cent. on the preference stocks and of 1 per cent. on the consolidated ordinary stock for the half-year ended June.

In order to provide capital for the development of the business, Messrs C. A. Vandervell & Company, Ltd., have made an issue of £300,000 in 3,000 6½ per cent. first mortgage registered debentures of £100 each.

The South London Electric Supply Corporation, Ltd., has declared an interim dividend on the ordinary shares at the rate of 4 per cent. per annum (less tax) for the half-year ended June 30, payable on Sept. 13.

At a series of meetings of the shareholders of the British Coalite Company, Ltd., resolutions have been passed providing for the amalgamation of the company with Coalite, Ltd., and Low Temperature Carbonisation, Ltd.

The Metropolitan Railway Company recommend payments of the dividends on the several issues of the preference stock and of an interim dividend at the rate of 1 per cent. per annum on the ordinary stock for the half-year ended June 30.

The Metropolitan District Railway Company has declared interim dividends for the six months ended June 30, as follows: On 4 per cent. guaranteed stock, 2 per cent.; on 4½ per cent. first preference stock, 2¼ per cent.; and on 5 per cent. second preference stock, 2½ per cent.

Interest on the 6 per cent. first cumulative income debenture stock of the Underground Electric Railways Company of London will be paid on Sept. 1 next at 3 per cent., and coupon No. 23 off the 6 per cent. income bonds will be paid (tax free) at 3 per cent. on the same date.

The directors of the Charing Cross, West End & City Electricity Supply Company, Ltd., have declared an interim dividend on the ordinary shares of the West End undertakings for the half-year ended June 30, 1919, at the rate of 4 per cent. per annum. Warrants will be posted on Aug. 15.

The net profit of Marconi's Wireless Telegraph Company, Ltd., for the year 1918 was £597,938, and with balance brought forward the total is £974,699. Deducting the dividend of 7 per cent. on the preference shares and the interim dividend of 5 per cent. on the ordinary shares, the balance available for distribution is £896,016. The directors recommend payment of further dividends as follows: On ordinary shares, 20 per cent. (making 25 per cent. for the year), absorbing £244,730; and on preference shares 15 per cent. (22 per cent. for the year), absorbing £37,500, leaving a balance of £613,787, of which it is proposed to transfer to general reserve £150,000 and to carry forward £463,787. The general reserve will then stand at £1,250,000. There having been no settlement with any of the Government departments in respect of any of the company's claims arising out of the war or for services rendered during the war, no sum in respect of any of these claims figures in the year's accounts.

At the recent meeting of G. D. Peters & Company, Limited., the chairman, Sir B. Peters, K.B.E., stated that they were building a larger foundry fitted with the latest modern appliances. Judging from the numerous orders and inquiries received they had no doubt that their manufacturing resources as railway suppliers would be fully taxed. In addition to pre-war manufactures, they had opened up a new branch of business in power signalling, which promised to develop into a very considerable and profitable departure for the company. They had also become interested in electric welding, and one of the directors was devoting a large portion of his time and energy towards introducing the Wilson system of electric welding to the shipping, railway and engineering industries of the country. That system of electric welding was very largely responsible for the assistance given by America in defeating the German submarine menace, by the quick repair of the German shipping in American ports. They had been fortunate in securing those rights, which they hoped would be a very useful adjunct to their business.

In the Bill of the Shropshire, Worcestershire & Staffordshire Electric Power Company power is sought to increase the capital. By the Acts of 1903 to 1918 powers have been given to raise £900,000 by the issue of shares and £900,000 by the issue of debenture stock, and of this sum £500,000 share capital and £500,000 debenture stock have been issued. In 1918 the company were authorised to erect a new generating station on the Severn, which, with subsidiary works, is estimated to cost £1,890,000. To meet this expenditure, and to provide for the acquisition of the Kidderminster & Stourport Electric Tramway Company's generating station at Kidderminster, it is proposed to authorise the issue of £850,000 additional share capital and of £850,000 in debenture stock. It is also proposed to constitute the new generating station on the Severn at Droitwich and Stourport a separate undertaking, and to allocate to that undertaking not only the proposed additional capital, but "any part of the unissued share and loan capital authorised under the Company's Acts of 1903 to 1918."

At an extraordinary general meeting of S. Smith & Sons (motor manufacturers), Ltd., last week it was resolved to increase the capital of the company to £1,000,000 by the creation of 500,000 new shares, divided into 100,000 ordinary and 400,000 6½ per cent. cumulative participating preference shares of £1 each. The chairman, Mr. Samuel Smith, presided, and explained that they were acquiring a controlling interest in the M.-L. Magneto Syndicate, Ltd., one of the most successful manufacturers of magnetos on the market. The aim of the board was to become one of the largest motor accessory houses in Europe. The M.-L. Syndicate started about four years ago, and their turnover and profits were more than satisfactory. The company was paying just on £150,000 for the controlling interest of over 95 per cent. in the M.-L. Syndicate, and by using the joint selling organisation of the two companies a considerable saving could be effected. The M.-L. works had a capacity of from 1,500 to 2,000 magnetos a week, with a present approximate output of 1,000 per week. It was hoped that the output would be increased by at least 50 per cent. during the next 12 months. In addition to the new magneto, they had secured the exclusive selling agency of other motor accessories, among them the K.L.G. sparking plug.

At the recent annual meeting of the Suffolk Electricity Supply Company, Ltd., the directors reported that the last year's profit amounted to £2,362. A dividend at the rate of 8 per cent. was recommended on the ordinary shares, and a dividend at the rate of 80 per cent. (less tax) on the founders' shares. The sum of £865 was added to reserve for depreciation, a sum of £207 is to be devoted to the purchase of workmen's shares and the balance was carried to the general dividend reserve fund. As further reserve power was required at Stowmarket, the directors have decided to interconnect Stowmarket and Ipswich by means of an overhead main. To "secure the interest of the employees in the financial success of the concern, and to enable them to realise that they are working, not only to benefit the ordinary shareholders, to provide workmen with an opportunity for expressing, officially, their views as to the best means of achieving the objects of the company, to create a community of interest with the shareholders, and generally to secure a basis for carrying out the recommendations of the Whitley Committee, the directors have considered it advisable to issue special shares, to be known as workmen's shares." To inaugurate the scheme, and to mark the directors' appreciation of the employees' devotion to duty during the war and the subsequent satisfactory issue of peace, the directors propose to give, as a bonus, a £1 workmen's share to each employee for every complete year's service in the employ of the company, absence on naval, military or R.A.F. service not being deducted. Provision for the purchase of the shares has been made out of the profits of the past year's working.

The chairman (Mr. P. C. N. Pedder), who moved the adoption of the report and accounts, said the company had completed its 21st year of trading, which was very satisfactory. They had not been troubled with labour strikes or discontent and after explaining the scheme for the creation of workmen's shares the motion was adopted. It was stated that electricity supply was now available at Beccles and Needham Market.

New Companies.

COOPER & KING, LTD. : (157,008).—Private company. Reg. July 14. Capital £1,000 in £1 shares. Mechanical, agricultural, electrical and general engineers, &c. First directors are R. G. Cooper and C. King. Reg. office : 37, Westgate-street, Cardiff.

HAMER & COMPANY, LTD. (157,177.)—Private company ; reg. July 18, capital £5,000 in £1 shares. Objects : To carry on the business of electricians, mechanical and motor engineers, suppliers of electricity, &c. First directors are W. Hamer and J. Fletcher. Reg. office, Carlton Electrical Works, Bull Close-lane, Halifax.

HURST ELECTRICAL PLANT, LTD. (4,738).—Private company. Reg. in Dublin July 7. Capital £25,000 in £1 shares. To take over the business of dealers and manufacturers of electrical plant, carried on as the Hurst Electric Mfg. Company. First directors are A. E. J. Hurst, T. H. Hurst, J. A. McKee and T. F. Mackie. Reg. office : Brewery-buildings, Sandy-row, Belfast.

J. F. IRVINE & COMPANY, LTD. (10,510).—Private company. Reg. in Edinburgh July 4. Capital £4,000 in £1 shares. Objects : to construct, repair, maintain and run installations, wires, cables and other works for the supply and distribution of electricity. First directors are J. F. Irvine (managing director) and Mrs. D. E. Irvine. Secretary : J. Husband. Reg. office : City Hall, Dock-street, Dundee.

LAMLOK, LTD. (157,017).—Private company. Reg. July 14. Capital £2,000 in £1 shares. To acquire the business of consulting engineers, patentees, manufacturers and dealers in electric lamps and other fittings, carried on at Chiswick, under the firm of Lamlok. Life directors : C. G. M. Bennett and C. H. Jeffcoat. Reg. office : 36, Rusthall-avenue, Chiswick, W.4.

MEAD & JEFFERY, LTD. (156,944).—Private company Reg. July 11. Capital £1,000 in £1 shares. To acquire the business of electrical engineers and contractors carried on by A. G. Mead and C. H. Jeffery. Directors : A. G. Mead and C. H. Jeffery. Reg. office : 23, The Avenue, West Ealing.

P. & M. COMPANY (ENGLAND) LTD. (156,800)—Private company. Reg. July 7, capital £1,000 in £1 shares, to enter into an agreement with L. P. Winby and to carry on the business of engineers and founders, metallurgists, railway appliance manufacturers, &c. Directors : L. P., I. S. and F. C. Winby (London), and F. A. Poor (Chicago). Reg. office : 31, Budge-row, E.C.4.

SCOTTISH ELECTRICAL ACCESSORIES, LTD. (10,496).—Private company. Reg. in Edinburgh on July 1. Capital £5,000 in £1 shares. Electrical, mechanical and general engineers and contractors, &c. First directors are F. C. Gardiner and C. Ker. Secretary : H. C. Ferguson. Reg. office : 53, Bothwell-street, Glasgow.

TELEPHONE SUPPLIES, LTD. (156,950).—Private company. Reg. July 11. Capital £20,000 in £1 shares. Manufacturers of and dealers in electrical machinery and appliances, especially telephones, telephonic apparatus, &c. Directors : A. L. Collins, J. H. Smith and H. P. Smith.

A. L. UNDERWOOD, LTD. (156,932).—Private company. Reg. July 11. Capital £12,000 in £1 shares. To acquire the business carried on by A. L. Underwood, and to carry on the business of mechanical and electrical engineers, motor car manufacturers, &c. Director : A. L. Underwood.

WARMINSTER ELECTRIC SUPPLY COMPANY, LTD (157,166.)—Private company : reg. July 17, capital £4,000 in 300 cumulative preference shares of £5 each and 2,500 ordinary shares of £1 each. Directors, A. A. Douglas and J. H. Edwards. Reg. office, Cairncross, Stroud, Glos.

WESTINGHOUSE MORSE CHAIN COMPANY, LTD. (156,810)—Private company. Reg. July 7, capital £60,000 in £1 shares. Objects : To enter into an agreement with the Westinghouse Brake Company and the Morse Chain Company (Ithaca, N.Y.), and to acquire the business heretofore conducted by the Westinghouse Brake Company relating to the manufacture and sale of Westinghouse Morse chains and parts and appliances appertaining thereto.

Prices of Metals, Chemicals, &c.

Tuesday, July 29.

		Price.	Inc.	Dec.
Copper—				
Best selected	per ton	£112 0 0	£1 0 0	—
Electro wire bars ...	,,	£125 0 0	7 0 0	—
H.C. wire, basis ...	per lb.	1s. 4⅜d.	0 $\frac{13}{16}$d.	—
Sheet	,,	1s. 3⅜d.	0⅜d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	per lb.	1s. 7⅜d.	0 $\frac{13}{16}$d.	—
Brass 60/40—				
Rod, basis	per lb.	6s. 11⅛d.	0¼d.	—
Sheet, basis	,,	1s. 2¾d.	0½d.	—
Wire, basis	,,	1s. 2½d.	0½d.	—
Pig Iron—				
Cleveland warrants	per ton	£164 0 0	—	—
Galvanised steel wire, basis	,,	32 10 0	—	£3 0 0
Lead Pig—				
English	,,	25 0 0	0 5 0	—
Foreign or colonial	,,	24 0 0	0 5 0	—
Tin—Ingot	,,	268 10 0	12 5 0	—
Wire, basis	per lb.	3s. 4d.	1½d.	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £20.

,, (Roll Brimstone).—Per ton £19.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d. to £8.

Copper Sulphate.—Per ton £45.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 7d.

Shellac.—400s. October delivery at 403s. to 407s.

Rubber.—Para fine, 2s. 5¾d. ; plantation grades, 1s. 11d. to 1s. 11½d. lb.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W.T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From The Electrician, July 29, 1882.]

Proposed Electric and Gas Exhibition.—The gas companies are moving in this matter with some energy. It is stated that the South Metropolitan Gas Company and the Crystal Palace District Gas Company have promised to subscribe £500 and £250 respectively towards a guarantee fund to defray expenses. It is also probable that the Gas Institution will organise a committee to look after gas interests.

The Brush Light on the Tyne.—There are now in use in different works on the Tyne 64 Brush lamps, distributed as follows : 16 at the Palmer Company's engineering works, 16 at Messrs. J. Redhead & Company's, South Shields ; 16 at Messrs. Bell Brothers, Low Walker ; and 16 at Messrs. Hawthorn's, St. Peter's. In addition to these, we believe that Messrs. A. Leslie & Company, of Hebburn, are also to light their works by 40 of these lamps.

The Electric Light and the War.—The "Standard" Alexandria correspondent, telegraphing on the 23rd inst., says : "The electric light has been established at Fort Komel, and last night illuminated the country outside the walls for miles round, the panoramic effect as the light swept round being very singular and striking." The same correspondent reports that among some 85 Europeans and native Christians and Jews who had been brutally tortured and murdered at Tanta were two English telegraphists.

THE ELECTRICIAN:

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Notes.

The New Patents Bill.

THE discussion on Patents which was held last week at the British Scientific Products Exhibition elicited several points that are worth consideration and which will be found given in some detail in another column. Although we are quite of the opinion that the new Bill includes provisions which are advantageous and places the patentee in a better position, we still feel that there are certain points requiring very careful consideration. For example, the "licences of right" are by no means an unmixed blessing. There are doubtless people who hold that, in the public interest, it would be better to have no patents. This, however, is altogether a mistaken point of view. An invention which is not patented stands a very small chance of development, because the manufacturer who develops it has no protection for the work involved and stands the chance of other people stepping in as soon as his development work, which has probably cost a good deal of time and money, begins to be fruitful. For the same reason, nothing will be gained by permitting any number of licences for a given invention. In most cases the first licence becomes correspondingly reduced in value as subsequent licences are granted. Another point about these licences, as stated in the Bill, is that if the patentee does not take proceedings to stop infringement the licencee may do so, making the patentee a defendant, and it is by no means clear whether a patentee might not be very seriously involved by such proceedings. A good deal of the discussion turned upon the question of renewal fees. There is no doubt much to be said in favour of our system of renewal fees provided that these fees are not too heavy. Lord MOULTON, who was in the Chair, in his concluding remarks laid great emphasis on the fact that many patents are worthless, and therefore it is better to have renewal fees high so that they may be weeded out. We disagree with this view; indeed, that Lord MOULTON should have expressed such opinions was a little unfortunate. The general public already does not look upon the inventor with a very friendly eye. It must be remembered that there are many small patents which may be productive, but upon which the fees running to £100 are a severe tax when taken in conjunction with all the other costs of carrying an invention through to a successful conclusion. Suppose, for example, that the turnover from a patent is £5,000, and that 5 per cent. royalty is received by the inventor; this merely produces £250, and after the official fees have been paid, only £150 remains to meet al other expenses. The view may, of course, be taken that patents which do not give a turnover of at least £20,000 should not be encouraged, but we think this is a mistake. There is a good deal of truth in the statement by Mr. SWINBURNE that the inventor is popularly regarded merely as robbing other people; yet, as he remarked, the monopoly given is small in proportion to what is really required to make the country go ahead. We do not suppose that the inventor will ever get a proper position in this country until these erroneous ideas are eradicated, and that, we fear, will be a very long process.

Wireless Telegraph Licences.

IT is announced that after the Parliamentary recess the Postmaster-General will introduce a Bill for the purpose of regulating the use of wireless telegraph apparatus. According to the "Daily Express" the new Bill will restrict the use of wireless telegraphy, in so far as scientific persons and amateurs are concerned, to those who can prove that their experiments will be advantageous to naval, military and commercial ends. Even then the licences, in the majority of cases, are to be restricted to the reception of messages only, and those who have permission to transmit will be very carefully watched. Whether this is a correct forecast we do not know. If it is, we need only call attention to the absurdity of submitting proofs that possible experiments will necessarily be to the advantage of the naval and military authorities and of commercial users. In our opinion it is distinctly advantageous to allow receiving stations to be used by those who are interested in wireless telegraphy. Such reception in these days cannot be prevented, and therefore it is much better that it should be under reasonable control. Transmission is another matter, but providing this is in the hands of persons of repute we do not see that any harm can come from the licencing of such stations. Those who possessed licences before the war are well aware that these have recently been cancelled, and that applications for new licences will be considered at a later date when the regulations have been drawn up. It remains to be seen what the new policy will be. Having regard to this preliminary notice we suggest that all bodies who are interested in such matters, such as the Wireless Section of the Institution of Electrical Engineers and the Wireless Society of London, if this is still in existence, will do well to come together and to bring pressure upon the authorities to adopt a policy that is reasonable.

Electricity in Artisans' Dwellings.

With the advent of ambitious housing schemes, the supply of electricity to artisans' dwellings is a matter of some importance. The problem has been rendered much more difficult during recent years through the high efficiency of the metal lamp. This has made the position much easier for the consumer, but more difficult for the supply authorities to obtain a reasonable return upon their investment in services. In some towns a considerable study has been made of this subject, and as an example we may mention Brighton. In another column we publish an article by Mr. James Cleary, giving the results of experience there gained. This experience is distinctly encouraging. We gave some account of the first year's working at the end of 1915. Nearly five years have now been completed, and therefore a sound opinion may be formed upon the results obtained. There are at present 60 installations, with a total of 400 lights on 15 house services. During the past five years the revenue has steadily increased, and now averages £6 per annum for each house service. This must be considered as very satisfactory from the financial point of view. It is also interesting to learn that the life of a 32-watt lamp has been found to be 2,700 hours and the 40-watt lamp 2,200 hours. The original scheme was based on the assumption that each lamp would consume 40 kw.-hours during its life, but actually the consumption has been found to be 88·6 kw.-hours. With regard to services, it will be found that Mr. Cleary prefers underground cables, and looks upon overhead construction as a makeshift. We are not at all sure that he is right on this point. In dealing with this class of work, overhead wires have been used very extensively on the Continent. They are very easily erected and form a very flexible system. We do not see how they can give trouble if properly erected, and we can scarcely think that they would be so popular on the Continent if they were seriously at fault. We shall be glad to hear from other engineers who have adopted special systems to meet the case of artisans' dwellings, and particularly from those who have had experience in overhead work for this purpose.

One Effect of the New Electricity Bill.

In addition to the specific alterations and reforms which will follow the Electricity (Supply) Bill when it comes into operation, there will be certain influences which will make material modifications in the whole industry. One of these will be permanently to develop a tendency already begun, namely, for the technico-commercial aspect to come to the fore. In the early days of the industry the engineers, quite properly, ran the whole show. Dynamos were as refractory as mules, Joblockoff "candles" were given to winking wickedly, and conductors conducted to most illegitimate destinations. It was a one-man business, and the engineer was the "one." But when sedate turbines and trustworthy mains came along and the whole routine became stereotyped, the commercial aspect gradually became the more exacting consideration. Managers came into prominence, and many of the engineers themselves donned the cloak and title. At the same time, so long as generating stations survived, so long would the technical side be a big factor. But when the new scheme gets into operation and the generating stations begin to be converted into sub-stations, the engineering side must perforce subside into less significance. On the other hand, the commercial and business-getting side will have to stir with an ever-increasing activity. "A cheap and abundant supply" has been promised to the public, and the present undertakers will be the immediate purveyors. Moreover, there will be the Commissioner ever on the alert to see that the undertakers carry out this obligation to the fullest extent possible. The undertakings will, in fact, become merely selling organisations. The talent required will be commercial ability, united, of course, with the technical. For, after all, there will be plenty of scope for technical qualifications. The future problem of selling electricity will not be solved merely by bagman persuasion. It will consist rather in providing the consumer with more and more efficient and effective apparatus, and technical experience and discrimination will here be the all-important factors. The future, therefore, should be in no way discouraging to those in the industry. There should be much greater scope for individual initiative—and, what is by no means a secondary even if a personal consideration, there will be justification for adequate remuneration.

Scientific Lighting and Industrial Efficiency.

People are somewhat apt to speak of industrial efficiency in general terms, without reflecting that it consists mainly in paying close attention to a multitude of small things, and in taking the infinite pains regarded, according to one definition, as the essence of genius. In his lecture before the British Scientific Products Exhibition on July 28, Mr. Gaster drew attention to one of these items—scientific lighting— on which it must be admitted much has been said during recent years, but which is still often unaccountably overlooked. Mr. Gaster covered more or less familiar ground in staking out a claim for good illumination on the basis of better health, greater freedom from accidents, and better output. These claims are, in the main, admitted by enlightened manufacturers. It must in justice to the works manager be remembered that when a factory is working on top speed, it is exceedingly difficult to put up with disorganisation while the lighting is being overhauled. Only rarely can such work be executed in its entirety when the works are not running, or in such a manner as to cause practically no disorganisation of work. This, no doubt, explains why some manufacturers turn a deaf ear to suggestions for improvement. But there are at present a number of factories which are passing through a temporary period of slackness, and they might well use the opportunity to bring their lighting up to date. A new factory is, of course, a different proposition. Here there is no reason why the lighting should not be designed once and for all on judicious and scientific lines. The appeal for good lighting on the ground of health and safety is one which should find a hearing from Government Departments, and we hope that the work of the Departmental Home Office Committee will be consummated by at least a general provision requiring adequate lighting in general terms. The time is ripe for this step and it should be willingly received, especially in view of the good reception that has apparently been accorded to the relatively detailed "codes" of industrial lighting adopted by various American States. To our mind, however, the most interesting point is the relation being established between improved illumination and output. Common sense suggests that obvious errors in lighting must have a prejudicial effect. But a more startling result is that apparently reached in some recent American tests, which suggest that the limit of illumination, beyond which any advance in intensity has a relatively small effect on ease of working, is much higher than is commonly supposed. Thus an increase in illumination from 4 foot-candles (which most people would consider already a very fair illumination for most kinds of work) to 12 foot-candles was apparently instrumental in causing increases in output of 8 to 27 per cent. (Such a result naturally assumes that workers are anxious to increase their output!) It is admittedly not easy to arrange a full trial under the American conditions, but the matter certainly deserves much closer attention than it has yet received. Incidentally such experiments illustrate the difficulty of fixing a standard of illumination for different classes of work, and the British Home Office Committee probably acted wisely in confining themselves in the first instance to values based purely on safety and convenience. We see no reason, however, why a tentative scale of minimum working illuminations for rough, moderate and fine work should not now be added on the understanding that they are not final, but subject to revision according to the experience of the industries concerned.

British Scientific Products Exhibition.—We are informed that the attendances at this exhibition, which closed on Tuesday, have been extremely gratifying throughout the month, and great public interest has been evinced in the latest applications of science to industry.

Joint Industrial Councils.—A directory of Joint Standing Industrial Councils, Reconstruction Committees and Trade Boards has been issued by the Ministry of Labour. It gives the membership in each case and concludes with a complete index. The information so given should certainly be useful.

Institute of Metals.—The autumn meeting will take place at Sheffield on September 24th and 25th. This is the first meeting of the Institute to be held out of London since 1913, when the members met in Ghent. A large and influential Reception Committee has been appointed, and it is expected that some hundreds of engineers and metallurgists from all parts of the world will take part in the proceedings, which will include visits to several famous works.

Electromagnetic Theory of the Telephone Receiver.—A comprehensive Paper, by Dr. A. E. Kennelly and Mr. H. Nukiyama, on the above subject has been read before the American Institute of Electrical Engineers in March last, and is now issued as a booklet by the Research Division of the Electrical Engineering department of the Massachusetts Institute of Technology. The Paper is mainly mathematical, and does not lend itself to abstraction, but it introduces some interesting modifications in the theory developed by the authors and others during recent years, taking into account the magnetomotive force produced by the vibration of the diaphragm in the permanent magnetic field. The motional power is derived partly from the testing alternating current and partly from changes in power expended in the magnetic circuit. The motional impedance circle, derived by the authors to explain the phenomena in the telephone receiver, may therefore also be regarded as a power circle, with components along three different axes of reference.

Electrically-Heated Boilers.—A somewhat unusual problem is discussed in a recent issue of the "Schweizerisceke Elektrotechnische Zeitshrift," namely, the use of electric heating for steam-raising boilers. The method would probably only apply in exceptional circumstances—for example, in cases where coal is scarce but water-power is cheap. It appears that such conditions prevail in some wood pulp and paper factories of the far North. Narrow tubes of insulating material containing water are vertically arranged so as to communicate with the interior of the boiler at the upper and lower ends of the tubes. Current is passed through the water columns enclosed in the tubes. The resistance is relatively high, and accordingly, high voltage alternating P.D. is desirable, three phases being used. The current is regulated by moving the electrodes in the tubes. The efficiency of the boilers is said to exceed 95 per cent. One unit produces about 1·25 kg. of steam at 6 to 8 atmospheres. Electric steam boilers up to a capacity of 1,500 kw., with voltages of supply up to 10,000 volts, have so far been designed.

A Scientific Excursion by Hadfields, Ltd.—On Wednesday, July 30th, a visit to London was made at the invitation of Sir Robert Hadfield by a party of 150 visitors, consisting of members of the board of directors of Hadfields, Ltd., members of the staff, managers, foremen, under-foremen, leading hands and men and boys of the various departments. The party was brought up by special train, and the first object of the visit was to see the British Scientific Products Exhibition, after which luncheon was supplied in the Central Hall. The visitors then proceeded to the Science Museum, South Kensington, and finally went round Westminster Abbey before returning to Sheffield. At the Exhibition the party was addressed by Sir Richard Gregory, chairman of the Exhibition Committee. An interesting pamphlet was issued for the occasion by Sir Robert Hadfield, in which we notice "a word to the boys at Hadfields"; in this the boys are reminded of their opportunities, and two prizes are offered to the boys writing the best accounts of what they noted during their visit to London. Some interesting facts are also given in regard to the Science Museum at South Kensington, followed by some notes on invention and discovery. Lastly, some remarks are made on the points of view of British and American labour with regard to the encouragement of scientific research, discoveries and inventions. We congratulate Sir Robert Hadfield on the idea of a works visit and on putting into print sentiments which will no doubt be helpful to the younger men and boys at Hadfields, Ltd.

Obituary.

We regret to record the death of Mr. Henry Handley Pridham Powles, which took place on July 27 at a nursing home in London after a few months' illness. Mr. Powles, who was born at Upper Clapton, Middlesex, on Aug. 4, 1846, was educated partly at private schools and partly at the Ipswich Grammar School. In January, 1864, he was apprenticed to Messrs. E. R. & F. Turner, of Ipswich, and served his time there in the shops and in the drawing office. In 1869 he went as improver and engine fitter to Messrs. Ransomes, Sims & Head, but in 1871 he returned to Messrs. Turner's works, and was employed in the drawing office and on works in various parts of the country. He was employed by the firm as a draughtsman from 1872 until 1876, when he became head draughtsman. In 1890 he went to London as mechanical engineer to the Electrical Standardising and Training Institution (Faraday House), which had just then started in temporary premises in Adam-street, Adelphi. He arranged and fitted up the workshops at the new premises of the Institution in Charing-Cross-road, and remained there until January, 1898, when he joined Sir Alexander Kennedy's technical staff as assistant, and was put in charge of the drawing office. Mr. Powles remained as an assistant to Sir Alexander Kennedy until January, 1912, and had been, until his death, retained by Messrs. Kennedy & Donkin for research work and inspections. During 1916 and 1917 he was employed in inspecting constructional work and plant for one of the munition factories. In the years 1917 and 1918 he did extremely useful work on preparing a bibliography of all works connected with subject of lubricants and lubrication for the Scientific and Industrial Research Department. The work that he did in this connection was somewhat strenuous for his years, and he was, perhaps, over-conscientious in completing the work in spite of failing health. He was known by a large body of engineers, especially electrical engineers, who passed through Faraday House when he was there as mechanical engineer. His work for Sir Alexander Kennedy was highly valued, and his sound judgment and engineering experience will be greatly missed. He was elected an Associate Member of the Institution of Civil Engineers in December, 1880, and a full member of the Institution of Mechanical Engineers in 1891. Among his literary work was a translation of H. Haeder's book on the steam engine. Mr. Powles was responsible during the last seven or eight years for the revision and enlargement of D. K. Clarke's "Mechanical Engineer's Pocket Book." In 1905 he prepared a valuable work on the "History and Development of Steam Boilers."

We also regret to record the death of Mr. Mark Ruddle, formerly city electrical engineer of Dublin, which took place on Sunday. Born in Dublin, he was articled to the late Mr. George Porte. He became engineer and manager of chemical works in Portsmouth, and later joined the Bell Telephone Company. The New York directors of the Edison Syndicate appointed him one of their engineers when they started in London, and the first system of underground cables was laid down under his direction. He also acted as engineer to the syndicate in Manchester, returning after some years to the Metropolitan Company. He returned to Dublin in 1891, and later he became city electrical engineer, a position which he filled until his resignation at the beginning of the year.

Personal.

Mr. Charles Aldington, C.B.E., has been appointed general manager of the Great Western Railway, in succession to the late Mr. Frank Potter

The many friends of Sir Oliver Lodge feel that before he severs his connection with Birmingham something should be done to testify to the esteem that is felt for him by all sections of the community. A representative committee is being formed, with the Vice-Chancellor of the University as chairman, in order to carry out the arrangements. Although Sir Oliver will retire from the Principalship at the end of September, he will not be leaving Birmingham until a later period.

Weagant's Anti-Static Method in Wireless Telegraphy.

(Concluded from p. 111.)

The Static Tank.

Since the two-loop aerial system has not as yet shown itself capable of sufficiently differentiating between the horizontally-moving type of static and the signal so as to permit reception during the severest periods of signal fading, Mr. Weagant carried on a series of scientific investigations with a three-aerial arrangement, in which the two loops of the previous system were used as a "static tank." This system made possible the reception of signals from European stations of a much lower order of power than that employed by Carnarvon or Nauen. Although many times during the summer attempts were made to copy Eiffel Tower, France, on 8,000 metres, with the two-aerial arrangement, satisfactory signals were obtained only during the time when the "grinders" type of static predominated. When the "click" type of static occurred these stations could not be read. As a proof of the utility of the three-aerial system a particular test was made through static disturbances of such intensity that the signals from Eiffel Tower were much below normal. It was barely possible to determine the presence of signal with the two-aerial arrangement, but with the three-aerial arrangement the signal was not only readable, but was of such intensity that it could be read with the telephones removed from the ear.

The static tank may be characterised as a source of static currents of both the click and grinders type of variable frequency, but not a source of wireless telegraph signals. Hence, static currents can be withdrawn from the static tank to balance out the static currents in a third receiving aerial associated with the system (which picks up both static and signals) retaining only the signal currents. Several modifications of the static tank are possible, but the one about to be described has proved very effective, and from a commercial viewpoint is thoroughly practical for 24-hour transoceanic reception.

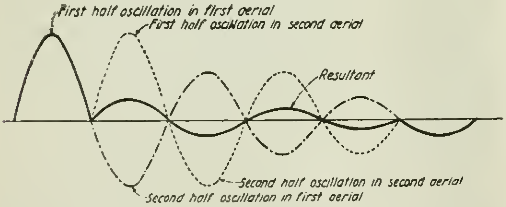
First half oscillation in first aerial
First half oscillation in second aerial
Resultant
Second half oscillation in second aerial
Second half oscillation in first aerial

Fig. 4.—Graphs showing how the Weagant Static Tank Retains "Clicks," a Type of Static which is Assumed to be Propagated Horizontally as Electromagnetic Waves.

Referring now to the diagram, Fig. 7, it will be observed that two closed circuit loop antennæ, each of which are 3 miles long (for the longer wave lengths) are mounted on short poles and connected to the primary coils of a goniometer located at a central point of the antenna system. As usual, the detecting circuit is coupled to an intermediate circuit which embraces the rotating coil of the goniometer. Immediately underneath the closed circuit loops is a long low horizontal antenna A-1, 6,000 ft. long (in the Lakewood installation) which, through the medium of the coils L-15 and L-16 is coupled to the intermediate tuning circuit, which circuit also includes the rotating coil of the goniometer. All three antennæ lie in the same plane and are preferably pointed in the direction of the sending station.

In contrast to the two-aerial system the two loops in this arrangement are used to build up the static currents and to balance out the signal currents. The two loops then constitute a static tank in which static currents of any desired frequency may be stored up, so to speak, for balancing purposes.

The long low horizontal antenna A-1 on the other hand, picks up both static and signals,'and its primary coils L-15 and L-16 also act upon the detector circuits. By effecting proper coulping and connections between the static tank and the receiving aerials, the static currents accumulating in the static tank can be brought into opposite phase with the static currents in the horizontal antenna, resulting in substantially complete annulment, yet retaining the full strength of signal.

How "Clicks" and "Grinders" Accumulate in the Static Tank.

The fact that the static tank becomes a source of static currents of both the *click* and *grinders* type requires some explanation. For it would appear that since the "clicks," which have been classified as a type of static that is propagated horizontally, would be neutralised as are the signal currents when the goniometer is adjusted to annul signals. The static tank, however, has proved to be a source of both "clicks" and "grinders," as will now be explained.

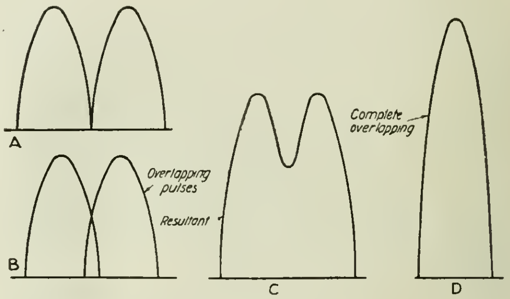

Fig. 5.

A shows the wave form of the resulting static currents in the Weagant static tank generated by "clicks" when the loop aerials are heavily damped by the insertion of resistances. *B*, *C*, *D*, show the wave form of static currents generated in the static tank by horizontally propagated "clicks," as the angle of the clicks increase in respect to the plane of the static tank.

Assume the reception of highly damped static waves from left to right or vice versa upon two loop aerials such as shown in Fig. 7, giving one-half wave-length separation for the signal wave: the static wave acts first upon one aerial and then on the other, with the result that the first half-cycle of the highly-damped oscillation in the first aerial is unopposed, because the current has had time to go through a complete half-cycle, before the wave continues its motion and affects the second loop.

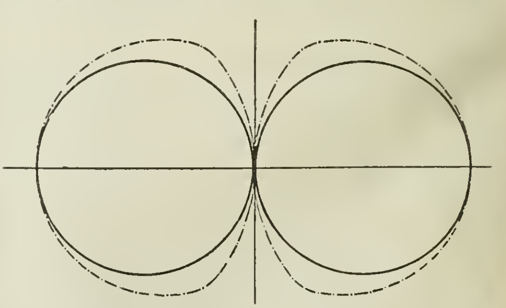

Fig. 6.—Reception Curves of the Weagant Static Tank and the Receiving Aerial.

The difference between the areas of the two curves shows the residue of static, which is practically negligible.

The current generated in the second loop then flows back to the receiving apparatus. Further consideration shows that the first half-oscillation from the second aerial is opposed to the second half-oscillation from the first aerial, and so on throughout the wave train. But because the oscillations are damped, the opposing cycles in the first and second loops do not have the same amplitude, and accordingly the result of the opposing oscillations is not zero, as shown in

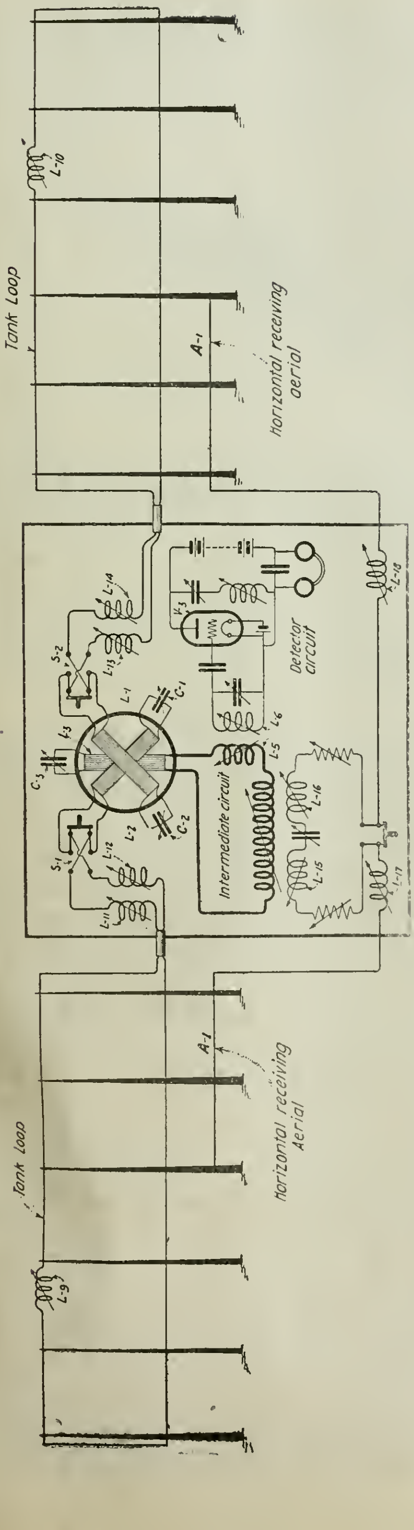

Fig. 7.—Fundamental Circuits of the Weagant Three-aerial System wherein two Loops are used as a "Static Tank."

Fig. 4. In other words, useful amounts of the click type of static as well as the grinders type are retained by the static tank and may be used to balancing out similar static currents in an ordinary receiving aerial. Still better results are secured by damping heavily the loop antennæ through the insertion of series resistances until the wave trains due to static, become shorter and shorter until all the energy is dissipated in the first half-cycle. Under these conditions, although the loops are coupled to the receiving set so that the wireless signal completely cancels out, the entire static current remains, resulting in the curve A shown in Fig. 6, which comprises two half-oscillations, both in the same direction.

In regard to the reception of the clicks propagated at an angle to the planes of the loops, it is interesting to note that as the angle increases, the resulting static pulses overlap, as shown in Fig. 5 (B, C, D), and through part of the azimuthal angle the intensity of the oscillations produced by static vary along the cosine curve, spreading out somewhat as the angle increases. If, therefore, this system is balanced against a third aerial, the curve of reception of which is a cosine curve and both signal and static currents are flowing the static currents due to the click type of static will oppose, and the residue will be the order of the difference between the dotted curve shown in Fig. 6 and the cosine curve shown in the solid lines. From this it is apparent that a very large order of reduction is possible, retaining the full signal strength developed by the third aerial.

The "Whippet" Static Tank.

In order that the static tank aerials may give one-half wave length separation, very long antennæ, up to 6 miles in length, are required for the longer waves employed in wireless communication from continent to continent. Offsetting any objection which might arise on this score, Mr. Weagant described a miniature form of static tank and associated receiving aerial capable of transoceanic reception, which could be mounted upon the speaker's platform. The arrangement, shown in Fig. 8, in addition to acting as a static tank, serves to prove that electromagnetic waves while in transit may be considerably distorted from their initial angle in respect to earth.

In brief, a horizontal antenna A-1, 25 ft. in length, is mounted on a "tether" arm B, which may be rotated around its vertical axis on the pivot P and placed at any angle in respect to the earth. The horizontal antenna mounted on the "tether" is associated electrically with the closed circuit loop A-2 which is employed as a receiving antenna. The "tether" antenna is employed as a static tank; that is, it may be made a source of static currents, but not a source of signal currents. The loop, on the other hand, is a source of both static and signal currents and the static currents therein may therefore be opposed to those in the "tether" and thus be annulled.

In point of explanation of the phenomenon of the pivoted antenna: It has been believed for some time that because the earth is not a perfect conductor, the wave front of horizontally propagated wireless waves may not be strictly vertical, but may be tipped forward or backward at an angle to the horizontal. Weagant was the first to prove this in practice, for he found that by tilting the antenna A-1 of Fig. 8 at various angles to the horizontal and pointing it in the proper direction, an angle can be found which presumably is normal to the wave front of the signals, and at which the antenna will not pick up signals; but it continues to pick up static which was to be expected on the assumed theory of vertically propagated static waves. The "tether" antenna then becomes a static tank, but the correct angle, of course, must be found for each transmitting station in order that the tank will not pick up the signalling wave.

Mr. Weagant has found that the "tether" antenna determines the angle of the advancing wave with remarkable accuracy, it being possible to determine the position for minimum signals within one or two degrees.

To illustrate more clearly the assumed operation of the "tether" antenna, a possible direction of wireless telegraph waves is shown by the single pointed arrows in Fig. 8; the vertical propagated static waves by a number of double-pointed arrows. When the "tether" anetnna A is adjusted at a right angle to the actual wave front, no E.M.F.s will be induced therein. The static waves, however, act upon the "tether" antenna and induce therein E.M.F.s, the frequency of which can be adjusted to the same value as the frequency of the static currents induced in the receiving loop A-2. Since the loop antenna A-2 is a source of both signal and static currents, the static currents of the "tether" antenna A-1 may be opposed to the static currents in the loop A-2, retaining the signal.

The two antenna in Fig. 8 may be, of course, coupled through the agency of a goniometer to obtain the desired static balance. The diagram simply shows the fundamental connections of the circuit.

It is to be noted that a condenser in dotted lines is connected across the tuning elements of the "tether" antenna. This is the preferred connection for average working.

Owing to the very small length of the "tether" antenna A-1, large loading inductances must be inserted in the central point to obtain resonance with a transmitter operating at long wave lengths; and an eight-stage amplifier is required to bring the signals up to practical audibility. It is interesting to note that with an amplifier of such capabilities, when properly designed, a very small loop A-2 will give readable signals from high-power stations several thousand miles distant.

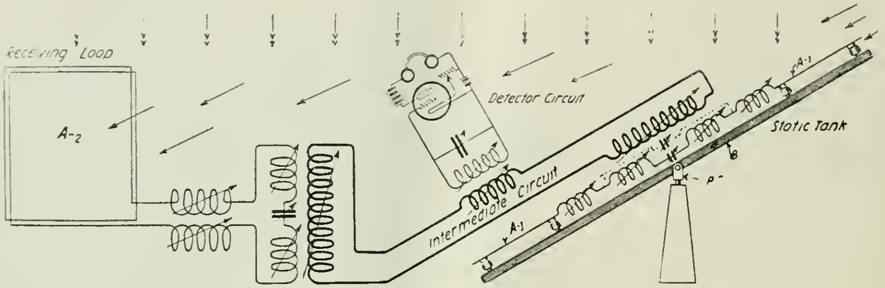

Fig. 8.—Diagram of the Weagant "Whippet" Static Tank.

By the use of multi-stage valve amplifiers to bring the incoming signals to audibility, such small antennæ are perfectly feasible for the reception of radio telegraphic signals over great distances, and it is quite possible that they will be employed in commercial practice.

Mr. Weagant stated that with this arrangement transatlantic radio telegraphy can now be carried on free from interruptions due to static of any kind whatsoever except local lightning. This cannot always be neutralised, but since the cables are also interrupted by this latter cause, it follows that a continuity of communication equal to that of cable operation is now possible by radio telegraphy, while the latter has the great advantage of cheapness and greater speed of operation. For many years attempts to work automatic high speed radio telegraphy have been made, but they have been successful only when static was absent. It is therefore evident that use can now be made of this method of working to a very great extent, thereby greatly increasing the number of messages which can be handled over a given circuit.

Tramways and Light Railways Association.

Annual Meeting and Conference.

(Concluded from p. 115)

Post-War Problems.*

By H. ENGLAND.

When I found myself confronted with the actual work in connection with this Paper, I wrote to a few of my personal friends, asked for their assistance, and requested them to tell me which were the most pressing and important problems they now have to face. With one voice, pen or typewriter they replied "Finance," and, although there are many problems, they are all subsidiary to the one great overwhelming consideration of how to make ends meet and keep the various undertakings up to concert pitch.

Problem 1.—Finance.

Now, gentlemen, we have to find a way to so adjust affairs that tramway revenues shall be sufficient to enable operators to pay wages, purchase materials for daily use, and to leave a margin to pay a fair return on the capital invested in the undertaking, and also accumulate a renewals or reserve fund to replace the wasting assets at the end of their lives. Income is, therefore, our first consideration at the moment, and we are up against a grave difficulty. The revenue of a tramway can be increased in two ways: Firstly by charging each passenger a higher fare, and, secondly, by carrying a greater number of passengers.

Perhaps the real fact of the matter is that the Government, as represented by the Board of Trade, is the stumbling block, and our remedy is against the Board of Trade, and we should not blame the consumer at this stage, because in most instances the public have readily assented to an increased charge, recognising the impossibility of having the same facilities at the pre-war price.

Our difficulty is to find a way of making the Government department see reason, and to grant us relief before our undertakings get into a state of disrepair and inefficiency.

Company owned undertakings are in a different category from Corporation tramways in this respect, but it cannot be good for the town or the State to have rate-aided tramways, and the only sound and lasting method is to conduct a trading concern on a strict financial and self-supporting basis.

It really comes to this—we must have a sufficient income, and, in my opinion, the only way to obtain the revenue is to charge each passenger the sum it costs to carry him the distance he travels. This cost is, of course, made up of working expenses, depreciation and capital charges.

Why we should be restricted to such absurd fare limits at this day I cannot see, because the public are fully able to take care of themselves, and if we foolishly demand an exorbitant fare our business will disappear, and our last state would be worse than the present. There is an economic limit to fares chargeable on a tramway, and as soon as that limit is exceeded away goes the business.

Whilst speaking of fares, I think I should mention for your consideration the advisability of demanding powers to charge higher fares on Sundays, Bank Holidays, gala days, race meetings and special occasions. We are called upon to pay higher wages on these days, it costs more to give the service, and we are entitled to increase our charges. Not only so, but the great bulk of the traffic on these days is purely pleasure, as distinguished from commercial traffic, and it cannot be argued that a higher fare would be in any way a restraint on trade.

Again, there is that bugbear of workmen's fares. Surely it is high time that anomaly was swept away. The so-called working classes are now drawing more cash per week than the middle classes, or even many professional men; but who can expect a change of this kind when vote catching politicians rule the destinies of the country and expediency supplants justice?

Well, gentlemen, I commenced by saying that tramway revenues can only be increased by two methods—viz., by raising fares or by carrying more passengers. I have dealt with the fare question, and I have very little to say about the alternative. Look at the published records of tramways, and it is demonstrated that the great majority of systems are full to capacity, and it is a vain hope to look for relief from additional passengers. I make that statement in a general sense, because what may be true of the many may be untrue of the few. Still, practical men know full well that the net result on most systems, if additional passengers involve a greater number of cars in service, will be adverse.

We now come to the other side of the ledger, and one is at a loss to decide where to begin. There is so much to say on the labour question and on the subject of wages that it is hopeless in the limits of this Paper to try to write even a portion of what could be written on this thorny subject.

As regards materials, the position is chaotic. We are paying any prices asked by the manufacturers, and even then have difficulty in obtaining deliveries. I am tempted to ask whether we cannot do a great deal more to help ourselves in this matter. Surely a way can be found to standardise the bulk of our daily stores, and to buy on a co-operative basis. Things have come to such a pass that we must put aside all our little preferences and prejudices.

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* Abstract.

Let us encourage brains and inventiveness by all means, but set up a standing committee to consider and decide upon suggested improvements to standardised articles, but keep them standardised, embodying all the improvements that are discovered from time to time.

By co-operative buying I mean to suggest that we, a body of organisers, should be able to devise an organisation to collect data of all materials in use on our tramways and to place bulk orders with manufacturers.

To illustrate my meaning, take gear wheels as an instance. I take it that no manager would have any objection to stating now how many gear wheels of a certain class he would want for next year. His sole object is to get the best quality gear wheel at the lowest market price, and the only way to do this is for a manufacturer to be employed as constantly as possible on a particular type of gear. Why cannot this be done? By organisation bulk orders can be placed, not only for gears, but almost all the material we use, and we should benefit by quality, workmanship and price, and the manufacturer by increased output and economy of production.

My next point in the finance problem is depreciation, renewals or reserves—designate them as you will. In 1900 and subsequent years, when electric tramways were being installed at a rapid rate, renewal funds were calculated and set aside on the basis of prices then prevailing.

The funds have accumulated, and now, when renewals beckon to us like a spectre, we are horrified to find that the cash available is about 150 per cent. less than will be required to renew our wasting assets at prices now current. The only solution of this problem is to earmark every possible penny for renewals, and any balance will have to come out of revenue. Not a cheerful or encouraging prospect, especially for those undertakings that have patiently borne the lean years building up and making traffic, and now to find that present-day revenue must bear costs that no man could have foreseen.

There is another disagreeable item in connection with reserve or renewal funds that are invested in securities. Almost all securities have depreciated, and it is apparent that when we have to realise to enable work to be undertaken we shall get back much less than we put in, so that we seem to be hit on all sides.

Problem No. 2.—Rolling Stock.

The problem here four your consideration is the one often discussed, but recently with gathering force—viz., is the design of the cars we now use the right one, and are the materials the best for the purpose? We seem to be committed to ugly, unwieldy double-deck tramcars, and I am afraid the time has gone by when any radical alteration will be made on systems now in operation.

The only thing that can be said in favour of the cars at present in use is the seating capacity; but many objections can be raised to their use, the chief being excessive weight, time taken in loading and unloading, difficulty of fare collection, and so on.

Excessive weight per axle not only means large maintenance costs of cars, but it also carries with it heavy maintenance cost of track, and, as these are the two chief items in the repair bill of a tramway undertaking, we cannot pay too much attention to them. Nobody will contradict the statement that cars fitted with roof covers are the acme of ugliness, nor will they seek to deny that they are ungodly current gluttons and voracious enemies of rails.

The question is, are we on the right lines regarding cars, and is it too late to make a change if a change is found to be desirable? I really think this matter should be fully investigated, and we ought not to go on blindly buying cars of this pattern simply because the other fellow does it.

One thing is certain—the design of cars should be simplified; a freer use should be made of steel and malleable iron, and the use of wooden corner posts and intermediate pillars, which in many cases require renewal in a few years' time owing to dry rot, &c., should be stopped. We should eliminate all brass work, gold leaf and fancy stunts of that description. The plainer the interior of a car can be made the better from the upkeep point of view and also the health of the passengers.

Car equipments should give ample clearances. Equipments are on the market to-day that only give a clearance of from 2 in. to 3 in. between the rail head and the bottom of the gear case. This is not sufficient, and if we are to get the best out of our tyres and gear cases, equipments must be designed to give much better clearances.

The present springing of cars is faulty. It is a sure indication that this is a recognised fault when one finds managers all over the country experimenting and trying dodges to improve springing.

Problem No. 3.—Maintenance of Roads.

Under present traffic conditions, the abnormal growth of heavy motor traffic, and general wear and tear of wheeled traffic, the upkeep of the paving between tramway tracks and on the 18 in. margins has become a terrible tax on all tramways.

Unfortunately, the paving is not the sum total of the damage, the concrete foundations of tramways also suffer severely. I have noticed, particularly in places where the concrete foundation only extends to the width of that portion of the road maintainable by the tramways, that in innumerable instances the concrete has broken longitudinally with the rail, and—in my opinion—this damage is caused by the passage of heavy vehicles on the unsupported portion of the concrete.

In places where the whole width of the road, from kerb to kerb, is concreted, such cracks are not often found; but I cannot suggest any solution to this problem, unless the local uathorities can be persuaded to excavate and concrete their roads when the rails and road bed of tramways are due for renewal.

Is it possible for us to get any relief regarding maintenance of road surfaces? We have discussed this matter from time to time without attempting to press it home, but conditions are daily becoming worse, because of the great increase of heavy vehicles, and road maintenance is growing by leaps and bounds, and why we as tramway operators should bear the entire cost of maintaining road surfaces which we do not use I cannot imagine.

Problem No. 4.—Motor Buses.

Motor buses have forged ahead during recent years, and I am wondering what their future is in relation to the passenger-carrying industry in this country.

Many wild statements are made by out-and-out motor bus advocates, but it is certain the motor bus is rapidly gaining a place that many people a few years ago thought unlikely.

It is difficult to free one's mind entirely from the traffic conditions of London and apply one's judgment solely to the conditions we have to meet daily in the provinces; but I have tried to do this, and have come to the conclusion that motor buses in provincial towns cannot compete successfully with tramcars for handling dense rushes of traffic; but in the future tramway tracks will not be laid into urban and country districts serving comparatively sparse populations, and in such districts the motor bus is undoubtedly the vehicle of the future.

The cost of carrying a passenger is the measure of economy as between buses and tramcars. By cost I mean all charges, operating, capital and renewals, and there is a wide margin at present in favour of cars under provincial conditions.

The question of road maintenance—or rather of road adaptation and maintenance—is throttling the motor bus business at present, and until this question is settled on a national basis the motor bus will not take its rightful place as a passenger carrying vehicle in this country.

Of late most exorbitant demands have been made by road authorities on bus owners and operators, and the matter has gone to such a pitch that something will have to be done, and done quickly, to decide this question. Corporations are agreeing to pay road authorities a round sum for road adaptation, and a contribution per bus mile for road maintenance. One company of which I have knowledge is paying the ridiculous sum of 3d. per bus-mile for road maintenance charges, and Corporations have even made an offer of such a sum as £700 per mile towards road adaptation.

A company which is subject to the whim of licensing authorities is obviously not in a position to pay down a lump sum for adaptation, even if such a charge were fair and reasonable; but unless a company is agreeable to pay a contribution for road maintenance I think they will have great difficulty in getting licences.

This is a national question, and one that should not be left to every small road authority to meddle with.

If we have to pay a contribution for road maintenance, let everybody pay alike; but I do think it most unfair to compel passenger-carrying vehicles to contribute and leave trade vehicles of double the weight and of equal speed absolutely free of all charges.

Unless you are going to introduce the old turn-pike gate and toll bar, I think it is illogical to make any charge on a particular class of vehicle, and the roads should be put in a condition fit to carry present-day traffic, which of course includes motor buses, and no charge whatever should be made.

Problem No. 5.—Housing.

I do not mean the housing of our workpeople, although that is a matter in some localities that causes us much annoyance and difficulty; but I refer to the housing and town planning schemes many local authorities are now considering. Tramways are required, and as many of the housing sites are some distance from the centres of the towns, some means will have to be found to serve the people who will reside in the houses. Extensions of tramways at to-day's prices are unthinkable, unless assistance is afforded by the authorities, and even then, in the present unsettled state of affairs in the traction world, I question much whether any company is warranted in sinking money to meet demands which in all likelihood cannot yield an adequate return for some years on the capital it will be necessary to expend.

The efforts of companies have of recent years been sterilised because of the powers of purchase which may be exercised by local authorities, and in many cases the period at which local authorities are empowered to purchase is drawing near, so that it is quite impossible for any company to put down new lines unless assured of an immediate return.

A Corporation tramways department would be affected rather differently by the various town planning schemes; but even Corporations will have to step warily, otherwise the department will find itself operating a considerable mileage of tramways at a loss.

I assume care will be taken that, whenever sites are laid out for new buildings, roads will be made wide enough to give a high speed tramway track free from other traffic, and on these lines the future development of tramways in this country will depend. We have sacrificed speed, and have made what are virtually street railways into a hybrid between a hackney carriage and a private brougham. We stop our cars at every street corner, and even then get complaints that the wife of a town councillor has to carry her parcels 20 yds. from the car to her door step.

The time has come when this sort of thing should be stopped, and our tramways should take their rightful place in the traction world, and be regarded as high-speed street railways, leaving the finicking door to door traffic to a different class of vehicle entirely.

Problem No. 6.—To Provide Useful and Remunerative Employment for Disabled Demobilised Men and Spare Hands.

On some systems the task of finding suitable work for disabled men has proved very serious. It is bad for the job generally to have a man who is regarded as a pensioner, and who is not doing his "whack," on the premises, and unless work of a suitable nature can be found for such a man, I think it would be almost better to allow him a sum, if there is any moral obligation so to do, and tell him to stay away.

Many undertakings have a sufficiently serious problem to solve regarding spare men, particularly places catering for a seasonal traffic or where the traffic is irregular and fluctuating.

This is one of the problems brought about by the last wages settlement, and it is the general opinion of most of the managers with whom I have come in contact that there is not sufficient elasticity considering the peculiar nature of tramway employment. If public demands are to be met, we must run our cars regularly and on time, and to ensure that this is done we must have available a percentage of men to understudy those who may be sick or idle, or who have missed their duty because of other reasons.

"Made" work pays nobody, and in very few instances has it been found possible to provide suitable work of a remunerative character for men who are not required to drive or conduct, but who have to be paid.

Problem No. 7.—Skilled and Unskilled Labour.

The tendency of the day is for unskilled labour to demand and obtain the same rates of pay as skilled labour, and if this is to continue I wonder what the result will be in the future. Are we to denude the country of skilled craftsmen? Really, that is where the present-day development will lead, and I cannot think the peril of this is realised by those who have so freely granted the extortionate demands of unskilled labour. There is no incentive for any youth to stick to a particular trade and to make himself an efficient and capable craftsman, and in days to come we shall have a race of handy-men, jacks of all trades, incapable of doing a first-class job in any particular calling.

Problem No. 8.—Peak Loads.

Cannot some effective steps be taken to flatten our peak loads? During the war an effort was made in this direction, but the response of labour was negative. It means so much on a busy system to spread the peak load rush over a wider period, and the advantages to the public are so patent that one would have thought the proposal would have met with immediate acceptance. As the better distribution of traffic not only means improved facilities for the public, but also a marked saving in the wear and tear of rolling stock, economy in the generation of electric energy, and to some extent diminution of split turns, a further effort should be made to stagger the hours of commencing and finishing work.

In conclusion, the author mentions a number of other problems, and emphasises the need for adequate publicity.

DISCUSSION.

Mr. E. H. **Edwardes** agreed that the case for an increase of fares at present was not too rosy, but it was a serious matter as to what was going to happen during the next few years. Propaganda was one way of dealing with the problem. Standardisation of plant and material, which was referred to in the Paper, had been tackled by the tramway authorities in a very slovenly way, and he believed he was right in saying that, except as regards overhead equipment, they were very little better off in the matter of standardisation of plant and material than they were 10 years ago. A resolution from the conference to the new Council to tackle the question might be of service. He did not altogether agree with the author as to the size of tramcars. A good deal, of course, depended upon the system; but it seemed to him that tramcars of large seating capacity were the thing they ought to be looking for, owing to the fact that the labour cost per passenger was less. He believed they all knew his views as to beautifying tramcars, and he was convinced that before long they would all come to the same views that he had expressed for some years, that all heavy mouldings and the like could be dispensed with, and a large sum of money saved. As regards gear cases, it was the fact that on many systems the gear cases were only 1½ in. or 2 in. from the rail head, owing to the state of the paving. In other cases there was great difficulty in being able to keep the gear cases on; he himself had none, and he was coming to the conclusion that, whereas a gear case cost about £9 and lasted only a very short time if the track was not in good condition, whilst a gear wheel cost about the same amount of money, it was almost best to do without gear cases altogether.

Mr. W. V. **Edwards** pointed out that, whilst it was true there was a Standardisation Committee of the Association, it seemed to him that they were inclined to favour the manufacturers instead of the operators in connection with car wheels. A new centre had just been fixed, and he would like to know the thickness of the tyre that would have to be scrapped with this new centre. It seemed to him that a much greater thickness would have to be scrapped with the worn out tyre than if the larger centre had been adopted. He wore his steel tyres down to ⅝ in. before scrapping, but he did not think it would be possible to do that with the new centre that had been adopted as the standard.

Mr. R. **Humphreys** thought a lot would have been done in the direction of standardisation during the past 10 years if they had only followed the lead of those who were doing the work of standardisation. Only recently tyre makers had done considerable work, and truck builders were doing a lot; but the great difficulty was that everyone would not fall into line with the manufacturers and designer, who in many cases had a great deal of experience with what they were standardising. In ordering parts they should take the manufacturers into their confidence as to what they wanted, and not say that they wanted a definite article, because it might very often happen that the manufacturers had a design or something in stock which would answer the purpose, and which could be supplied more quickly. He was not quite with Mr. England as to the type of car which we should standardise. The Americans had passed through the same phase, and were now going strong on what they called their safety car. This was a single deck car, holding 34 passengers, with vestibule ends, with all bulkheads abolished, and all weight cut down to the minimum. All heavy cars were being scrapped in America, and, speaking from the point of view of 3 ft. 6 in. gauge, he believed that such a car had a very great future before it. In Birmingham and the Black Country they had run a number of this type of car during the last few years, and they were earning as much per car-mile as roof-covered double deckers. With the same current consumption they could give a very much more frequent service, and that was the tramway ideal—fast-running cars with low current consumption that would climb gradients at something more than 4 miles an hour. That was what he believed they had to look to if tramways were to fulfil their function as passenger carriers.

Mr. A. L. **Barber** said it would be interesting to know if the electrification of suburban railway systems had any effect upon tramways. The L. & S.W. Railway was now running a 10-minute service between Richmond and Wimbledon, and the lines were practically parallel with the London United tramways, and the experience so far had been that, whilst the tramways might have lost a little of the long-distance traffic in the morning and evening, they had lost no local traffic, and possibly were getting more local traffic. He did not think they had lost anything on Bank Holidays. He would like to hear from Mr. Fell what was the effect on his tramways of the electrification of the L.B. & S.C. Railway South London lines.

Mr. C. W. **Mallins** expressed the opinion that the 1870 Act must be removed before anything would be done to alter the basis of fares and the other matters which had been referred to. The Board of Trade, moreover, had set itself against any alteration in fares. He believed that a high-speed system of tramways was absolutely necessary if they were to hold their own. Some attempt must be made to separate the short from the long distance passengers. The conditions in Glasgow were so different from other towns that it was not surprising that results were shown there under the ½d. fare system which could not be shown in any other town. If something could be done to separate the short from the long-distance traffic, so that by a high-speed system the long distance passengers could be conveyed rapidly to their destination, that would help considerably to solve the problem. It could not be done under present conditions, but whether it could be done by a motor bus system working in conjunction with the tramways he did not know. It was possibly one way out of the difficulty, but it all came back to the question of fares, and it was in the interests of all undertakings that they should co-operate and make some genuine attempt to get the law altered in such a way that they would be able to meet their liabilities, because there was no doubt that there were difficult times ahead, as had been suggested by Mr. Dalrymple. There might be a slump in traffic, and at the same time they would be faced with large expenditure in renewing tracks and rolling stock. That could not be done without a proper fare, and this ought to be arranged on the logical basis that the passenger should be made to pay for his ride. As to the size of car, he thought it was an absolute impossibility to get as good a return with one carrying 30 passengers as with one carrying 70, where there was a dense traffic and a cheap fare. It all came back to the fare. If they got, as in the United States, the equivalent of 2½d. for every passenger, no matter what distance he travelled, it could be done; but it could not be done with less than 1d. Therefore they would be compelled to go in for large capacity cars, because they had a greater earning power.

Mr. E. Benedict, speaking on the question of standardisation, suggested that the combined councils of the two tramway associations should make some arrangement with the Engineering Standards Association to settle which parts of the truck, overhead equipment and car should be standardised. The Engineering Standards Association would be very pleased to carry out any suggestions of the two tramway associations.

The Chairman said he happened to be one of the representatives of the Tramways and Light Railways Association on the Engineering Standards Association, which was doing a great deal of work. They had dealt with rails, fish plates and the steel work of the permanent way. They were now engaged on wheels and axles. Mr. Edwards had drawn attention to the necessity for getting full wear out of the tyres, and in that connection he would say that when they came to examine into the size of wheels in use throughout the United Kingdom, they found a very big divergence, and after full discussion the centre which had been adopted had been recommended, in the knowledge that there were some few cases where it could not be adopted. It was adopted, however, with a view to it being the standard centre for the future, and that car builders should adopt it in future designs. The Council of the Association, at a recent meeting, had decided to set up a Standing Engineering or Technical Committee, and the proposal was adjourned until the next Council meeting, when the new Council would deal with it. He, for one, should strongly support the proposal, as all problems could be submitted to it, and it would form a background to the few representatives now on the Engineering Standards Association, who would have the assistance of the Standing Committee in putting their views before the Standards Association. Reverting to the question of propaganda, he thought they ought to make it a strong point that the overcrowding which now existed could only be improved by a large expenditure of capital, and that capital could only be found by an undertaking which was financially in a sound position. There was no doubt that the public was very agitated about the present uncomfortable conditions of travelling, and as one who travelled in London a good deal he was in hearty sympathy; but undertakings which were not financially sound could not find the additional money necessary to provide the rolling stock required to remove the overcrowding. It was not the sort of case that could be brought forward in a flippant way or by general argument—it would have to be proved up to the hilt; and the Council of the Association ought to take steps to be prepared when the time came to put a satisfactory case forward for the industry. One of the serious matters they were faced with, and to which sufficient attention had not been given, was that of deferred repairs and delayed renewals. If the figures which Mr. McElroy had referred to, as showing that tramway undertakings were as well off now as they were in 1914, took into account this matter, he believed it would be seen that very few undertakings were working at a profit. The Temporary Increase of Charges Act had one great blemish, and that was that the undertaking had to show that it had suffered financial hardship before any relief could be given. In other words, an undertaking had to go down hill before it would be helped. That was not to the good of the public, and he hoped that the new Government department which was going to supplant the Board of Trade, would take a wider and broader view than the Board of Trade had shown in these matters in the past.

A hearty vote of thanks to Mr. England concluded the Conference.

Electric Welding: Its Theory, Practice, Application and Economics.*

By H. S. MARQUAND.

(*Continued from page* 118.)

Summary.—In the present article the author deals with the preparation of welds and then passes on to certain properties of iron and mild steels which have a marked bearing on the methods adopted. The welding of copper and copper alloys has not received very much attention, but electric welding is nevertheless applicable to such work. Finally, examples are given of various types of welding.

Fig. 65 shows the main driving wheel of an Atlantic type locomotive, in which three of the spokes gave way by cracking in the neighbourhood of the coupling rod crank pin boss.

These were repaired as indicated and strengthened at the ends as shown.

As already can be seen, the field for arc welding is very extensive, and, in point of fact, many thousands of pounds' worth of material is scrapped every year by machine shops, foundries and manufacturing establishments, a very large portion of which can be very cheaply and successfully reclaimed by resorting to electric arc welding.

Machine shops can use arc welding for reducing the cost of tools for machining operations by welding small sections of valuable high-speed steel to ordinary tool steel (Fig. 64). The shank is first forged and then one end bevelled horizontally and vertically, as shown in the illustration. The small section of high-speed steel is prepared likewise, and both thoroughly cleaned. The tip can then be tacked on to the shank in a jig and afterwards welded completely with the metallic electrode. The tool is subsequently ground to remove the roughness of the welded part and to give the desired cutting set, and afterwards tempered in the ordinary way.

Errors in machinery can be made good by depositing new metal and re-machining.

Castings which reveal defects during machining can be repaired by cutting away any defective portion and building up new metal (Figs. 66, 67 and 68).

Foundries can use the graphite arc process for cutting risers and sink heads off castings, reclaiming defective castings, or accidentally broken castings, filling in blow holes solid, &c.

Steel mills can reclaim to great advantage driving pinions, wobblers and spindles, &c., by building up worn parts to original sections (Figs. 69 and 70).

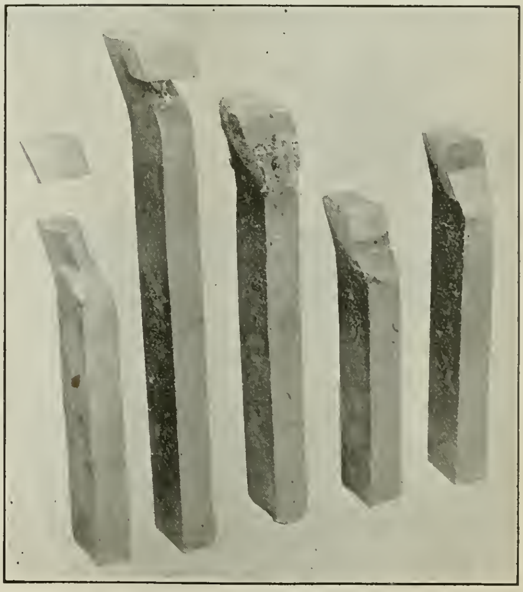

Fig. 64.

A very heavy gear wheel is shown in Fig. 71. The defects as indicated were repaired by the metallic arc process, the wheel being still in position.

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* All rights reserved.

If the wheel could have been dismantled and lifted about, the repairs could have been effected more quickly and at a far less cost by the application of the graphite arc system.

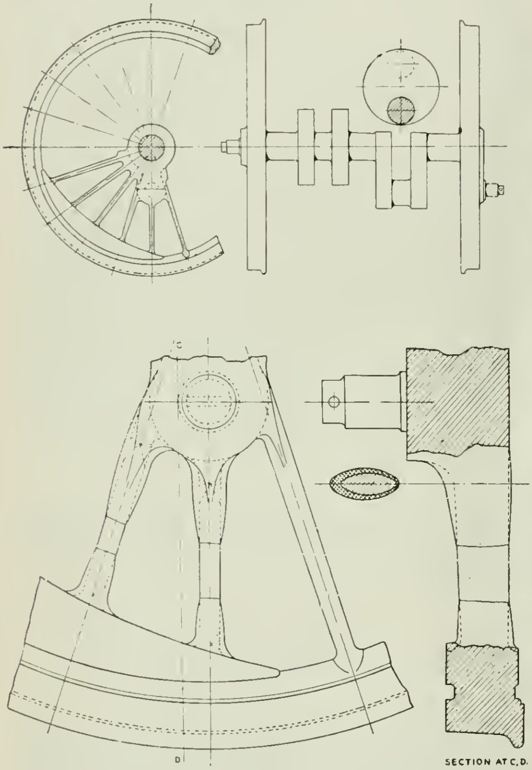

Fig. 65.

Annealing covers repaired by arc welding are shown in Fig. 59. So far as the author is aware, electric arc welding is the only successful and satisfactory method of repairing these boxes. The oxy-acetylene process has been tried again and again with unsatisfactory results. It is easy to see that a fire weld on these boxes cannot hope to stand long in practice. The firm with whom the writer is connected cannot weld these in sufficient numbers to satisfy the demand for repairs.

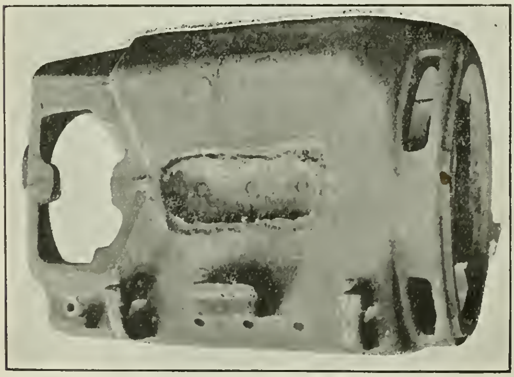

Fig. 66.

Motor car cylinders, crank and gear cases, clutch dogs,

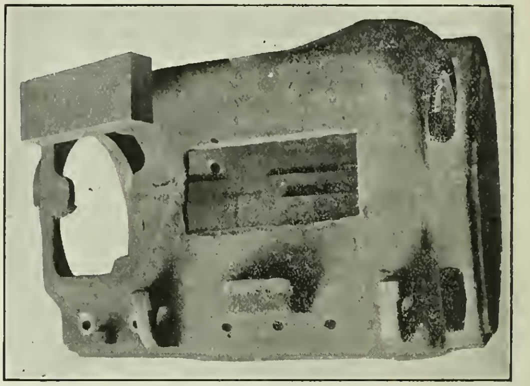

Fig. 67.

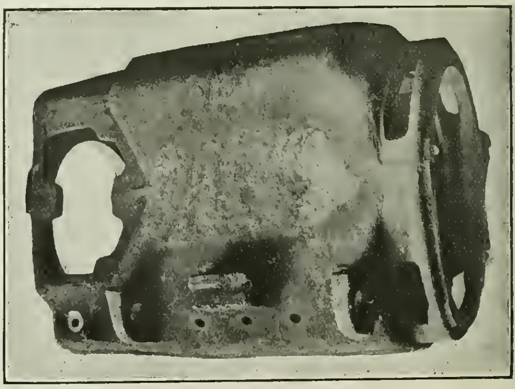

Fig. 68.

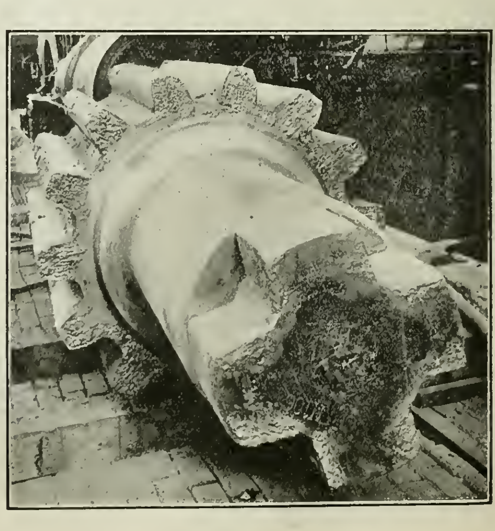

Fig. 69.

axle casings frames, gear wheels and shafts can be very successfully welded by means of the arc processes.

Broadly speaking, the same kind of material is used for filling in as in the structure worked upon, but it is preferable to secure material containing certain elements which help to increase the strength or softness of the weld.

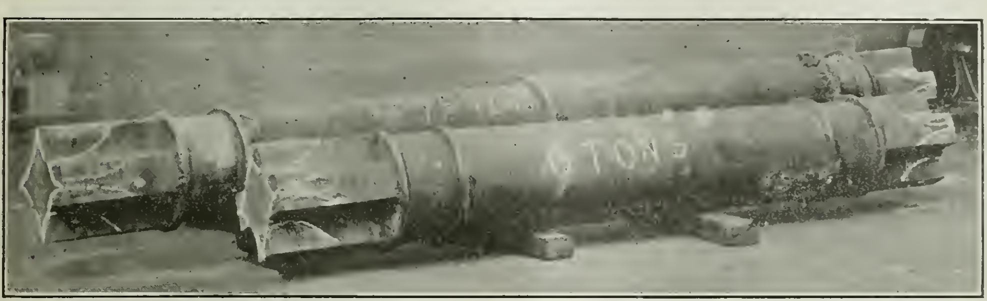

Fig. 70.

Metallic pencils of alloys of steel, such as manganese steel, nickel steel, vanadium steel, silicon steel, &c., are excellent electrodes for reinforcing certain welds.

In general, the process of preparing the fractures or joints for welding is the same in all cases—namely, preparing a cavity large enough to allow for working the metal before starting to weld.

Cracks in plating or structures must first be chipped on to the solid metal with a chisel or burned out with the graphite electrode, and a V groove formed which is filled in with the most suitable metal. With heavy sections it is sometimes necessary to make more elaborate preparations, and for cast iron and special shapes it is advisable to pre-heat parts, or, if possible, all of the piece before welding.

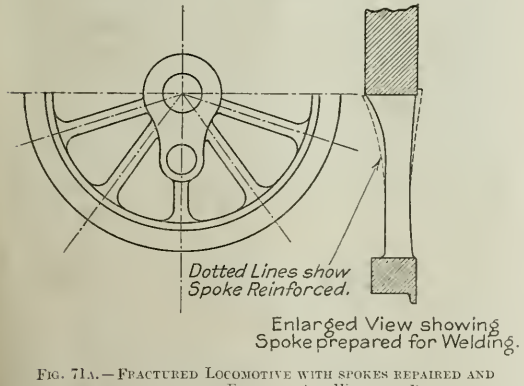

Fig. 71a.—Fractured Locomotive with spokes repaired and reinforced by the Electric Arc Welding Process.

Cast-iron welding can best be carried out with the graphite electrode, and a cast-iron rod containing an excess of silicon, and such other elements as are liable to volatilise at the high temperature, should be used for filling in or building up as may be required, though in certain special cases of the building up process the metallic electrode may be used with advantage.

It is very desirable to pre-heat cast-iron articles to a dull red heat before welding, and then to re-heat them afterwards, both for the purpose of reducing stresses due to shrinkage when cooling, and consequent liability of cracking, and also to ensure a good soft weld which can be easily machined. Salt or borax is a good flux to use in the welding of cast iron. Copper can also be welded with the graphite electrode; the additional copper used as filling material can be literally puddled in. It is necessary to prevent the molten copper from running out of the joint, and this will necessitate, in some cases, building a temporary mould of clay or other material round the joint.

A good flux is desirable, such as a mixture of sodium phosphate and boracic acid. Great care is needed not to burn the metal, and copper welds should be upset and worked with a hammer to restore the fibre and prevent crystallisation.

Copper alloys, such as brass, manganese-bronze, phosphorbronze, &c., are very difficult of treatment, because the zinc, manganese, &c., burn very rapidly, leaving only copper in the weld.

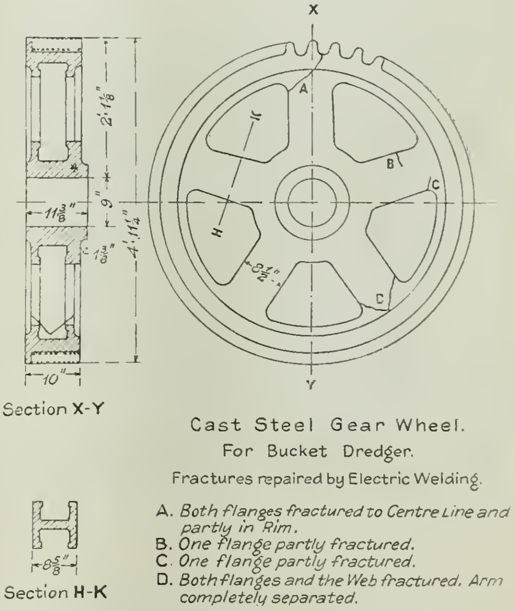
X
Y
A
B
C
C
D
H
K
2' 1 1/8"
9"
4' 11 1/4"
11 3/8"
1 3/8"
10"
8 1/2"
8 5/8"
Section X-Y
Section H-K
Cast Steel Gear Wheel.
For Bucket Dredger.
Fractures repaired by Electric Welding.
A. Both flanges fractured to Centre Line and partly in Rim.
B. One flange partly fractured.
C. One flange partly fractured.
D. Both flanges and the Web fractured. Arm completely separated.

Fig. 71b.

(To be continued.)

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Electric Mining Machinery." By S. F. Walker, M.I.E.E. (London: Sir Isaac Pitman & Sons.) Pp. xii.+375. 12s. 6d. net.

"Storage Battery Practice." By R. Rankin, B.Sc. (London: Sir Isaac Pitman & Sons.) Pp. xi.+169. 7s. 6d. net.

The Marconi Direction Finder.

A standard Marconi direction finding installation comprises the following parts, with auxiliary gear appropriate to the type:—

(1) A special aerial system; (2) the direction finder; (3) a special transformer; (4) the detector.

Where space is a secondary consideration, as with most permanent land stations, large aerials may be used, and the components 2, 3 and 4, together with the necessary auxiliaries, may be installed as separate units. On board ship and for aircraft special aerial systems are provided, and the remaining components are arranged in a compact form as one unit. The installation about to be described has its components arranged as separate units.

The Aerial System.

In this system no movement of the aerials is required, and they may be any convenient size. Two independent aerials are used. They are in the form of closed loops, rectangular or triangular in shape, erected with their centre lines on the same vertical axis and with their planes at right angles. A standard aerial equipment for land stations comprises one 90 ft. central mast supporting two triangular aerials with inclined limbs 110 ft. long and horizontal limbs 144 ft. long. In ship installations the aerials usually take the form of triangles suspended by their top corners. Their horizontal base wires ordinarily lie in directions fore and aft and athwartships, crossing each other at right angles.

The Direction Finder.

The external appearance of this piece of apparatus is illustrated in Fig. 1. Fig. 2 shows the inside and Fig. 3 a diagram of connections. In this direction finder the two aerial circuits are tuned by means of separate condensers, which are connected to the terminals *BC* and *FG*. The two coils *a* and *b* (Fig. 3), termed "field coils," are mounted in fixed positions at right angles. Each is connected in circuit with one of the aerials by means of the terminals *AD* and *EH*. The field coils are split at their centres, whence leads are taken to the terminals *BC* and *FG*, thus enabling the condensers to be connected at points of symmetry in the aerial system. In the space within these coils is mounted the rotatable search coil *S*, which is connected to the detector through a special transformer. The function of the direction finder is to combine the signals received on the two aerials in such a way that the movable search coil is influenced by them when it lies in a plane corresponding to the direction from which they are received, and is unaffected when it lies in a plane at right angles.

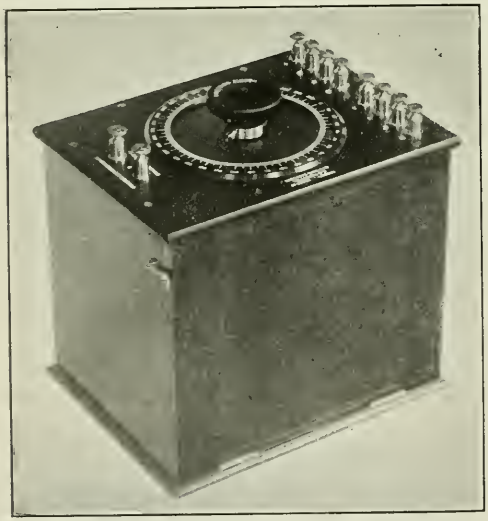

Fig. 1.—External View of Direction Finder.

The search coil is most strongly influenced when it embraces as much as possible of the field due to the fixed coils. Thus, if the sending station lies in the plane of the aerial *A*, the aerial *B* will receive nothing, and the search coil must lie in the plane of the fixed coil *a* in order to embrace as much as possible of the field and receive signals of maximum strength. If it lies in the plane of the coil *b* it will receive no signals, and it is clear that if the sending station is in the plane of the aerial *B* the conditions will be reversed. When the sending station lies in a direction which is in the plane of neither aerial both receive signals, and the strength in each is proportional to the cosine of the angle between the direction of the sending station and the plane of the aerial. The two fixed aerials *A* and *B*, with their corresponding fixed coils *a* and *b*, are then equivalent to an imaginary movable system, consisting of one field coil and one aerial, which automatically adjusts itself to lie in the plane of the incoming signal. The direction of the sending station can be ascertained, therefore, by rotating the search coil until the signals are of maximum or minimum strength and noting its position. In practice the minimum is used, being sharply defined.

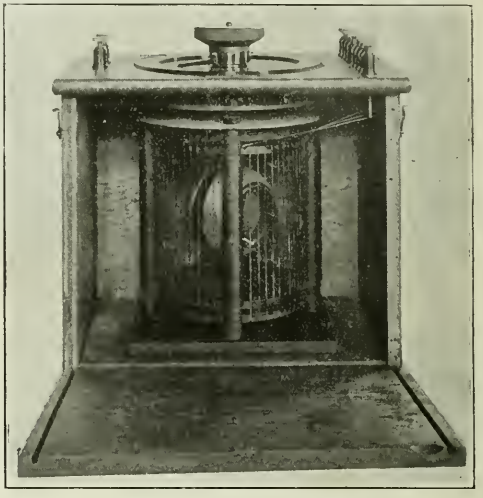

Fig. 2.—Internal View of Direction Finder.

The search coil is mounted upon a vertical spindle provided with a handle and pointer, which moves over a fixed scale graduated in degrees. On land 0° on this scale is the minimum point for signals received from stations on a line running true north and south from the direction finder. On ships and in aircraft 0° is the minimum point for stations on a line directly ahead and astern. The standard direction finder naturally gives no indication as to whether it lies to the north or to the south, but this does not detract from the value of the instrument, excepting in the special case of one ship or aircraft being desirous of rapidly ascertaining the relative course of another. In such a case a wireless query as to the course should be made.

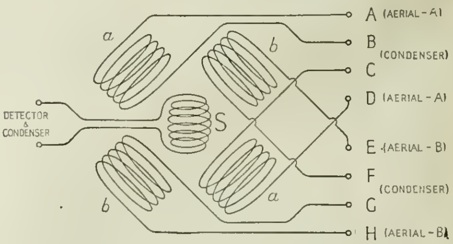

Fig. 3.—Direction Finder. Diagram of Connections.

Transformer.

The transformer of the air-cored shielded type. The primary receives current from the direction finder, search coil and the secondary, together with a variable condenser, forms the tuned high-frequency circuit which supplies current to the detector. Between the primary and secondary windings is a shield consisting of a copper sheath which is connected to earth, and prevents the detector from being influenced by the aerial system in any other way than that necessary for direction finding. By means of the shield inconvenient oscillations are diverted directly to earth, and the detector is therefore unaffected.

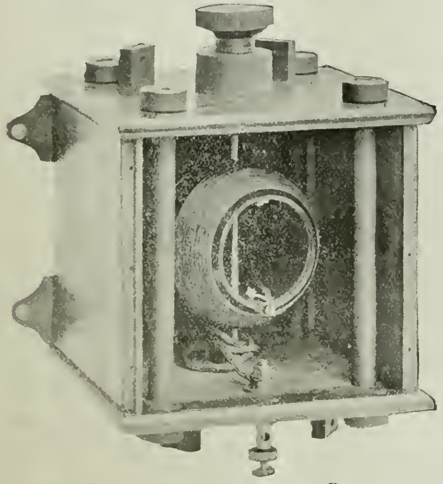

Fig. 4.—Wavemeter Coupling Box.

The transformer is designed for wave lengths of 400 to 2,000 metres in two ranges. The transformer windings are in close proximity to, and electromagnetically coupled with, a spherical reaction coil which is connected across the terminals *F*, *G*, and thence by means of external leads to the detector. The value of the coupling, and hence the amount of reaction, can be adjusted by turning the graduated ebonite handle, which is mechanically connected to the spherical coil referred to.

The Detector.

Amplifying detectors of the multivalve type, suitable for use in direction finding circuits have been fully described. They are extremely sensitive and of great magnifying power, and yet reliable and easy of manipulation. They are a great advance on the non-amplifying receivers previously in use, and their introduction very considerably increases the range over which direction finding may be carried out.

In the Type 6 Direction Finder, the aerial circuits must be tuned and balanced before directional readings are taken, by means of an auxiliary calibrated tuning circuit, excited by a buzzer and coupled to the two aerials. The aerial circuits will then require no further adjustment providing the wave length of the received signals does not vary by more than 10 per cent. Within this range tuning by the amplifier condenser alone is necessary.

The positions of the minima depend upon the position of the wavemeter coupling coil, which can be adjusted by rotating the handle at the top of the coupling box (*see* Fig. 4). It is to be noted that any but the strongest signals will be inaudible at the minimum point. To find this point it is usually necessary to swing the pointer either way, and note where the signals are audible of equal strengths. The mean of these two readings gives the desired minimum corresponding to the direction of the receiving station.

The Magnetic Properties of Varieties of Magnetite.*

By ERNEST WILSON and E. F. HERROUN.

Magnetite is widely distributed throughout the earth's crust, and the authors summarise the results of an examination of the magnetic properties of various forms of magnetite, ranging from the crystal itself to such substances as magnetite-calcite, including the collection of magnetite of the Geological Survey and Museum, numbering about 30 varieties.

The type of instrument used involves the ring method with ballistic galvanometer, and is capable of measuring both susceptibilities of a very high order, and also those so small that the magnetometer can be brought in with accuracy as a check. It has thus been possible to obtain experimental evidence of the accuracy obtainable. The electromagnet consists of a ring built up of nine stampings of stalloy, having an air-gap 2 cm. wide with its sides parallel to a diameter. The specimen is 4 cm. long, and has a square section 1 cm. across each side, and is inserted in rectangular holes cut in the pole-pieces of the electromagnet, thus bridging across the air space. Surrounding the ring is a coil of insulated copper wire, which is wound on a circular former sufficiently wide near the air-gap to allow of the tilting of the three upper stampings, and also provided with a gap sufficiently wide to allow of the insertion of the specimen. In the original Paper the relation between the current *C* and the magnetic force *H* is calculated. Their ratio should be a constant if the line integral in the stalloy were vanishingly small. The ratio is a maximum when the magnetising force is such that the permeability in the stalloy is a maximum, and it does not seriously deviate from a constant value.

In the earlier stages of the investigation a galvanometer of the needle type was employed, but owing to the disturbances set up by the ring magnet when remote from the galvanometer and to other local causes, an instrument of the moving-coil type was substituted. This galvanometer had a resistance of 25·7 ohms and a periodic time of 5·95 seconds, and its sensibility was such that a steady deflection of one scale division at a distance of 1 metre was produced by a current of $3{\cdot}77 \times 10^{-2}$ ampere. An exploring coil consisting of 120 turns of fine silk-covered copper wire was wound on a square former of thin card, which allowed of the specimen being inserted with considerable closeness of fit. The coil was connected to the galvanometer, and an adjustable resistance was included in the circuit to limit the deflections. Deflections were obtained on reversal of the magnetising current *C*, firstly with the exploring coil supported on a wooden core having the same dimensions as the actual specimens, and secondly when the wooden core was replaced by the test piece itself. The ratio of the deflections, allowing for the alteration in the resistance when necessary, and correcting for the air space occupied by the card former, has been taken to be the permeability; and hence the susceptibility has been obtained.

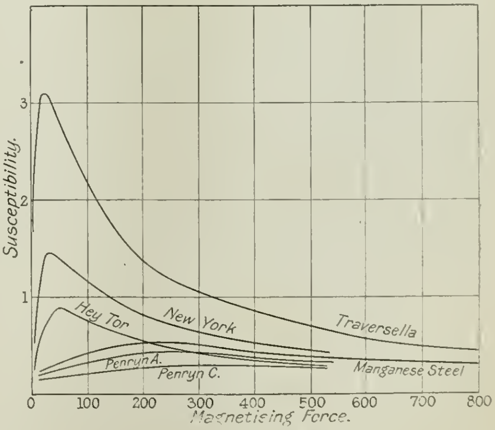

Fig. 1.—K-H curves for Magnetite.

Some typical results obtained are illustrated by curves in Fig. 1. In the original Paper the results obtained with the various specimens are discussed in considerable detail, special attention being given to the effect of heating on magnetic properties. It is noteworthy that considerable variations in behaviour were encountered. Thus, in some cases there was a distinct diminution in susceptibility and coercive force, following the application of heat, while in other instances the reverse behaviour was noted.

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* Abstract of Paper read before the Physical Society.

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The Control of Industry.

We have often felt that the defence of the Capitalist system has not been put forward as energetically as it might have been, and more often than not it has simply gone by default. This is a mistaken course. The fact remains that all the great industries of the world have been built up on this system, and that it has met the varying needs of the case more readily than would have been possible by any other known system. We are, therefore, glad that the Federation of British Industries in a report on "The Control of Industry," which has just been issued, lays emphasis upon some of these points. One of the most important features of the Capitalist system is that it enables capital in the smallest denominations to be used in industry, thus leading to the accumulation of wealth and to more enterprise than would be otherwise possible. Another point is that the system has a great deal of elasticity and is thus capable of meeting competition.

In the report before us the view is taken that the development of combinations is very necessary and is a normal feature of the industrial evolution consequent upon the use of power-driven machinery. It decreases unnecessary and wasteful competition, and secures to the world the economies of large scale production. At the same time. it is admitted that the administration of large centralised concerns is still in an experimental stage and that the development of combinations of Capital is responsible for some of the present-day unrest in the industrial world.

To meet this unrest, nationalisation has been suggested in many directions. We have referred so often to the dangers of such a policy that we need not say much on this subject on the present occasion. These dangers are set out seriatim in the present report, and the last statement in this connection is worth noting, namely, that our different industries are very closely inter-dependent, and consequently if one industry is nationalised this might lead to the nationalisation of other industries, which would be disastrous to the community, even though public policy might indicate the desirability of nationalising the first one under consideration.

Although the present Committee would view nationalisation of any industry as a serious evil they quite frankly admit the desirability of regulating monopolies, so as to remove any fear on the part of the workers and so that the public should be protected against any possible exploitation. The Committee, therefore, agree that the Board of Trade should be given powers, as recommended recently by the report of the Government Committee on Trusts. The only reservations that are made are that no restrictions should be placed on British industry which would prejudice its position in the export trade, and that information should not be published regarding the activities of trade associations or combines which might be useful to foreign competitors. With these safeguards the Committee are quite willing that the Board of Trade should have the power to inquire into any reasonable complaints.

With regard to the democratic control of industry, so many claims have been made, varying greatly in their degree, that a clear cut choice should be made. The Committee take the view, which would certainly be acceptable to the great majority of well informed workers, that Labour should be given the fullest possible voice in the determination of the conditions of employment provided this does not encroach upon the operations of the commercial management, or lessen the proper authority of the foreman. Consequently, joint councils are welcomed; but it is pointed out that the success of these councils must depend upon the loyal acceptance of their decisions by both sides. Any share in the commercial management of the business would be undesirable and impracticable.

Lastly, it is pointed out that the function of the State in relation to industry should be confined to the laying down of minimum conditions of employment and safeguarding the public. A power of monopoly is not confined to organisations of Capital. The trade union which endeavours to exploit the community by withholding its labour is acting as much in the restraint of trade, and should be subject to the same State control, as the combine which endeavours to exploit the consumer by means of a monopoly of its products. There is no doubt that these views, as laid down in the present report, will become increasingly important, and we are glad that a body so powerful and representative as the Federation of British Industries has thought well to embody them in a report.

Reviews.

Handbook of Mechanical and Electrical Costs Data. By Halbert P. Gillette and Richard T. Dana. (London: Hill Publishing Company, Ltd.) Pp. xvii. + 1734. Price 30s.

This book is the production of American consulting engineers who hold a very high position as valuing engineers for public utility undertakings. Besides the collection of cost data of an immense number of items, it includes chapters on "General Economic Principles" and "Depreciation Repairs and Renewals," explanatory of the methods which the authors consider correct for the application of cost data in ascertaining the values of undertakings as a whole. Such valuations or appraisements have been somewhat frequent in the United States of late years, in some cases to determine the price to be paid on the expropriation of companies by public bodies; in others to determine the prices, rates, fares, &c., which companies may be permitted to charge where the element of "fair return" has to be considered.

So far as the data of costs are concerned (occupying 1,572 pages of the book, out of a total of 1,716), they are pre-war costs in the United States, and are not capable of direct application to English undertakings in the post war period. Detailed criticism of the figures—as figures—even if it were possible in any allowable space would be of little value to English readers for work at home. The authors anticipate the criticism that the rise in prices due to the war invalidate the costs tabulated by pointing out that relative labour costs do not change much if similar methods are employed. Certain costs worked out more than half a century ago are still useful if the necessary corrections are made to the changes in wages. They suggest that correcting factors for the changes of prices in material, machinery, &c., can be obtained by getting current quotations for some typical quantities or sizes. These correcting factors can then be applied to the tabulated costs and to the items of construction cost directly dependent on them. Carried out completely, this means that for future work the figures might almost as well have been omitted, but obviously the data may be required as much for ascertaining fair figures for the establishment of undertakings in the past, and are of value for that purpose as well as a record of conditions which may not return.

For work in this country the actual figures are of little use. They may be found instructive for purposes of comparison, but many British engineers are so much concerned with foreign undertakings where American plant is more readily available, or where American tenders may have to be considered, that they may find the tabulated figures—properly corrected as suggested, of considerable utility. Even if the figures are useless to them, British engineers will find that these tables contain a great deal of technical information as to the relative efficiency, performance factors, life, depreciation, and so forth; as well as quite a lot of details on construction methods, considered in relation to prime cost and working expenses. Estimates of the working expenses of plants and the effect of load factors also provide useful relative figures. But perhaps the most useful feature of this major part of the book is that for every subject treated it provides a very complete inventory of all the terms and factors affecting costs, so that if one follows it in drawing up a skeleton form or plan, which has to be filled out by putting in the correct values, he will incur little or no risk of finding that some essential item has been overlooked. There are also interspersed discussions of items of cost or value which are less tangible than the cost of materials and labour. Quite at random, for exmaple, one finds in the section on "Lighting and Wiring," a discussion of the economics of factory lighting dealing with the increase of output resulting from good lighting as against the extra cost of good over bad lighting. So that these data contain a good deal of economic philosophy on the choice of plant, methods, &c., which is of very general application, and will be found suggestive at least. The blanking out of the figures by no means deprives the book of its value.

The subjects included comprise: Buildings, Chimneys, Moving and Installing, Fuel and Coal Handling, Steam Power (227 pages), Internal Combustion Engines, Hydro-Electric Plants, Electric Light Power Plants, Overhead and Underground Electric Transmission, Lighting and Wiring, Compressed Air, Gas Plants, Pumps and Pumping, Conveyors, Hoists, Cranes and Elevators, Heating, Cooking, Ventilating, Refrigerating and Ice Making, Electric Railways (the items common with steam railway construction not included), and Miscellaneous, from which list any reader can judge whether it will interest him.

In the two preliminary chapters the general principles are set out in a very lucid way. The authors lay considerable stress on the loose way in which many terms are used which for purposes of appraisal and accurate estimates need to be strictly defined, and they go through these terms, giving each the definition they consider it should bear, and the implications of such definitions. Taking collectively, these definitions are thoroughly sound. Particular emphasis is laid on the importance of accuracy in estimating "fixed charges," especially where the "rates of fair return" on the investment are an object of discussion. The general discussion of value, price, costs and profits is particularly good. It would be of inestimable advantage where these questions come up for judicial or arbitral decision if all parties were agreed on definitions of these terms. Instead of which much time and brainwork is wasted in discussion on these general questions between people who have different ideas, or vague ideas, of what the terms mean. One point worth quoting has an important bearing on questions of obsolescence and depreciation:—"Assuming the gross income to be unchanged by substituting an alternative part in a plant, the value of any part is the first cost of its most economic alternative plus the capitalised difference in their respective average annual operating expenses." But algebraically, this is:—

$$V=C+E-e/R,$$

where C=first cost of the most economic alternative plant, E=average annual operating expense for the most economic alternative plant, e=the same for the existing plant, R= a capitalisation rate made up of an interest rate representing the "fair return" and a sinking fund rate of annual depreciation, and V is the value of the existing plant. It will be seen that V may have a negative value. If it has, this negative value is the amount of new capital which may be properly devoted to the substitution of the more economical alternative.

It is impracticable to deal thoroughly with the chapter on "Depreciation, Repairs and Renewals." The principles enumerated appear to the reviewer to be sound. Opinions may differ, but whether one agrees or not with them, there can be no doubt of the author's meaning, and such clear and detailed exposition brings out definitely any points of difference, enables the dissentient to see how they originate, and to consider under a clear light whether he or the authors are right.

It may not be inopportune to say that as the electric supply industry may be shortly faced with a wholesale valuation of its generating stations for purchase by public authorities clear notions of these questions of cost, value, depreciation, &c., will have extensive application.

Generally, every engineer should have correct ideas on these subjects. As the authors put it:—"Engineering is the application of science to the problems of economic production. The engineer's ultimate aim, therefore, is to effect a desired result at a minimum cost. The engineer should, where it is feasible, formulate a unit cost equation in which all the dependent variables are included, and should then solve for a minimum unit cost. . . . . No economic problem can be solved merely by the use of qualitative terms, yet many a poor reasoner attempts to solve the most complex of economic problems without the use of a single item to which a definite cost is assignable."

The engineer who reads the first two chapters of this book will have no excuse for such slackness afterwards. It can, therefore, be highly commended, though nobody, even in America, will find it a mine of ready priced-out estimates available for post-war conditions. H. M. S.

A Calendar of Leading Experiments. By W. S. Franklin and B. MacNutt. (South Bethlehem, Pa., U.S.A.: Franklin, MacNutt & Charles.) Pp. 210. $2.50.

This little calendar of experiments certainly falls outside the beaten track, and shows some originality in the treatment of laboratory work. In their introduction the authors remark on the tendency amongst students to deal with a problem in general, vague and conventional terms, influenced mainly by a knowledge of past events, instead of attempting an analysis expressed in appropriate and simple terms of what they *actually see*. It is, in fact, difficult to develop the habit of analytical thinking and to eradicate the tendency to take things for granted. The book covers a series of simple experiments in mechanics and physics. In many cases the experiment might appear at first glance almost trivial, yet it conveys a lesson and stimulates thought. The authors also adopt the practice, approved by most of the more advanced technical teachers in this country, of illustrating each problem by practical things. Thus, in dealing with the gyroscope, reference is made to the bicycle, to rudder control in torpedoes and aircraft and the Brennan mono rail. Hydrodynamics are illustrated by reference to the Roman aqueducts; and in the treatment of heat there are references to cloud formation, Diesel engines, safety lamps, &c. Many of the experiments in electricity are simple and well devised, and the method of illustrating processes of induction by various mechanical analogies is good. The work loses nothing from the fact that the authors occasionally strike a note of whimsical humour and even draw on the "Bab Ballads" to illustrate their ideas. While we do not mean to convey that the course as it stands is necessarily adapted to all colleges, a study of the book will suggest ideas to many technical teachers, and it is at least an attempt to get away from the tedious, grave and conventional manner in which physics and mechanics are so often treated.

Electricity Supply for Artisans' Dwellings.

By JAMES CLEARY.

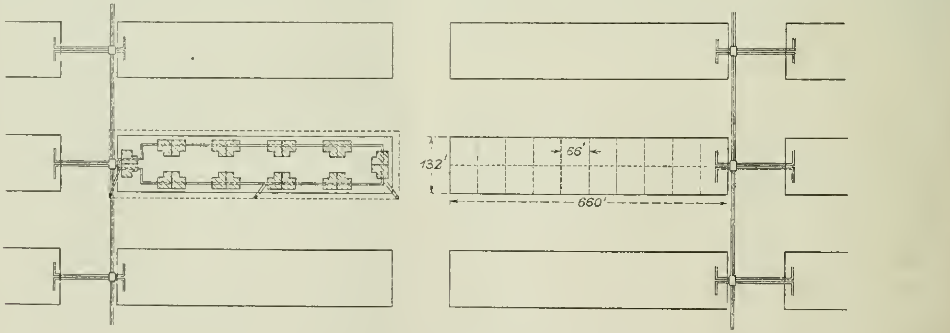
At a time like the present, when much activity obtains with the view of solving the housing problem, and many schemes are in the making, most of which depend upon the application of electricity as an aid to success, it is essential that safeguards be introduced so that the mistakes of the past may be avoided. This new business under existing conditions, calling for the application of fresh ideas, can be made to effect a balance on the right side of the scale, and be a lasting benefit to the supply undertaking and the consumer alike, if advantage be taken of this unique opportunity.

The revenue to be derived from Artisans' Dwellings may not appeal to all engineers; but the majority of stations would benefit from this class of business, and even in those cases where small fish are considered undesirable there still remains a duty for them to perform. That this work, if properly planned can be profitable, has been abundantly proved, even under conditions in the past which have bristled with difficulties. It has rarely happened that provision has been made for installing electricity in large blocks of cottages during construction, but in most cases the work has had to be done after the houses have been built, and often times inhabited, introducing difficulties and expense at every stage. In the schemes now under consideration the installation during construction can be made to effect a considerable saving, and one which will compensate in a large measure for the increased cost of materials and labour.

In every case the installation should be fitted as a necessary part of the cottage during building operations, and provided for in the cost of building. If this be done the cost will be paid by the saving effected during the first five years, as during this period there will be no need for redecorating—an operation which promises to be well worth avoiding in the future, on the score of cost alone, apart from the inconvenience.

Once the question of the installation is disposed of, that of the connection to the main, requires consideration. This, no doubt, will call for great discrimination, as schemes will vary both as to lay-out of the residences and design. Perhaps the suggestion of limiting the houses to 10 to the acre, which will necessitate semi-detached or detached houses, if acted upon, will be the one which will demand the most original treatment. This can be planned in a manner which will be an advantage over previous efforts; the simpler schemes of adjoining houses presenting no such difficulty.

The Brighton scheme, of which an account of the first year's working was given in The Electrician of December 3rd, 1915, is now nearing its fifth completed year; a period sufficient to test it from every point of view. There are 60 installations connected, a total of 400 lights, on 15 house services. During the past five years the revenue has steadily increased, and now averages over £6 per annum for each house-service laid in. This effort has been a great success from the national economy point of view, as not only have the occupants had a light available in each room and the hall, whenever necessary, but have, by the judicious use of the switches provided, maintained the consumption on such an economical basis that the minimum allowed by the Fuel Controller was not exceeded. Further the economy of matches was very much appreciated by the tenants during the period of shortage. The scheme has been a greater success than its advocates anticipated, as the war, which commenced soon after the scheme was launched, introduced altered conditions which greatly enhanced its prospects, as not only was a good light of uniform quality available at a time when every other illuminant was adversely affected in quality as well as price, but, in addition, the necessary accessories became almost unobtainable. The users of electricity escaped the inconvenience caused by the shortage and increased cost of paraffin, lamps, wicks, glass chimneys and candles. This, with the poor show put up by other lighting agents, due in a large measure to uncontrollable circumstances, enabled electricity to assert itself very emphatically as the light for the multitude, sweeping away all obstacles, and opening up a clear road for future progress. During this period five of the houses have not had one lamp failure. For every lamp renewed there has been an average consumption of 88·6 units. This is equal to 2,700 hours' life for a 32-watt lamp, and 2,200 hours for a 40-watt lamp. This feature in itself is the crowning point of the success of the scheme, which was originally based on "each lamp consuming 40 units during its life." The fact of having obtained double the life estimated for the lamps is sufficient reply to those critics who foresaw their being recklessly broken.



Distributing System for House and Street Lighting.

Although a very good case can be made for the success of the Brighton and many other schemes, notwithstanding this, the same methods will not suffice for the new schemes now under consideration. Whilst taking advantage of the experience gained, allowance must be made for the increased cost of materials and labour, and the reduction of working hours, and if possible matters adjusted to compensate for these.

Whereas most of the existing schemes have been developed on cable net-works already available close to hand, the new ones will necessitate cable extensions, the capital charges of which must be met from the revenue obtained. It is here where a new departure is necessary, as the old methods, at double the former prices are prohibitive. Under the new conditions it is unnecessary to lay mains in a position 30 to 60 or more feet from the point where the service is required. This may have been expedient in the past, as invariably conflicting interests blocked the way, and there was no alternative but to repeat the long and costly service to each house with its attendant heavy re-instatement charges. There is now no necessity for this, as provision must be made for every house. This state of unanimity never prevailed before among existing or potential consumers, and it now can be usefully employed to effect a considerable economy in the general lay-out, in many cases reducing the costs to half, and at the same time abolishing re-instatement charges, and the vexed question of extra length of service which has been a bar to progress in the past, especially in residential districts, and also save the cost and incidental trouble of much of the fault-locating necessary in the past.

In the accompanying plan the houses are shown in pairs, spaced 10 to the acre, so as to give the maximum air and garden space to ensure healthy surroundings. If this plan were adopted it would be possible, as here shown, to connect twenty residences together in a block of two acres. It would only be necessary to lay mains in alternate vertical roads from which tappings would be taken through a net-work box. A two-wire ring service could be connected through every house in each group by a loop system drawn into 2-in. earthenware ducts, laid in a position under the garden path to the side-entrance of each house. If the groups on the right are coupled to the positive side, and those on the left to the negative side of the net-work, a satisfactory balance will be effected. If the cables are looped from house to house to form a ring, there will be a minimum of drop, and if necessary the supply can be cut off from any house from the adjoining houses without excavation or interrupting the supply to the remaining consumers. The absence of all underground joints would be a distinct gain, both as regards the initial costs and maintenance, and the life of the cable would considerably be prolonged.

There may be some who will advocate over-head construction on the score of economy. This method at its best is only a temporary makeshift, as cables exposed to the extremes of temperature soon deteriorate, and require renewing periodically, and the insulator brackets and supports will require continual attention, the cost of which would be a perpetual tax on the revenue.

The system outlined above, even at existing costs, can be made to render a very profitable return with an annual average revenue of £2 per house, which could be augmented if facilities are given for the use of irons, grills and similar devices. If in some cases large numbers of smaller houses or flats are built in compact blocks, the cost of connecting will be very much less, without any appreciable drop in revenue, as it is found that the consumption in a four-roomed flat is in most cases equal to that of a six-roomed house. In both cases the maximum use is made of three lights, bed-room lights being very little used as a general rule.

If in planning the house installations due attention be given to details, here again economies can be effected that will more than compensate for increased cost of materials and labour. The wasteful methods of the past, in these schemes at any rate, need not be repeated, as it should be to the interests of all parties connected with the building to assist each other whereever possible. It should not be necessary for the wiremen to tear up floor boards that have just been nailed down, to wrench off wainscotting that has received its last coat of paint, to plug walls that have been papered, and many other things that could easily be avoided if precautions are taken. It should be the duty of the building foreman to see that facilities are given for fixing all cables under floors, in cavity walls or other positions before these are closed up. All plugs should also be fixed before the walls are plastered, this would not only save the time of the wireman, but would also make it unnecessary for painters, plasterers, joiners, &c., to follow in his wake making good. Undoubtedly the best wiring system is metal-cased V.I.R. twin. Not only is this a great time-saver in erecting, but it also ensures a cable of uniform good quality, which in itself justifies its use. A great deal of trouble in the past has been due to inferior cable being fixed by inferior workmen, in a reckless manner. Cables have been dragged through tubes of varying qualities, with the burr of the saw-cut at each end, and oftentimes in positions out of sight, with no protection whatever.

It has been most unfortunate for the contractor of repute, who appreciated the need for bends and elbows and other incidentals requisite for a satisfactory job, that he too often lost contracts to the man who did not. If time saving has to be practised in the future to effect the utmost economy, this can only be accomplished by the use of metal-cased cable, as both wood-casing and tubing are slow operations in comparison. The time taken for mitreing and fixing, capping and casing, and cutting, bending and fixing split tubes must militate against the use of these systems in the future. The efficient bonding and earthing of split tube even with the many special contrivances in the form of pins and grips which have been introduced for the purpose has been practically impossible; whereas the metal-cased cable is designed for this.

One other reform which is long overdue, that could well be included in this scheme, is charging without meters. Although this has been advocated in the past, only one or two feeble attempts have been made to put it into practice. It could, with advantage, be included in this class of installation, and effect the greatest economy of all, the cost and upkeep of meters could be saved for all time. If this were done, the need for a second meter for "other uses" will also disappear. The cost of two meters to register the small amount of current likely to be used under these conditions certainly places an undesirable burden upon both consumer and supply authority, but this is another question, and will provide a meaty meal in itself for separate treatment.

Scientific Lighting and Industrial Efficiency.

In a lecture at the British Scientific Products Exhibition on July 28 Mr. Leon Gaster pointed out that scientific methods of lighting, which have a direct bearing on the efficiency of production, are of great interest as illustrating the aims and objects of the Exhibition. There is no industry that is not dependent on the use of artificial light and during the war the great increase in the amount of night work had made the conditions of artificial illumination of even greater consequence than formerly. In the future, with the possible extension of the "three-shift" system, this aspect might become even more important. Moreover, in working processes which depended on accurate duplication of parts and interchangeability of pieces of complicated machinery, the highly skilled workmanship and precision made great demands on the illumination, as a small error might easily be caused by difficulty in seeing the work. In these standardised processes, such as those adopted in the Ford Motor Works, any defect so caused at any point in the chain of operations might delay the whole process of production.

Mr. Gaster then proceeded to deal in turn with the effect of industrial lighting on health, accidents and efficiency of work. For many years the Home Office had demanded good illumination in certain dangerous or poisonous trades, where inadequate illumination had specially serious results. It was, however, a matter of common knowledge that employees worked better and more cheerfully in well lighted surroundings. In cases where work was necessarily done almost exclusively by artificial light at night-time the hardship to employees of poor lighting was very great. While there were admittedly important economic factors, he thought that the fact of miners working underground by such a relatively feeble light had much to do with the prevailing discontent; while in the case of bakeries there was also an agitation against night work, which was often carried on under conditions which imposed a strain on health. There was also no doubt that unsatisfactory lighting added greatly to industrial fatigue. Delicate researches had shown how the senses and perceptions became dulled during the day's work, and how recuperation took place during the night. If a worker had any difficulty in inspecting his work and observing defects, this added immensely to the difficulty of his task. He hoped that this matter would be studied by the Committee recently appointed by the Department of Scientific and Industrial Research on Industrial Fatigue. There was thus a good case for proper lighting on purely humanitarian grounds; but, as Mr. Gaster next proceeded to show, the case from the economic standpoint was equally sound.

During recent years a great deal of information had been obtained which placed the matter beyond mere conjecture. Statistics had shown that some varieties of accidents—*e.g.*, persons falling—were particularly subject to the influence of lighting; and the report of the Home Office Departmental Committee on Lighting in Factories and Workshops had shown that in some industries where such accidents were common—*e.g.*, in shipbuilding—the accident rate by night was double that prevailing by day. This showed clearly that inadequate artificial lighting played a part. Yet there was no apparent reason why artificial lighting, being strictly under control, should not be as well adapted to the work as daylight in interiors. When one dealt with very large open spaces it was naturally more difficult to secure perfect conditions. Mr. Gaster mentioned many other typical forms of accident which were apt to be caused by insufficient light, and quoted statistics from the data of the Travellers' Insurance Company to show that about 25 per cent. of accidents were in some measure connected with artificial lighting and preventable. It was to be anticipated that the British Industrial "Safety First" Association in this country would have a valuable influence in diminishing such accidents. Besides the direct financial loss of compensation for death or injury, there was the indirect loss, more difficult to assess, of time lost and disorganisation of work processes. Here again, therefore, the humanitarian case was reinforced by economic arguments.

The most direct evidence of the economic disadvantages of poor lighting were, however, to be obtained from a scientific study of the relation between conditions of illumination and output. Breakdowns in machinery, due originally to dim lighting, which resulted in apparatus not being properly cleaned, were obvious sources of loss, and in many cases caused serious delay in important contracts. It was folly to pay high wages and instal costly machinery and grudge the small expenditure necessary to enable a workman to see what he was doing. He recalled the case of a cleaning factory, where the percentage of faulty articles rose inexplicably on a certain day. It was then discovered that at the time these mishaps occurred the artificial lighting was disorganised. In a leather factory in the United States it had been recently found that rejects diminished 80 per cent. when the illumination was improved. Of special interest were some experiments recently conducted in Chicago, where plants were run at the existing illumination for a month, then for a month with improved illumination, and then again under the old conditions, a careful record being kept of output. Increases in various departments of 8 to 27 per cent. were noted. It would be well worth while for manufacturers in many cases to put up with some disorganisation of normal procedure while making such tests.

In the next section of the lecture Mr. Gaster analysed the relation of cost of lighting to other expenses. In general, the running cost of lighting amounted to less than 1 per cent. of the wages bill, and in many factories the ratio of cost of lighting equipment to the total costs of plant, buildings, &c., was likewise very small. Thus, Mr. Clewell estimated that in the Ford Motor Works it came to only 0·3 per cent. If, therefore, a slight additional cost to make the installation quite satisfactory caused even a small percentage increase in output it would be well worth while. In the case of an existing works busy on orders, the manager often found it difficult to arrange for an overhaul of the lighting installation, merely because he could not see his way to letting a part of the works stand idle. But in a new factory there was no excuse for not having lighting which was thoroughly up to date.

In his final remarks, Mr. Gaster traced the development of interest in industrial lighting on the part of Government departments. This interest was growing in Europe before the war, and in several cases committees to deal with the subject were proposed or initiated. But only in this country had the Committee set up actually completed a section of their inquiry, and the report issued by the Departmental (Home Office) Committee in 1915, despite the interference of war, was an event of great scientific interest. During the war the United States had taken the matter up with enterprise, and there were now five States which actually possessed codes of industrial lighting. Experience of the working of the codes had been favourable, and managers readily acquiesced in suggestions for improvement; it was generally recognised that the step was beneficial alike to employer and employee. In the future he anticipated that there would be international action on the matter. The Exhibition had illustrated many directions in which this country had successfully initiated processes of manufacture previously undertaken by Germany. He might mention that in illuminating engineering this country had been ahead of Germany. When the latter country eventually decided to form an illuminating engineering society some years before the war, they came to Great Britain for information as to the best procedure.

The British Scientific Products Exhibition.—III.

An involuntary injustice was done to the Edison Swan Company in an earlier part of this description in reference to the "Pointolite" lamp. Contrary to our statement, it was shown, not only in its complete form, but also in the constituent parts, together with a large variety of lamp bulbs and glass apparatus. The show case was located with exhibits which are other than electrical, which accounts for its being overlooked before. If the lamp had been shown in operation, only the blind could have failed to notice it, and it seems a pity that this was not done.

Electric Heating, Cooking, &c.

The British Electric Transformer Company has a complete kitchen installation in operation, fitted up with their well-known "Tricity" appliances. The electric fires show considerable evidence of attention to heat diffusion by combining radiation, reflection and convection effects. The individual elements are easily replaceable. Perhaps the most attractive cooking appliance shown is the grill. Operating by radiation from above, well lagged and totally enclosed, this apparatus should show a high efficiency. It takes up a small space and sells at a low price. The ovens are similarly designed for efficient use of the energy. The electrical hay-box shown by the Benjamin Electric, Ltd., seems likely to be a convenience in the household. It should be said that the lagging material is not actually hay. The food to be cooked is heated to cooking point in any way, then put into the "Merrett" self cooker, which is so well heat-insulated that the cooking completes itself, and the food is kept hot for a very long period with no risk of burning. Another appliance of a somewhat similar kind is shown by Mr. Leoline Edward under the name of the "Quidos" electric lamp hay-box oven. This is a very well lagged casing fitted with shelves to carry dishes, &c., and has an ordinary carbon lamp inside it. The lamp gives sufficient heat to more than make up the losses from the oven, so that the cooking is not entirely dependent on the pre-heating. In fact, if time is no object, the whole cooking can be done by the lamp, though there is an obvious economical limit to this. But for such a purpose as having a meal to cook without attention, as during the night for breakfast, the oven seems convenient. It can be fitted with an automatic clock control to switch the lamp off or on at certain times.

Electrically heated clothing for airmen and heater for the lubricating oil of aeroplane machine guns are among the exhibits of the British Electric Transformer Company and the Dowsing Radiant Heat Company; the latter also show a large number of appliances of their well-known types, including irons, soldering bits, glue and wax heaters. Some electric irons without connecting cords and electrically heated ear mats and driving rugs are novelties to the general public at least. Messrs. Benham & Sons show some "electro-vapour" radiators, which make use of water as the convection medium between the heating element and the radiating surfaces. This keeps the temperature of all parts within very safe limits, approximately water boiling point.

Electric Furnaces.

The Wild-Barfield electric furnaces for hardening steel are shown in various forms and sizes by the Automatic and Electric Furnaces, Ltd. Those for hardening and quenching carbon steel tools have capacities of 10 lb., 30 lb. and 65 lb. per hour. The watt capacities are proportional at 1,400, 4,200 and 9,500 respectively. These furnaces are fitted with the often described automatic detector, depending upon the steel reaching its recalescence point and the accompanying magnetic change. A small research muffle on the same principle admits of experiments on heat treatment with freedom from oxidation or contamination by products of combustion. The firm shows a "Magnetic Schrometer" for testing the effect of heat treatment on the magnetic hardness of iron and steel. The specimen is turned to a standard size of 3 in. by ½ in., and after treatment is tested for coercive force on magnetisation to saturation, and for open circuit remanence with a Grassot fluxmeter and search coil. It is claimed that these tests may be used to determine the "refining" temperature of steel, the hardening temperature of carbon steel and alloy steels, the quenching power of various media at various temperatures, effect of various temperatures and periods on tempering, and the requirements for correct normalising and annealing. Presumably the inventors have investigated the connection between magnetic properties and these elements; at any rate, the apparatus lends itself to such investigations. The Bastian Electric Company show muffle, crucible and tube furnaces, in which the magnetic change at recalescence point is utilised to indicate the best hardening temperature. The charge is shown by a compass needle so placed in reference to the magnetising coil and the earth's field that it is deflected about 180 deg. from its normal position so long as the steel retains its magnetic character. On the temperature reaching the recalescence point the needle swings back, and may be made to actuate a signal bell, or to discharge the furnace. These furnaces may be heated electrically or by gas. Messrs. A. Gallenkamp & Company, Ltd., show a number of laboratory appliances heated electrically. These include muffle and combustion furnaces. One of the latter takes four combustion tubes, and permits of 50 carbon estimations in steel in eight hours—quite a good day's work. There are also water baths, water ovens and fat extractors, which should prove highly convenient in laboratories. An electrolytic analysis set by the same firm is worth mention. In the most convenient arrangement the central electrode can be rotated by a small motor.

Thermit welding is hardly electric heating, though the electric furnace is the source of the energy utilised; but the process has a good many applications of interest to electrical engineers. A few specimens of welds are shown, but of far more general interest is the display of carbon free metals and alloys produced by the process. These include manganese, chromium, titanium, ferro-manganese, ferro-silicon, manganese-copper, arsenic copper, magnesium copper, cadmium copper, manganese-tin, &c. Some of these compounds may be worth attention by instrument makers and others requiring metals with special qualities

Miscellaneous.

The Morgan Crucible Company show a number of their well-known dynamos and motor brushes, welding carbon electrodes, turbine gland rings, microphone diaphragms and granules; as well as many other articles of carbon of less electrical interest.

The new "synthetic resin" products, which form the basis of the modern moulded insulating materials are shown in great variety of form, colour and application under the name of "Formite," by the Damard Lacquer Company, Ltd. A resin soluble in alcohol, acetone, &c., moulding powders and mixtures and insulating varnishes will interest electrical men generally. The production of transparent and opaque coloured forms is shown by a number of fancy trade products, which simulate such things as horn, amber, and minerals in a remarkable way. It is, perhaps, not generally known that this material is soluble and fusible like some natural resins in its original state, but that after heating to 120°-130°C. it changes into a chemically inert insoluble form unaffected by hot oil, spirits, and most chemicals, and possessing high insulating properties. It is a valuble addition to the insulating resources of the electrical engineer. Micanite & Insulators, Ltd., show an extensive variety of insulating tubes, sheathings, collars, sluices and washers, troughs and other parts. A new material called "Paxolin," is a combination of paper and synthetic resin varnish, which has good insulating properties and lends itself to manufacture in many convenient forms. It has considerable mechanical as well as dielectric strength. It is claimed that these synthetic resins destroy the hygroscopic character of fibrous and textile materials with which they are incorporated.

Ozonair, Ltd., show some very compact sets of ozone producers for sick room use, contained in boxes about 12 in. × 8 in. × 8 in. high, worked by a plug connection to any lighting circuit.

A rather remarkable generator for aeroplanes is shown by G. E. Mortley & Company. It is driven by an air screw, and contained in a "stream line" aluminium case. The whole thing weighs 13 lb. 1 oz. It has a capacity of 100 milli-amperes at 1,500 volts, for wireless; and also gives a supply at 12 volts for heating clothing. It is a distinct feat to get a 1,500 volt winding and commutator on to such a toy size armature, not to mention the low-tension winding. The machine was accepted by the Government for aeroplane equipment, and is reported to have stood up well to its work. The speed is kept approximately constant by a centrifugal governor acting on a clutch between the screw and the armature spindle. About 6,000 revs. per min. is the normal speed. Motor cycle lighting dynamos and lamp fittings are shown of small weight and size, which should commend themselves to the users of these popular vehicles in substitution of acetylene and oil lighting.

Dr. E. E. Fournier d'Albe shows a ship's compass fitted with a "Tell-Tale Controller." The card carries a mirror over the pivot, and a small glow lamp is fixed on a collar surrounding the case. A selenium cell is carried on the same collar. So long as the course is that set, the card mirror reflects light on to the cell. If the vessel falls off the course the beam leaves the cell, whereupon apparatus in the circuit of the cell makes a noise or shows a light to call attention. It should be said that this account is the result of inspection through the case, as no printed explanation was on view. The instrument was invented by Major D. W. Buddicom, late of the "Tanks" branch, Ministry of Munitions. Some other applications of selenium cells are exhibited by Dr. Fournier d'Albe, including the "Optophone" for transforming the printed page into articulate speech for the benefit of the blind.

Mr. H. R. Tidswell shows an improved trolley head for tramway cars, &c. It combines the advantages of the swivel-head with the definite orientation of the wheel in a fixed head. The wheel is carried on a plunger backed by a spring in a socket on the head. When on the wire the spring is compressed and the plunger swivels easily. When off the wire the spring pushes the plunger out, but brings the wheel in line with the trolley boom, so facilitating the re-wiring, sometimes a tantalising job with a swivel head on a dark night. The spring action is claimed to improve the running of the wheel.

The testing of ignition sparking plugs under pressure is shown by Mr. A. C. Parnacott, in a little apparatus containing a hand-driven magneto, a pressure chamber into which the plug is screwed, with a glass window giving a view of the spark and a pressure gauge. The behaviour of the plug at any desired pressure up to 150 lb. per sq. inch can be observed, and any gas leakage through the plug detected by watching the gauge. The same exhibitor shows some drawing compasses of highly original design. Extension is provided for by telescopic legs. The marking and centring points can be turned about the legs, so that they always make a favourable angle with the paper, even at extreme radii. It is claimed that circles can be accurately drawn from 1/32 in. up to 24 in. diameter with the one set. The construction is simple, strong and light. The compasses are made in "stainless steel," and seem to mark a real advance in a class of design which has shown little movement for centuries.

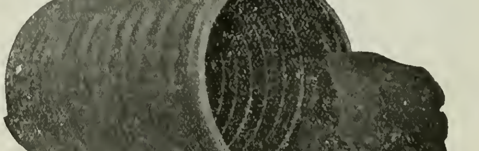
Errata.—The gyrostat rotor of Messrs. Elliotts was described as having "turned" slots. It should have been "tunnel" slots. Messrs. Graham's instruments, as perhaps the context showed, are "Naval," not "Norval"

Some Hose Applications.

The purposes for which hose is used are many and various, and to follow this sinuous conductor of liquids and gases throughout its myriad applications would involve an exceedingly instructive and protracted course of study.

Hose is one of the most important manufactures of the India Rubber, Gutta Percha & Telegraph Works Company, Ltd. (the Silvertown Company), and in their extensive works at Silvertown is produced hose of all types and sizes for every conceivable purpose. These include, in addition to delivery, steam, hydraulic and suction hose, both plain and armoured, special hose for pneumatic tools, coal cutters, coke quenching, sand blast, oxy-acetylene welding and divers.

For salvage and dredging service the Silvertown Company have developed a special hose. Originally the suction method of dredging was confined to the removal of sand, but it has proved so effective that its application has been extended to the salvage of such materials as metallic ore, coal, gravel, clay, scrap iron, &c. Essentially the suction dredging method consists in drawing up material from the bottom of the water by suction through a continuous hose, and discharging it into a hopper or through a pipe line to places some distance away.



As an example of successful suction dredging and remarkable hose durability, a recent salvage operation of Messrs. Thomas Ensor & Sons, the well-known Queenstown salvage contractors, may be mentioned. A Silvertown dredging hose of 10 in. bore was used, and this one hose salved 460 tons of copper ore and thousands of tons of gravel, sand and scrap iron. Many of the pieces of copper ore were of considerable size (that in the illustration weighs 31 lb.), but they were all successfully negotiated by the Silvertown hose.

The Silvertown Company have paid a great deal of attention to the design and manufacture of hose to meet special requirements, and they are prepared to deal with any hose proposition that may be advanced. Engineers who desire hose information, whether relating to regular or to hitherto untried applications, are recommended to get in touch with the Silvertown Company, whose works are at Silvertown, London, E.16, and whose head office is at 106, Cannon-street, London, E.C.4.

Patents in Relation to Industry.

A Conference on the relation of patents to industry was held at the British Scientific Products Exhibition on Thursday, July 31, Lord Moulton presiding

Sir Robert Hadfield, F.R.S., who opened the discussion, said he had come straight from a meeting of a sub-committee of the Federation of British Industries which was dealing with this question. Through that Federation, and also the British Commonwealth Union, which did the Parliamentary side of the work, they would have a very good chance of getting the views of industry put before Parliament in a way which was not easily possible otherwise. The Federation was backing up the views that had been expressed by the conference of scientific and technical societies which had already gone into the question in regard to the new Patents Bill, and agreed that there should be a much longer term for the life of patents, that the file wrapper system should be adopted as was the case in America—the file wrapper system consisted in allowing an examination of the various remarks by the Examiner on any particular application—the constitution of a special tribunal for dealing with patent actions, and an extension of the term of provisional protection from six months to two years. He could speak from experience of the value of the file wrapper system. He was in Washington on one occasion and by being able to examine the reports of the Examiner on various patents in which he was interested, he not only saved a considerable amount of time but had been able to avoid costly litigation. He could not help saying that it seemed an anachronism in these days to find that a Britisher could not get as good and as long a patent as an American. An American patent commenced, not from the date of application but from the date on which the patent was actually granted, whereas in this country we might waste 12 or 15 months and all that time the life of the patent was running out. He did not think that was the original intention, and it had probably grown up as a matter of long practice, but it placed the Britisher very much at a disadvantage. With regard to fees, the Federation of British Industries rather thought that the British patentee could afford to pay a very considerable charge compared with an American inventor. He could not see that himself, but finally it was agreed that if fees were reduced by 50 per cent. it would be a very great advantage. With regard to an Empire patent, he agreed with the view of the Federation that it was too late to do anything in this matter in regard to the new Patents Bill and that, for the moment, that point should not be pressed. A point which the Federation was introducing, and with which he thought they would agree, was that the publication of a paper before a learned society should not be taken as in any way barring a man from getting a patent. He hoped that the meeting would show our legislators that industry was determined to have some change in our patent laws.

Mr. Walter F. Reid, Chairman of the Council of the Institute of Inventors, urged the necessity for encouraging inventors, upon whom the whole progress of the world depended. Our present system of granting patents, with its limited search of 50 years in this country only, did not give a patentee a monopoly at all; it really gave him a licence for litigation and nothing more. At present the Patent Office made a profit of £100,000 a year out of the fees paid by inventors, and that went to the Treasury. That was a very wrong state of affairs. The inventor was an asset to the State, and as such, the State ought to help him at the beginning of his work and not tax him during that period, as it did at present. That, however, did not seem to be the view of those who drafted the 1917 Bill—which was withdrawn—nor the present Bill. Many of the weak points in the 1917 Bill had been repeated in the 1919 Bill. Patents ought to be cheap and he was not at all sure that they ought not to be cheaper here than they were in America where the total fees for a 17 years patent amounted to £7. Why should we not go one better and make the total fees five guineas? He personally knew British inventors who went to America because the patent fees there were low and because patents were taken up more easily than they were in this country. He was sorry to say that the Committee which was set up by the Government during the war to examine inventions, turned down many really good things. The real object of that Committee was to find inventors, but we ought never to have been in that position. The inventor in Great Britain should be so encouraged that when he was wanted we should know where to find him. He therefore hoped that the Government in future would take a broad view of the matter and encourage the inventor in every possible way.

Mr. J. Hunter Gray said he could not understand the attitude of the public towards invention in this country. So far, the making of patent laws here had been left to Government departments, which always received support from some section of the community which was desirous of getting the work of others for nothing if it possibly could. It was appalling, judging from the reports of the second reading debate on the Patents Bill, that not a single word was said in favour of the inventor, and that all the main questions which should have been discussed for the purpose of improving the position of the inventor were left absolutely alone. To some extent this state of affairs was the fault of the industries themselves, which, until recently, had never troubled to represent properly to the Government what the position was and what improvements were necessary. The subject was of such vital interest to the nation and to industry that he felt the best course would be to hold a conference at which all the views of various industries could be put forward, and evidence taken if necessary, so that recommendations could be drawn up for incorporation in an Act of Parliament, expressing exactly what the industries of the country thought was necessary. That would help industry properly, which was not the case with our present method of procedure.

Mr. Douglas Leechman said that under clauses 1 and 2 of the new Patents Bill the patentee might, voluntarily or involuntarily, find himself in the position that he had to grant licences to practically any person who liked to apply. If a patentee thought of having his patent endorsed "licences of right," because the Government offered him a bait in the shape of a reduction of his renewal fees, by 50 per cent., he would like to draw his very careful attention to these clauses. For instance, under Clause 2, subsection (*d*), the "licensee shall be entitled to call upon a patentee to take proceedings to prevent the infringement of the patent, and if the patentee refuses or neglects to do so within two months after being so called upon, the licensee may institute proceedings for the infringement in his own name as though he were patentee making the patentee a defendant." He would not trust himself to comment upon that sentence. He could not understand how it could have been conceived that that would do anybody any good, except perhaps the licensee who had his knife into the inventor and wished to take every means of wrecking him. At present when a licence was granted in the ordinary way—an exclusive licence and not a general licence—it was sometimes put in the licence that the licensee should have the right of taking proceedings in the name of the inventor at the expense of the licensee. That was a very different thing from what was now proposed, because the licensee could call upon the inventor to take an action against somebody whom the licensee thought was infringing, whether he was or not, and could force the inventor into litigation that might cost him hundreds or thousands of pounds when he had received royalties, perhaps, of £10 or £20. He therefore cautioned any patentee who thought he was going to save money on his renewal fees in this way, that he would be putting his head into the noose if he attempted that clause. The more he studied patent law, the more he realised that patents were granted in the interests of industry; if that were not so there would be no encouragement to inventors at all. He was afraid that there was a widespread impression that patent laws were in the interests of inventors, and it seemed to him that when some officials went into the question they looked at it jealously because it might benefit the inventor. That should not be the attitude at all. The point of view in devising patent laws and in granting patents was whether it would or would not benefit industry. That was what patents were for and was what we ought to get. It was no use trying to squeeze the inventor out. If they wanted plenty of inventors, and good ones, there must be proper conditions of inducement. Clauses such as the one he had mentioned would not make people invent. He thought it was the most foolish thing in the world for the Government to throw away a whole lot of good inventions as was being done in regard to the patents which could not be worked during the war. He believed he was right in saying that in August, 1914, there were something like 100,000 patents in force. Some of these were in use. Manufacturers were already carrying on business with them whilst negotiations and contracts were being entered into with regard to others. Then came the control of factories and the Government, quite rightly, said that the manufacture and development of these patented articles must be abandoned and the factories must go on munitions. Nobody complained of that, but it was at the time felt that it would be foolish to throw away these inventions. The Institute of Inventors, therefore, wrote to the Board of Trade and suggested a moratorium for patents, and that the rights under these patents should merely be suspended during the war. The Board of Trade said they did not see how they could do it. They then brought the matter before the Commercial Committee of the House of

Commons, which also approached the Board of Trade with the same result. Other bigger societies were then approached and the Institutions of Automobile, Mechanical and Electrical Engineers took the matter in hand, and eventually 26 of the principal technical societies, as well as the Federation of British Industries, sent a very powerful deputation to the Board of Trade. It seemed to him that a deputation from such a large number of technical societies and from the Federation of British Industries, which represented the manufacturing and industrial side, really represented the public on the question of patents, but they got nothing. He submitted that trade was being injured by the cancellation of a term of the life of these patents. Only a few days ago the works manager of one of the biggest industrial undertakings in the country told him that in respect of one patent there were two years still to run, but it would not pay them to put it on the market for that short period. If they could get back the five years that had been lost the position would be different. That was happening with hundreds of firms and they did not know what to do. Sir Auckland Geddes stated, in introducing the second reading of the Patents Bill, that the interests of inventors had been considered and that their troubles would be met by increasing the term of patents from 14 to 16 years. That increase was good, and they were very pleased to have it, but it was not directed to the evil at all. It was considered that 16 years was a better period than 14 years for all patents, but it was not directed to relieving those who had suffered through a cancellation of a term of the life of their patents owing to the war. It also only applied to those patents which were in existence to-day or at the time of the passing of the Act. What about those that had died in the meantime? Were they not to have their period back again? There was a procedure in the 1919 Bill for getting the term of a patent extended beyond the 16 years, but they had to prove first of all that the invention was of special merit and special value to the public. Why should that be called for now? It was not called for when the patent was granted. Another thing which had to be proved was, to his mind, an absurdity. They had to prove that the patentee had used his best endeavours to make the thing a commercial success. That meant they had to prove that, in spite of DORA, they had during the war gone behind her back and got the thing on the market. A number of objections had been raised to a moratorium for patents, the chief of which seemed to be that if they did this for patentees they would have to put everybody else in the same position that they were before the war, and that, said the Government, was impossible. He had heard no other serious objection, but it was in the interests of industry that this should be done, and he urged that a moratorium for patents should be made the subject of a Bill and passed through Parliament quickly. The Government action in suspending patents was wholesale and automatic, and the restoration of them should similarly be wholesale and automatic. A man ought to apply for the restoration of his patent because many patents were topical and with the changes which had taken place during the past five years some inventors would not wish to have their patents restored. With regard to renewal fees, if the inventor had paid his fees during the war, they should count in respect of the next five years. If he had not, then he should begin to pay them now. He believed that was quite a practicable method. All that he had said about patents applied equally to designs. People seemed to think that a design was a sort of poor relation and it did receive very much consideration, but in some cases a design was even more important than a patent, and everything done for patents should also be done for designs.

Mr. W. M. Mordey said that, as chairman of the committee of technical and scientific societies which framed the report which was placed before the Board of Trade by the deputation previously mentioned, he did not propose to deal with all the points included therein. He would concentrate on one or two points, and particularly on the question of cheaper patents, because that could be dealt with apart from an Act of Parliament. Under the Act of 1907 it was provided that patent fees should not exceed £155 on a full 14 years patent, but it also provided that with the consent of the Treasury and the Board of Trade, lower fees might be imposed. Acting under that provision the fees had been reduced to what they were now, viz., £5 for the first four years and £95 for the remaining 10 years. It had been mentioned that in the United States a 17 years patent could be obtained for £7 against our £100 for 14 years, but he thought most of us would prefer our own system, viz., a cheap patent for a short term of years with power to renew by annual instalments if it was desired to keep the patent up. Many patents even the inventors did not wish to keep up. The great fault of the United States patent system of having full 17 years patents in every case was that the records of the American patents office was simply choked with corpses, patents that even the inventors had lost any interest in and did not wish under any circumstances to keep up. The proposal, therefore, that was put before the Board of Trade was that it was only the renewal fees that should be halved and not the fees for the first four years. The effect of the present high renewal fees was very serious. The infant mortality was very high. Only 40 per cent. of them survived the first four years and only 4 or 5 per cent. lived out the full term of 14 years. It had been admitted by Sir Michael Hicks-Beach and other Chancellors of the Exchequer, that the principle of taxing inventors through their official fees was wrong. It was admitted—and it seemed to him common-sense—that inventors should be taxed through their income tax. That, at least, would have the advantage that it would not tax the unsuccessful inventor as the present system did. If the fees were lowered he believed it would have the effect of increasing the revenue of the Patent Office, because many more patents would be kept alive for their full period. The revenue of the Patent Office was about £300,000 a year and the expenditure something under £20,000 a year. The surplus was about £120,000, so that the inventor was being taxed to the extent of about £10,000 a month. That was an extremely objectionable state of things which should be remedied. The Designs and Trade Marks Department produced only about 10 per cent. of the revenue of the Patent Office, and it was clear that that department was being run at a loss and was being paid for out of some of the profits obtained from patentees. What had been proposed was that the renewal fees for the final 10 years of the patent—this proposal was put forward before the new Bill granting 16 years life was introduced—should be halved, so that the total cost of a 14 years patent would be £52 instead of £100. Even assuming there was no change in the number of inventions patented there would still be a surplus of £30,000 per annum on the Patent Office, but he believed that the number would be greatly increased and that, in addition to an increased revenue to the Patent Office, there would be a substantially increased national revenue due to the greater activity in the inventing and manufacturing part of the community. In the United States they made a profit of about £40,000 per annum with a total fee of £7, so that surely we, with fees of £52, ought to provide something substantial in the way of a surplus. In that case the surplus ought to be applied towards the still further reduction of patent fees. Finally, he wished to allude briefly to the question of Empire patent law. He was glad to hear from Sir Robert Hadfield that this matter had received the consideration of the Federation of British Industries which now represented concerns of a capital value of more than £2,500,000,000. At the same time he was sorry that the Federation thought no progress could be made in this direction at the present moment. It was a subject which bristled with difficulties, but he thought it was within the region of practical politics. A Committee of the Institution of Electrical Engineers, of which he was Chairman, had prepared a report which would shortly be published, in which was outlined a scheme for Empire patents which he believed was a workable and practical scheme, although he did not suggest that it was ideal. They had worked on the principle that there should not necessarily be any alteration in any patent law in any of the Colonies or Dependencies that had got their own patent laws, although most of them followed very closely British law. The main object in view had been that an Empire patent should not cost much; that it should be easy of application; that there should be reciprocity; that there should be no change in the existing laws and that adherence on the part of any Colony or Dependency should be optional. Briefly, under this scheme, details of which would be published almost immediately in the "Journal" of the Institution, a British patent could be applied for in the ordinary way, but it would be endorsed at the request of the applicant with the name of the Colony or Dependency in which he wished it also to have effect. The fees would be paid to the British Patent Office and the proportion due to the Colony or Dependency paid over, so that there would be no reduction in the fees. The patent would also be subject to the local laws of the Colony or Dependency as to validity or infringement. He asked for their sympathy for this scheme and hoped that they would regard it as one which was practical to-day, and to accept it as a large instalment towards something which experience would show to be possible in the future.

Mr. James Swinburne, F.R.S., said that if the whole of the proceedings of the Conference were to be published in the daily papers they would not be read, yet he contended that the subject was 50 times more important than the whole of the Irish question and more than 50 times more important than 99 per cent. of the subjects that were being discussed in the daily press. The monopolies that were granted to inventors were ridiculously small in proportion to what was wanted in the way of motive to make the country go ahead. One of the fundamental difficulties was the fallacious idea that anybody who made money was robbing the community. That was one reason why inventors were not encouraged properly. He believed that even industrial people had the idea that if inventors were encouraged by granting them monopolies, trade was hampered and that everything the inventor made was taken out of somebody else's pocket. He was afraid there would always be a strong prejudice against patents because people did not realise that a patentee's royalty was really a very small payment for a very big work, work upon which the prosperity of the nation depended. He thought that the suggestion of Mr. Gray that a Bill should be framed by a committee representative of industry ought to be practicable. Another difficulty was that inventors, as such, had no vote. Politicians pretended they did this or that for the benefit of the country, but they really only considered what would help them in the way of getting votes, and they did not care a little bit for the inventors of the country. It was really monstrous that the Treasury should make £100,000 a year out of inventors, but how could it be stopped ? They could not ask the Treasury to stop it, because they would like it to be stopped. The Treasury would say that it would have to be put on income tax, and that people did not like their income tax being increased and would vote against the Government, whereas patentees could not do anything. On the other hand, he believed that if only enough fuss were made, the Government would act. They had already had £2,000,000 granted for scientific research, and he suggested that £2,000,000 might very well be used not only in paying back to inventors that £100,000 a year, but in providing money to forward the cause. If the Patent Office had more money it might use it exceedingly well, and one example was the provision of similar libraries to that of the Patent Office Library in London in all the large cities of the country. Money spent in that direction would do an enormous amount of good.

Sir G. Croydon Marks, M.P., suggested that they should be fair to the Board of Trade in this matter and examine what it was that was proposed in the Patents Bill now before Parliament. He regretted, with Mr. Swinburne, that the daily press took so little interest in these matters. On the occasion of the second reading of the Patents Bill, some of them spoke several columns of Hansard but the daily papers only gave one or two little paragraphs, and these had more reference to an alleged abuse on the part of a particular company than they had to do with the Bill itself. He did not hesitate to say that the Bill was practically a new Charter for industry, but it was discussed in an assembly not of 670 or 700 members but an assembly of 35 members. That showed that the inventing industry or the inventor's relation to the industries of the country was neither appreciated in the House of Commons nor in the press. Therefore it was essential to use every means in their power to awaken public opinion to a realisation of the fact that something was being done towards improving the very grave defects of the patent law of the country. The Bill lengthened the life of all patents by two years, and that two years was added to the end of the first four years, so that renewal fees would not have to be paid for six years. At the same time he agreed that the Bill did not deal fairly with those patents which could not be worked during the war. The fact that such a large proportion of patents fell out at the end of the initial period of four years showed that the fee charged for that period had not been detrimental to the patenting of inventions. It was the renewal fee that caused the trouble. Therefore by lengthening the period by two years before the renewal fee had to be paid, they were giving the inventor encouragement just at the most difficult period of his invention—at the beginning. Another encouragement was that if an inventor had not the means to work his invention himself, he could have his patent endorsed "licences of right." That was an invitation to all the world to come to the man and take up the invention, and at the same time the inventor had only to pay half the renewal fees. He regarded that as a very great concession. The object of the Bill was to assist industry, and it was laid down, for the first time, although it had always been the theory, that patents were granted not only to encourage invention, but to secure that new inventions should, as far as possible, be worked on a commercial scale. In this way the Bill should bring inventors more into touch with industry than they had ever been before. It afforded a man who could not work his patent means for getting it worked, and it provided means for compelling a man to work his patent—where no steps were taken to work it—through the simple procedure of the Patent Office. The Bill gave a man a patent for six years for £5. There was no other country in the world which gave the same protection at so low a price. America gave 17 years for £7, but probably at the end of six years many inventors would be glad to get rid of their patent. Therefore they would have spent £7 for six years, whereas in England they would get it for £5. In Germany considerably more would have to be spent and in France considerably more. Therefore, he thought the aim of those represented at the Conference should be to study the Bill very closely with a view to improving it during the Committee stage, which would probably be reached some time in October

Lord Moulton, in bringing the Conference to a close, said he had heard the various speeches with very mixed feelings. There had been some gloomy speeches by those who had perpetually been refused when they made most reasonable applications to the various departments of the Government. There must be some cause for that. What was the reason for it ? He must say it was not a mystery to him, and he would tell them why. Although they had an excellent case, they never seemed to have realised that, in order to succeed in getting the modifications of the patent law, some of which had been referred to that day, and would be of enormous importance, they would not convince the public until they made the public feel that patents were in the interests of the public. They had heard of the gifts that inventors had given to the country, but there had not been a word, except from Mr. Swinburne and Sir George Croydon Marks, to suggest that they were paid for by the country consenting to put itself under restrictions for 14 years from using ideas which might well occur to it. Therefore, if they wished to convince the public, inventors must show that they realised that, and must also show that their claims over-top that so much that more liberal terms ought to be given them. To do that they must frankly confess one thing. When they heard of the tens of thousands of patents that were taken out, there was no man on his side of the table who did not know that 50 per cent. of them were rubbish, and that most of the others were of very little value. Therefore they must realise that the public was suspicious when these inventions were protected by patents and it was found that so few of them were really meritorious. The value of those that were meritorious could not be over-estimated, but there were many trivial things that were made the subject of patents which did not justify them in speaking of the person who was the patentee as an inventor. The test of that was in the number of cases in which a man, by not renewing his patent, in effect said that it was not worth £10 to him to protect it any longer at the end of the first four years. Therefore, it seemed that the bulk of inventions were realised even by the inventors themselves to be of no value to the country ; and his experience of them was that it would be in the interests of the country to sweep them away. Renewal fees, therefore, were a valuable test as to whether an invention was of substantial utility. Nobody esteemed the value of invention to industry more than he did, but such patents as those he had referred to restrained invention. A man took out a patent in which probably 50 improvements could be made, but could not be developed because of the earlier patent. Nobody would take up these patents because it was necessary to get the consent of the man with the first patent to use them. He remembered that very well in connection with telephones. At first there were any number of patents taken out for improvements, but they were all dropped. What was the use of inventing telephones ? The whole of the monopoly was in the hands of the National Telephone Company, and the consequence was that nobody would look at these patents, and it was possible that very great improvements might have been made in telephony if they had been worth while inventing, but they were not because of the earlier patent. It was to remove that difficulty that the system of compulsory licences was introduced in the interests of the country and in the interests of invention. He agreed with Sir Robert Hadfield that it would be an excellent thing if the files at the Patent Office were always open, as they were in America. One of the things that had done the inventor so much harm in this country was that nothing was considered anticipation that could not be shown to have been published in England, whereas the invention might not be new. It might have been worked in another country, and yet we stuck to our idea of importer, and the man who first published it in England was called the inventor. Of course, he was not the inventor at all. He would give an example of the way that defect in our patent law was hurting England. Patents came from America and Germany by way of communications, and according to English law the person who communicated them was called the inventor. One of the primary duties of an inventor in drawing up a patent was that he should frankly tell the public the best way he knew to work his invention. It must be drawn up in the utmost good faith between the inventor and the public in order that when the patent lapsed the public might enjoy the full benefit of the practical use of the invention. But suppose it was communicated through a patent agent ? The patent agent was the inventor. The duty applied to him only, but he knew no more of the subject than was in the document itself. The man who really knew was either in America or Germany, and he might have abundant knowledge which he ought to put into the specification, and which he would have to put into the specification if he were an Englishman taking out a patent ; but because he was abroad—because the so-called inventor was the patent agent to whom the patentee wrote—that basic duty of the patentee to give his best knowledge to the English nation in return for the monopoly granted him, became an absolute dead letter. If, in attempting to amend the patent law, these things which damaged the nation and the commerce of the nation were put forward, he believed that patentees would get generous terms from the nation. He did not think that the nation was niggardly towards patentees at all. He believed, as Sir George Croydon Marks had said, that the new Bill was an attempt to give a new charter to inventors. It lightened the burden on them in many ways, but one thing the country was determined upon was that the grant of a patent should help the trade of the country, and not strangle it. During the last 30 or 40 years the patent law of this country had been worked mainly by people outside—very slightly, comparatively, by people who were Englishmen—solely for the purpose of keeping trade out of the country and strangling the trade of the country. The aim now was to keep the trade of the country flourishing, and no variations of the patent law would be approved by the public that did not clearly assist the trade of the country. That was the intention of invention. The speakers that afternoon had said that the debt of the country to the inventor was enormous; but it was not so enormous if those inventions were not so governed by law and were not so used by the patentees as to benefit trade. If they could only convince Parliament, or the Press, or the people, that the changes they wanted would bring these changes more quickly and more thoroughly into the life-blood of the industry of the country they would find no difficulty in getting support. He would have been very glad if the discussion had been more on the bearing of invention to industry, but it had rather drifted into the question of the status of the inventor. He had hoped that they would have discussed the status of invention. No one valued invention, and no one appreciated the struggles or delighted at the triumphs and grieved at the failures of inventors more than himself, who had for so many years lived in such close contact with them, and he was satisfied that if they would take the advice he was giving to them, and tried to get those benefits only which directly improved the harvest that the country derived from its inventors, they would have nothing to complain of in the generous soul of the British people.

On the motion of Sir Richard Gregory, Chairman of the Organising Committee of the Exhibition, a hearty vote of thanks was accorded Lord Moulton for presiding at the Conference and to those who had taken part in it.

A New Indirect Unit for Industrial Lighting.

We are interested to observe that the British Thomson-Houston Company are introducing a type of indirect fitting specifically for industrial use. This unit (known as the " Icumfa ") utilises a lamp with the lower half of the bulb silvered so as to reflect rays on to a large steel reflector above it, which in turn re-directs and diffuses the upthrown light. The silvering completely conceals the lamp filament, and the fitting is suitable for factories where it has hitherto been impracticable to use indirect methods, owing to the darkness of the ceilings, or to the presence of skylights, &c. These fittings are made in two sizes, the 24-in. for 150 and 200 watt, and the 30-in. for 300 to 1,000 watt lamps of the half-watt type.

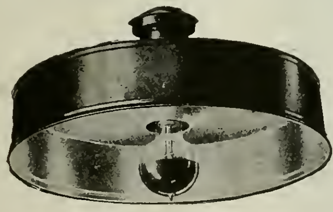


Fig. 1.—" Icumfa " Indirect Fitting, for Industrial Lighting.

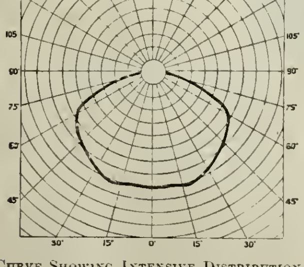


Fig. 2.—Curve Showing Intensive Distribution given by " Icumfa " Unit.

Birmingham Housing Exhibition.

The big housing exhibition which was recently held in the Birmingham Town Hall proved a great success, and attracted many visitors. The exhibition was opened by the Lady Mayoress on July 9, and it remained open until July 19. One of the most striking features was the attractive electrical stand, which was arranged by the City of Birmingham electric supply department. Ten firms of electrical manufacturers displayed a fine, up-to-date selection of lighting fittings, shades, radiators, ovens, cooking utensils, vacuum cleaners, boot and knife cleaners and other modern domestic appliances. The exhibition was visited by many hundreds of people interested in the provision of houses in Birmingham and the Midlands. The energy and enterprise of the Birmingham electric supply department are to be highly commended, for the greatest possible interest was taken in the electrical exhibits, and this is probably the best method of stimulating interest in the domestic applications of electricity and of developing its use for household purposes. The names of the firms exhibiting were Berry's Electric, Ltd., British Thomson-Houston Company Credenda Conduits, Ltd., Premier Electric Heaters, Ltd., General Electric Company, Edison Swan Electric Company, St. Helen's Cable Company, Benham & Sons, Daisy Vacuum Cleaner Company, and the British Westinghouse Electric Mfg. Company, Ltd. The above illustrations are reproductions of photographs of some of the exhibits on view at the electrical stand.

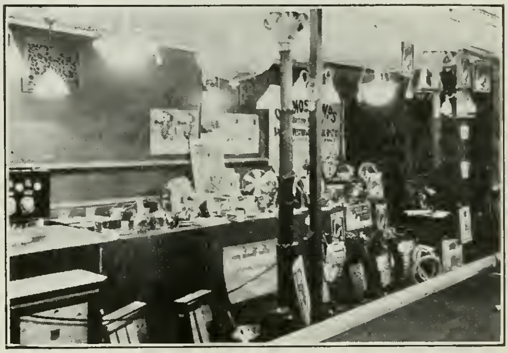


Fig. 1.—The Electrical Stand at Birmingham.

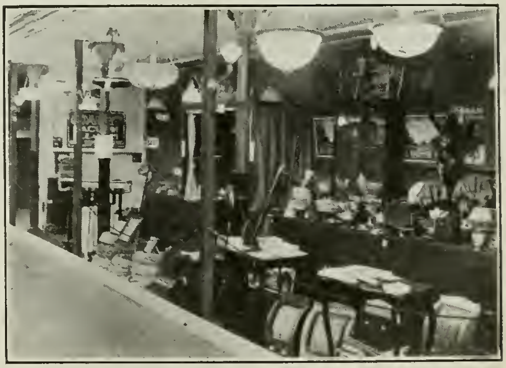


Fig. 2.—View of some of the Electrical Exhibits.

Electricity (Supply) Bill.

Standing Committee B of the House of Commons has continued the consideration of this Bill.

Mr. Dawes moved an amendment to clause 7 (acquisition of generating stations), that the price should be the cost actually incurred for the construction of the generating station or main transmission lines and the acquisition of the site, less depreciation.

Mr. Shortt stated that they ought to treat the local authorities and the power companies differently. They ought to treat the local authorities as authorities and take over their liabilities. If a municipality had paid off its annuities years ahead that ought to be made good. The power companies must be looked upon as profit-making concerns and treated differently.

Mr. Thompson denied that the fact that a municipality was out for giving a cheap supply of electricity, while companies were out for profit, was not ground for differential treatment.

Mr. Geo. Balfour contended that while no one objected to equal treatment for the municipality and for the company, yet equal treatment involved a consideration of the risks incurred. He knew of a case where the municipality had declined to supply a locality with electricity because the risk was regarded as too great; a company had stepped in, but it was some years before they got any return for their money.

Lieut.-Commander N. Craig thought that the value of the undertaking, and the cost of it, should be the basis of the payment.

Mr. Bridgeman said if the amendment were carried it would make differential treatment impossible. They did not seek to differentiate in regard to justice,but it must be realised that companies which had raised money and submitted to restrictions and obligations to carry out public duties had, in return, been promised certain terms of purchase in certain eventualities. Surely those companies stood in a different position from local authorities.

The amendment was negatived, but the Government accepted an amendment that, subject to a proviso, the local authority, in lieu of an annuity, should be entitled (if so desired), to be paid a sum to be determined, in default of agreement, by an arbitrator appointed by the Board of Trade.

Mr. Marriott moved an amendment that, failing agreement, the cost should be determined by arbitration, the arbitrator to make no allowance for compulsory sale, and not to take into account any enhancement or depreciation of the market value of the stock of a company due to the passing of the Act: also that the sum should not be less than would be payable under terms of any special Act or agreement with any local authority.

Mr. N. Chamberlain protested against any suggestion that members of the Committee were there to represent any particular interest. In the valuation, it was not so much the ownership as the rights attaching to it which had to be taken into consideration. He did not agree with the amendment, and he was not altogether in agreement with the Government in their proposal to drop the question of depreciation.

Mr. Shortt maintained that the Government were keeping their Parliamentary bargain under the Act of 1888. If the companies were prepared to accept words in the Bill for exceptional treatment where exceptional circumstances could be shown, and to allow their concerns to be purchased less depreciation, he was prepared to agree. Power companies were different and were treated in a different way. They would be taken over as going concerns.

Mr. Geo. Balfour said the generating stations could not be separated from electricity supply undertakings without robbing the undertakers of free right of action and flexibility of business. In the reconstruction of trade and commerce, the Government would fail if they started on a foundation of fraud, and that was what the Government proposals amounted to in regard to the power companies, if they did not compensate the companies for power stations generally on the terms on which the money had been invested.

Mr. Marshall Stevens said that the cost of the total generating plant in London, the provinces and Ireland concerned in the Bill was £7,000,000. In the case of the companies, other than the power companies, the plant represented £5,250,000.

The amendment was negatived.

On Tuesday the Committee rejected an amendment moved by Mr. MacVeagh, providing that where a tramway undertaking was bought regard should be had to the terms on which it was already purchaseable.

Mr. Geo. Balfour moved an amendment that the purchase price of a generating station should include an additional sum as compensation for the unexpired tenure.

Mr. Shortt opposed, and said the companies would receive electricity equally cheaply, and their profits would be as great as before.

Lieut.-Commander Craig said business people would no longer be willing to invest on the security of Parliamentary sanction after what the Committee was doing; and Mr. Neville Chamberlain said that where companies could not be bought out for a certain number of years, they should be compensated for the period during which they might earn more dividends.

The amendment was lost by 24 votes to 13.

On Wednesday Mr. Balfour's amendment to insert a provision that an electricity board having acquired a generating station otherwise than by agreement under section 7 should be bound to supply all electricity to meet the requirements of the previous owners of the station, was withdrawn upon a promise being given by the Home Secretary that it should be made compulsory for the board to supply the whole of the requirements.

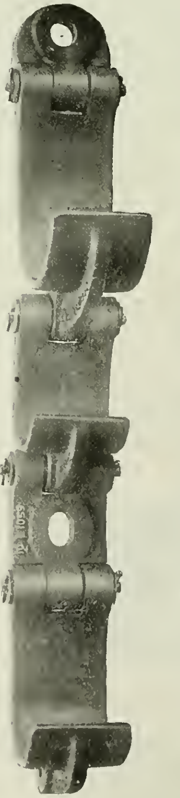
An amendment proposed by Mr. Kiley was altered on the suggestion of the Home Secretary and carried in the following form: Clause 7, page 6, line 2, after "generated," insert "in the event of any change of frequency or pressure, pay such expenses as the authority, company or person may necessarily incur in consequence of such change."

The following addition at the end of the clause was also carried on the motion of the Home Secretary: "Where a generating station, which is vested in a district electricity board under this section, is in course of construction, extension or repair, the rights and liabilities of the former owners thereof under any contract for such construction, extension or repair shall be transferred to the district electricity board."

An amendment, providing that interest at the rate of 6 per cent. on the price should be paid by the district electricity board to the former owners of any generating station or main transmission line taken over as from the date of such station or line vesting in such board until payment, was carried, but the Home Secretary said he could not definitely accept the figure of 6 per cent.

It was agreed that clause 7 as amended stand part of the Bill, and the Committee adjourned until the autumn session.

Chain-Type Cable Hooks.



Owing to the impossibility of providing a stock of cable suspending hooks in sufficient variety to meet the differing conditions which arise in attaching cables to walls, &c., a call has arisen for the design of a standard pattern hook which will meet all general requirements. In order to meet this want Messrs. Siemens Brothers & Company, Ltd., of Kensington Court, London, W. 8, and Woolwich, have recently placed upon the market chain-type cable hooks, for which a patent has been applied. By the employment of these hooks only a comparatively small number of standardised parts is required, which, when assembled, provide an excellent means of suspending any of the usual sizes of cables in such arrangement as may be necessary. The top fitting can be fixed by a bolt or screw to girder work or, if the attachment is to be made to brickwork or concrete, by a Lewis or expanding bolt. The intermediate or bottom fitting may be used as an additional support where the number of cables is large, or it may be used to hold back the lowest of a series of cables when the pull of the other cables tends to draw it away from the wall, as may occur when the run is on the outer wall of a curve in a railway cutting or tunnel. The Lewis bolt fitting, which is provided with a knuckle joint in order that any of the hook fittings may be directly hung from it, is made of malleable cast iron, being subject to the greatest strain. The hook fittings are coupled to one another, or to the other standard parts by means of coupling-pins in the manner shown in the illustration.

One of the great advantages derived from the use of these hooks lies in the fact that, when it becomes necessary to extend an existing bank of cables, all that is required is to select the correct size of cable hook from a stock which can be kept, and to attach this hook to the existing hanger by means of a pin supplied for the purpose. Where the number of cables depending from one hanger has been increased to such an extent that the weight on the suspension and the original fixing becomes excessive, the intermediate fitting can be employed as an additional support. This intermediate fitting may be used also as a means to keep the bottom of a chain of hangers fast against a wall should the run of cables be along the side of a curved surface. A large stock of each size of both hook and fitting is always in stock at the Company's Woolwich works, and orders can be executed with rapidity.

Zinc Production in Germany.—From "Metal und Erz" we learn that German zinc works during the war depended entirely on home raised ore. During 1916 the production of raw zinc rose to 196,500 tons, and in 1918 the figure was still higher. This was sufficient for the war, and there is now over-production.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1917 Specifications.

128,594 Graham. Electrical signalling or indicating apparatus especially applicable for signalling orders or numerical data. (4/8/16.) (Divided application on 11,052/16.)

128,600 Antonoff. Electric batteries. (2/8/17.)

128,606 Mauclaire, Garbarini & Gautier. Electric arc lamps with rotary arcs. (3/8/17.)

128,624 Rota & Binetti. Apparatus for the concentration of electric waves in a single direction or upon a fixed point. (14/8/17.)

Consists of a series of cylinders united by means of reciprocal transformers and connected to a battery, accumulator or dynamo, the connection between the cylinders being so made that each cylinder is connected to the opposite pole to that to which the next adjacent cylinder is connected, the connection being made by coils having such an inductance as to prevent the wave circulating in the battery circuit.

128,648 Johnson. (F.I.A.T. Fabbrica Italiana Automobili Torino Soc. Anon.) Direct current electric motors. (22/8/17.)

128,665 Marconi's Wireless Telegraph Co. & Franklin. (Marconi.) Reflectors for use in wireless telegraphy and telephony. (29/8/17.)

The reflector consists of two or more sets of rods arranged on a parabolic surface around a transmitting or receiving aerial as a focus, each rod being in tune with the aerial.

128,672 Splitdorf Electrical Co. Method of generating ignition currents for internal combustion engines, and apparatus therefor. (31/8/16.)

128,673 Marconi's Wireless Telegraph Co. & Franklin. Receivers for wireless signals. (1/9/17.)

128,676 Soc. de Metallurgie Electrolytique. Apparatus for the electrolytic production of zinc, copper, or other metals. (28/10/16.)

1918 Specifications.

128,682 B. T.-H. Co. (G. E. Co.) Wireless signalling systems. (30/1/18.)

Relates to a method of transmitting radio signals which consists in producing a continuous radio frequency current in a radiating system and simultaneously producing amplitude pulsations of said current proportional to the sum of several sine waves of different frequencies below the radio frequency.

128,689 Phillips & Elliott Bros. Magneto generators. (4/5/18.)

128,697 Short. Electric lamp-holders. (22/5/18.) (Addition to 102,111.)

118,092 Dinin. Device for ensuring liquid-tight passage for the connections of electric accumulators with containers made of celluloid. (25/7/17.)

128,739 Vickers, Ltd., & Barclay. Dynamo-electric machines. (27/6/18.)

128,786 MacDougall & Beresford. Electric cable conduit fittings. (6/8/18.)

128,787 Evershed & Vignoles & Clark. Dynamos for the production of uniform continuous current. (6/8/18.)

128,790 B. T.-H. Co. (G. E. Co.) Automatic regulators for dynamo-electric machines. (9/8/18.)

120,376 Harlow. Electrical relays. (28/8/17.)

128,809 Automatic Telephone Mfg. Co., Savin & Wade. Telephone switching apparatus. (21/9/18.)

128,831 Tavani. Electric circuits instantaneously sensitive to photo-electric acton. (11/11/18.)

124,207 Burnham. Dynamo-electric machines. (6/3/18.)

128,885 Rouzet. Regulating-device for maintaining a constant voltage or intensity in dynamos working with great variations of output. (28/3/19.)

126,640 Levin. Electrolytic gas generators. (22/5/17.) (Divided application on 8,207/18.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

June 11, 1919.

14,731 Cummuskey. Locking steering gear and switching-off electric current from magnetos.

14,732 Ellis. Electric theft or burglar alarm apparatus.

14,734 Sclater. Junction boxes for electric conduits.

14,757 Glasson. Electric circuit connecting devices.

14,760 & 14,761 Lutz. Insulators.

14,762 Lino. Container for secondary cells.

14,776 Augell. Electrically-heated laundry irons.

14,782 Crochat. Preventing manipulation of electric motor vehicles.

14,790 & 14,791 Olivetti. Magneto-electric machines.

June 12, 1919.

14,808 Collie. Interlocking devices for combined tumbler switches and sockets.

14,842 Macropoulos. Rotary rectifier of alternating current.

14,879 Barfield & Wild. Electric furnaces.

June 13, 1919.

14,909 Brecknell, Munro & Rogers & Willis. Trolley heads for overhead traction.

14,913 Automatic Telephone Mfg. Co. & Roseby. Converting direct current from one voltage to another.

14,934 Polyblank. Holders, contacts and sockets for wireless or vacuum tubes.

14,940 Gleason. Magnetic or electro-magnetic measuring, indicating, &c., apparatus.

14,948 Myers. Electric switches.

14,956 Wood. Safety device or belt trap for electric lighting of trams.

14,991 & 14,992 Relay Automatic Telephone Mfg. Co. & Ward. Automatic telephone systems.

14,993 Relay Automatic Telephone Mfg. Co. & Johnson. Automatic telephone systems.

14,994 Frankis. Receivers of wireless signals.

June 14, 1919.

15,036 Powell & Willesford. Electric, &c., change letter signs.

15,047 Weatherill. Induction coils.

June 16, 1919.

15,070 Tucker. Switches.

15,080 Rickets. Controlling and regulating systems for dynamos.

15,081 Burrell, Myers & Itterson-Pronk. Signal apparatus for ships.

15,085 B.T.-H. Co. (G.E. Co.) Regulating systems for a.c. circuits.

15,087 British Westinghouse Electric & Mfg. Co. Current limit relays. (21/6/18, U.S.)

15,112 Owen. Brush holders for dynamos.

15,116 Benjamin Electric, Ltd. Switches. (13/9/18. U.S.)

15,132 Armstrong. Electric chain-welding machines.

15,140 Rushmores, Ltd., & Henn. Electric engine-starting devices.

June 17, 1919.

15,192 Coventry & Karno. Electric terminal.

15,208 Fuller's United Electric Works & Welch. Machines for armouring wires, &c.

15,229 Comparri Wireless Control Synd. Detecting impulses or waves communicated by radiant energy.

15,232 Snell. Commutators or current distributors for internal combustion engines.

June 18, 1919.

15,251 Readett. Electrically treating steel, &c.

15,269 Mortimer & Jones. Clips for supporting and fixing electric cables, &c.

15,270 Mortimer & Jones. Junction boxes for cables.

15,274 Scott-Taggart. Method of making connection to cathode heated by alternating current.

15,275 McNeill, Bash & Russell. Self-aligning electrical fuse handles.

15,276 White. Constant voltage dynamo.

15,278 Enderson. Constant voltage dynamo.

15,280 Pizzi & Compare. Electric switches.

15,301 B.T.-H. Co. (G.E. Co.) Electric voltage regulator.

15,317 Electric Heating Co. & Hughes. Electric irons.

15,341 Igranic Electric Co. & Wright. Electrical coils.

15,342 Bethenod. Indirectly coupling radio-telegraphic antenna to high-frequency transformer. (15/3/18, France.)

15,344 Harrison. Repair or renewal of incandescence lamps.

15,351 Murray. Telephones.

15,352 Telephone Mfg. Co. & Murray. Telephones.

June 19, 1919.

15,369 Hadwin & Willis. Coupling for electric conduits, &c.

15,382 Parsons & Waddington. Signalling apparatus for mines, &c.

15,439 B.T.-H. Co. (G.E. Co.) Control for electric furnaces, &c.

15,447 Ferranti & Wall. Measurement of a.c. power.

15,448 Nayler. Device for testing electric ignition of internal combustion engines.

15,474 Cummings. Electro-magnet.

15,476 Nielson. Combined electric lamp and alarm clock. (3/7/18, Denmark.)

June 20, 1919.

15,491 Turner. Electric charging station.

15,508 Dunn. Electric measurement of liquid.

15,515 Scott-Taggart. Electrodes in vacuum tubes.

15,521 British Insulated & Helsby Cables, Ltd. & Astley. Electricity collectors.

15,531 Scott-Taggart. Vacuum tube rectifiers of a.c. for wireless telegraphy.

15,533 Efandem Co. & Hooper. Dry batteries.

15,544 Smith & Burrell. Electric switches.

15,554 Pether. Magneto couplings.

15,556 B.T.-H. Co. (G.E. Co.) Amplification of electric currents.

15,574 Gill & Chaviara. Electricity meters.

15,596 Mather. Rail bonds, &c.

15,610 Barr. Electric water heaters.

June 21, 1919.

15,621 Williams. Terminal electrical connections for sparking plugs.

15,643 Cooke. Trolly pole reversing mechanism for tramways, &c.

15,654 Blades. Electric plug connecting devices.

15,662 Heslop & Sanderson. Electric switch.

15,688 Adams. Trip mechanism for electric ignition devices for internal combustion engines.

15,693 Hasselberg. Control device for contacts of electric bells.

June 23, 1919.

15,720 Clark. Printing telegraph.

15,735 Bush. Control switch for dynamos.

15,748 B.T.-H. Co. (G.E. Co.) Electric induction apparatus.

Legal Intelligence.

Electrical Manager's Notice.

In the City of London Court, on Aug. 1, his Honour Judge Atherley-Jones, K.C., delivered a considered judgment in an action brought by Mr. Frank D. Berners, electrical manager, against Messrs. C. A. Vandervell & Company, Ltd., to recover £82. 15s., salary and bonus due. Plaintiff's case was that he was employed by the defendants as a departmental manager at their electrical works. On April 5 they gave him a week's salary in lieu of notice; but he claimed that he should have had a month's notice in accordance with the custom in reference to a man in his position in the electrical trade. When he was engaged nothing was said about notice. On Jan. 7, 1918, an award was made by Lord Askwith with regard to increasing the wages paid in electrical works, and they were given by his award 12½ per cent. bonus. Defendants had refused it to him. Defendants pleaded that the award was never accepted by them and it had no legal validity. Judge Atherley-Jones, K.C., said he had had great difficulty in determining whether plaintiff was included under Lord Askwith's award, but he came to the conclusion that he was not, as he was not a "worker" in the ordinary sense of the term. The order was certainly lacking in lucidity as to who came within its scope and who did not. The claim to £60 for the bonus failed, but he found that he was entitled to a month's salary in lieu of notice. He held a responsible position, and did not come within the category of persons who would usually be in receipt of a weekly notice. Judgment was entered for the plaintiff for £22. 15s., and costs.

Electricity Supply to Cinema.

His Honour Judge Lush Wilson, K.C., heard at Totnes County Court, on Aug. 1, an action by Mr. W. W. Linsdell, proprietor of a picture house at Paignton, against the Paignton Electric Light & Power Company for £30. 10s. 2d., paid under protest to defendants, being an alleged overcharge for the supply of electric current, damages for disconnection, and also cost of re-connecting the supply.

After hearing the evidence, his Honour said it was proved that defendants issued to plaintiff printed forms of application for the supply of electricity, either for lighting or motive power. The charge for lighting was above the charge for power. Plaintiff applied for and obtained a meter, for installation as a stand-by to a motor generator, and connected it to a rotary converter, which was used for altering the voltage for the arc of the cinematograph. The greater part of the energy, after passing through coils of wire, was used for producing light in the arc lantern. The question he had to decide was for what purpose, within the meaning of the contract, the energy obtained by plaintiff from defendants was used. The primary use of the energy when introduced into the machine was for motive power, and he was of opinion that the electricity obtained was used for power purposes within the meaning of the contract. He gave judgment for plaintiff, with costs, and certified for 10 guineas, costs of an expert witness.

Leave to appeal was granted.

Commercial Topics.

The F.B.I. and Export Trade.

Sir Arthur Steel Maitland, Bart, M.P., late Under Secretary of State for Foreign Affairs, and until recently in control of the department of Overseas Trade, has now accepted the invitation to become a member of the Overseas Committee of the Federation of British Industries. We are pleased to see that the Federation is devoting its energies to the development of the export trade in co-operation with the department of Overseas Trade. In many countries of the world it is establishing its own commissioners, who are men of the highest integrity, with knowledge of the local language and customs, and men who have generally spent many years in the areas to which they are appointed. These commissioners will look after the interests of the individual members of the Federation, they will exhibit their samples, appoint agents, furnish status reports, and send home information with regard to local demands.

* * * *

British Industries Fair.

It is to be regretted that many manufacturers fail to realise the official and national character of this exhibition, especially so far as the two provincial fairs are concerned. The Municipal Council of Birmingham and the local chamber of commerce who, under the auspices and with the support of the Board of Trade, are organising that city's section, are anxious that it should be widely known that the British Industries Fair (Birmingham) is actually a part of the exhibition to be held at the same time (Feb. 23 to March 5, 1920) in London and Glasgow, and that the Birmingham schedule includes electric light fittings and accessories, table lamps, hall lamps, standard lamps, &c.

Only goods of British manufacture are allowed, and no productions which come within the above description can be shown anywhere except in Birmingham. The city is allotting all its available public buildings to the fair, but the Council are anxious to receive applications for space at the earliest possible moment. Those of our readers who are qualified to exhibit should get into touch with the General Manager, Chamber of Commerce Buildings, Birmingham, at once.

* * * *

The Vickers-Westinghouse Combination.

The shareholders of the British Westinghouse Electric & Mfg. Company, Ltd., have received a circular regarding the proposed alteration of the title of the company. It is pointed out that the contemplated change of name was under consideration at the time the control of the company was transferred from America to England, when certain agreements were entered into for division of territories. One of the conditions imposed on the company was that on the termination of the agreements the use of the name "Westinghouse" was to be discontinued by the British company, and, as those agreements would expire at five years from Jan. 1, 1917 (unless otherwise extended by mutual consent), the directors are only anticipating the inevitable. It is announced that negotiations for a revision of the agreements have resulted in a provisional agreement. The British Westinghouse Company secures greater freedom of action, which will result in mutual advantages to both parties, but it provides for immediate change of name of the company, and will become operative in October next. After serious consideration by the directors, it has been decided to adopt the title "Vickers Electrical Company, Ltd.," which appeared to be the natural corollary from the recent amalgamation of Vickers (Limited) with the Metropolitan Carriage, Wagon & Finance Company (Limited).

* * * *

The Need for Greater Production and Increased Exports.

The economic and industrial position of the country was surveyed by the president of the Glasgow Chamber of Commerce (Mr. F. C. Gardiner) in his address at the quarterly meeting last week. After dealing at some length with the effect of coal prices on industry, and giving a critical survey of current Government legislation, Mr. Gardiner said that, having emerged triumphantly from the great struggle of the past four and a half years, one would naturally think the first business of the people would be to address themselves to rehabilitating the position of the country and re-creating the wealth which necessity had compelled them to destroy. So far from that being the case, they seemed to be going on from expedient to expedient to meet some immediate difficulty, without regard to what was going to happen to the trade of the country. They had got subsidies and doles, but what was needed was that the country should get back to the realities of peace and face the facts. Surely those who were in power should, in season and out of season, remind the people of this country that if we were to live we had got to work, and if we were going to pay for our daily bread and what we get from abroad we must produce and we must export ? The interdependence of the people seemed to him to be ignored ; interdependence internationally appeared to be very largely ignored, and the country was kept very much in the dark. We had already borrowed 15 hundred millions abroad, and we had to pay interest on that sum, and in due time he hoped the principal. In addition to that, we had to pay for our foreign imports, and we went on importing freely and lavishly with a light heart. It was high time the people of this country recognised the facts.

We agree with Mr. Gardiner that there is great need for economy, hard work and industry on the part of everybody, but many do not seem to appreciate the facts, and an organised campaign should be undertaken at once in order to enlighten them. The Government can do much to help the movement by setting an example of rigid economy and sound administration.

Electricity Supply.

Bacup Council proposes to apply for sanction to a loan of £12,000 for cable extensions.

Rugeley Urban Council has decided to apply for a provisional order to enable it to establish electricity supply works.

Hull Corporation has been authorised to borrow £100,000 for extensions of the electric supply undertaking.

Derby Corporation has increased the charges for electric current to 80 per cent. above pre-war rates.

Lincoln City Council has increased the charges for electricity by a further 20 per cent.

Dronfield Urban Council has decided not to oppose the proposed application of Sheffield Corporation for a provisional electric lighting order for the district.

The Workington Corporation Electricity Bill, which will enable the Corporation to establish electricity supply, has now passed through both Houses of Parliament.

Mr. Boyce, borough electrical engineer at Morecambe, and formerly engineer to Todmorden Corporation, is being retained by the latter authority to act in an advisory capacity, at a salary of £100 per annum.

An inquiry was held yesterday at Leyton into the application of the Urban Council to borrow £17,500 for plant and cables required in connection with a supply of electricity in bulk to be obtained from Walthamstow Council.

The Board of Trade has authorised Ealing Corporation to increase its maximum charge for electric current from 8d. to 10d. per unit, but the extra amount to be charged "shall not be more than sufficient to enable the undertaking to be carried on without loss."

Croydon Lighting and Electricity Committee will give a supply of electrical energy to the Croydon Gas Company for a 250-h.p. compressor plant. The expenditure involved (about £1,000) will be repaid to the Corporation if and when the main ceases to be used.

The accounts of the Lincoln electricity department for the year ended March 31 show income £25,079 (compared with £21,804 in the previous year) and gross profit £7,376 (£6,153). Repayment of loans and interest required £5,378 (£5,352), and the disposable surplus was £1,907 (£658). Units sold were 2,770,339 (3,203,877). Total maximum demand was 1,400 (1,575) kw. Cost per unit was 1·533d. (1·172d.) exclusive and 1·999d. (1·572d.) inclusive of capital charges.

There was a gross profit of £9,182. 15s. on the past year's working of the Exeter electricity undertaking ; but after providing for interest, sinking fund and income tax there is a deficit of £1,735, due to increased cost of fuel, &c. There is a continual demand for extensions of supply, and when present restrictions can be removed the output and revenue may be expected to increase rapidly. It is proposed to make a further 25 per cent. advance in rates, making a total advance of 75 per cent. on pre-war rates.

Rochdale Electricity Committee estimate an increased expenditure for the current year of £14,197, including £9,333 extra for coal and £3,064 for wages. To meet this extra cost it is proposed to raise the charges for current as follows : Lighting from 6·2d. to 8d. per unit ; power, under 15 kw. by from 0·3d. to 0·4d. per unit, according to consumption ; over 15 kw., proposed addition of 10s. to the kilowatt charge, plus 0·55d. per unit, compared with 0·5d. per unit, as at present, plus coal clause ; tramways, from 1·45d. per unit to 1·5d., plus coal clause.

The receipts of the Newport (Mon.) electricity undertaking for the past year were £79,000, compared with £40,000 in 1912-13. The tramway receipts have gone up from £38,000 to £81,000, and the passengers carried from 9¼ millions to 14¾ millions in the same period. The gross receipts had also shown a satisfactory increase. On both undertakings there are credit balances notwithstanding heavy expenditure in repairs, &c. Last year £13,000 was spent on repairs to the tramway permanent way and this year £20,000 will be spent.

The works cost per unit sold by the Heywood Corporation electricity department for the past five years shows an increase during that period of only 0·17d. per unit, the 1919 figure being 1·24d., against 1·07d. in 1915. Coal and total bulk supply charges show an increase of 0·30d., but economies were effected in other directions. The working costs at Heywood are 32 per cent. below the average, and it is claimed there are only three undertakings in England, with outputs lower than 1¾ million units, with lower working costs than Heywood.

The total revenue of the Glasgow Corporation electric supply department for the year ended May 31 was £865,039 and the working charges were £567,259, leaving £297,780 to meet depreciation (£60,464), interest on loans (£106,482), and sinking fund (£98,073), a total of £265,019. The surplus of £32,762 has been transferred to reserve fund, which now amounts to £64,008. The revenue shows an increase over last year of £76,037, working expenses are up by £24,542, and the net profit has increased by £25,616 over 1917-18. The Electricity Committee recommend that no change be made in the ordinary rates charged for energy for lighting and power supplies.

Col. Ekin has held an inquiry at St. Annes into the application of the Council for sanction to borrow £13,510 for additional plant and cables required to supply electricity in bulk to Lytham Council. Another inquiry was also held at Lytham for sanction for a loan of £35,000 for the same purpose. Mr. H. J. Clothier, electrical engineer, said the application was to carry out an agreement made in 1915 with Lytham Council to give them a supply in bulk at the boundary. The distance was about

2 miles. The works, with a capacity of 1,640 kw., were well able to deal with the Lytham demand, which he estimated would not be more than 250 kw. in five years. He was advising the Council to be prepared to make application to the Board of Trade to increase the statutory price.

The question of Water Power Royalties was raised in the House of Commons last week by Dr. Murray, who asked the President of the Board of Trade whether the Government was demanding a royalty in connection with Highland water-power development, and, if so, what authority the Government had for making the demand. In the course of his reply, Sir Auckland Geddes said that in the case of the British Aluminium Company (Lochaber Water Power) Bill of last session, the Board of Trade agreed with the promoters that a royalty of 2s. per annum on the horse-power developed should be paid to the State. A requirement of that character accorded with the usual practice of foreign countries, in which concessions were granted on the development and utilisation for industrial purposes of the power latent in natural supplies.

The accounts of the Marylebone (London) electricity supply department for the year ended March 31, 1919, show revenue £228,966 (compared with £216,846 in previous year), with a gross profit of £110,449 (£112,655). Interest, special charges and provision for repayment of loans required £111,452 (£112,594), the net result being a deficit of £1,003 (against a profit of £61). Working costs were 1·712d. (1·323d.) per unit sold and total costs, including capital and special charges, 3·358d. (2·793d.). Maximum load on feeders was 9,485 kw. (10,817 kw.) and load factor 19·6 (19·4) per cent. Units generated were 21,878,878 (24,451,990) and sold 16,245,133 (18,387,268). The report of the Electric Supply Committee states that the item of rents, rates and taxes alone is £2,366 in excess of the previous year and the sales department showed a deficit of £233 (compared with £874 profit) due to the maintenance and repair work which was in arrears during the war.

On the 31st ult. a presentation was made at a smoking concert by the West Ham Corporation electricity staff to Mr. J. W. Beauchamp, until recently electrical engineer to the undertaking. In the phrase of Mr. F. W. Purse, the new engineer, Mr. Beauchamp has received a "higher call," as he is now director and secretary of the Electrical Development Association. A handsome spirit tantalus, which had been subscribed to by every member of the undertaking, was presented by Mr. Purse, and Mr. Croot, the chairman of the Electricity Committee, made some very appreciative remarks regarding Mr. Beauchamp and his comparatively long association with West Ham. From the general feeling expressed by the large gathering, and after making full allowance for the usual exuberance of such functions, there is no doubt of the great feeling of regret at Mr. Beauchamp's departure. However, West Ham is always fortunate in its engineers, and Mr. F. W. Purse has undoubtedly effectively replaced Mr. Beauchamp in the kindly feelings of the staff. Musical honours were accorded to both the departing and incoming engineers with much enthusiasm.

The accounts of the Bristol electricity department for the year ended March 31, 1919, were submitted to the City Council last week. Income was £169,313 (compared with £177,338 in the previous year) and working and general expenses were £122,226 (£105,351), leaving gross profit £47,086 (£71,987). Interest and stock dividends required £19,243 (£20,596) and provision for debt redemption £31,578 (£32,329), the net result being a deficit of £3,416 (compared with a surplus of £19,544). Total cost per unit was 1·099d. (0·920d.) exclusive, and 1·560d. (1·388d.) inclusive of capital charges. Units sold were 26,269,745 (26,839,580). Load factor was 30·5 (29·54) per cent., and maximum coincidental load was 10,884 (10,678) k.v.a. Total connections are equal to 999,236 (971,768) 30-watt lamps, and the aggregate horse-power of motors and heating apparatus connected is 26,733 (25,797). The engineer and manager, Mr. H. Faraday Proctor, says in his report the 6,000 kw. turbo-generator (No. 12) has been delivered, and is expected to be in working order about the end of August. The operation of the Household Fuel and Lighting Order, which prohibits the connection of new consumers other than industrial consumers coming within certain specified limits, and imposes other limitations of the use of electricity, has had an adverse effect upon the department.

The annual accounts of the Electricity Committee, which were approved by Wolverhampton Corporation recently, show total capital expenditure of £532,127 at March 31, an increase of £79,594 over 1917-18. Total revenue for year was £169,390, including £164,645 from sales of energy (against £111,137 in 1917-18), and after providing for all expenses the gross profit was £51,333. Interest and capital charges amounted to £32,980, leaving a net profit of £18,353. The cost of fuel was 0·582d. (0·508d.) per unit sold, the works cost were 0·734d. (0·670d.), and the total costs 1·055d. (0·928d.) There are 2,791 (2,609) consumers; the total connections are equal to 18,887 kw. (19,546 kw.), and the horse-power of motors connected is 17,006 (12,283). The units sold were 34,103,501 (against 31,938,127); the load factor was 43·79 (44·57) per cent., and the units sold per head of the population 340 (320). Last year the average total price received for all classes of supply, including all the war advances and coal clauses, was 1·159d. per unit, against an average of 1·02d. per unit for the year ended March 31, 1914. Thus, although the department had to meet extraordinary advances—in the case of coal 248 per cent., wages 116 per cent., stores, repairs, &c., anything from 200 to 600 per cent.—the average price only advanced by 14 per cent. In spite of this the financial results are eminently satisfactory. Last year the average selling price was the lowest in the history of the undertaking, and it was mainly due to inability to advance prices as quickly as the costs were advanced that a deficit was shown in 1917-18. During the present year these cases have been far less numerous and there has been more stability.

Electric Traction.

Merthyr Council will purchase an electric vehicle for refuse collection.

East Ham Council has received sanction to borrow £23,065 for the reconstruction of the tramway track in Romford-road.

Doncaster Corporation has applied to the Board of Trade for sanction to borrow £26,500 for the purchase of 10 additional tramcars and for building a new tramcar shed.

In view of the demands for extension of tramway and electricity facilities in adjoining districts, Leeds City Council has decided to promote a bill for the extension of the city's boundaries.

The London United Tramways, Ltd., have commenced to relay the Acton-Ealing tramway track with rails recently received from the United States.

Sunderland Corporation recently refused to buy American rails, and placed an order with Messrs. Bolckow, Vaughan & Company, who have now informed the Tramways Committee that it is impossible to promise delivery owing to industrial troubles.

Aberdeen Tramways Committee has authorised the building of six new tramcars with top covers at the municipal tramway workshops, at an estimated cost of £1,819. 10s. per car. The offer of the British Westinghouse has been accepted for the supply of twelve 35 h.p. interpole ventilated motors at £214. 5s. each.

During the war an arrangement was made at Bolton whereby current required for street lighting was taken from the electric trolley wires of the tramways, and the Tramways Committee has now asked the Electricity Committee to make arrangements for taking current for street lighting from the ordinary mains.

The annual report of Sunderland Corporation tramways states that the daily average number of passengers carried was 80,000 and the total for the year 26,251,700 (against 25,041,160 in 1917-18), with receipts at £118,029 (£97,877). The balance on the year's working was £51,038, with £5,000 allocated to the rates. In 1914 the wage bill for motormen and conductors was £13,797, but last year it was £22,001.

The Ways and Means Committee of the House of Commons has passed the London Electric Railways Bill, which authorises the construction of new underground works and the issue of £1,000,000 of debentures for the provision of railway stock, &c. In his evidence, Mr. Frank Pick, commercial manager of the company, said that an escalator was equal to four lifts for the transport of passengers.

The accounts of the Lincoln tramways department for the year ended March 31, 1919, show revenue £14,193 (compared with £13,999 in the previous year) and working expenses were £8,279 (£6,236). Interest required £1,544 (£1,529) and sinking fund £1,071 (£1,071). Revenue per car-mile was 23·02d. (17·69d.) and working expenses, including power, were 13·44d. (10·28d.). Passengers carried were 2,581,030 (2,209,286) and car-miles run 147,969 (145,577). Mr. Stanley Clegg, city electrical and tramways engineer, states that the increase of about 30 per cent. in working expenses is entirely represented by increase in wages. All being well, in a few months' time the "G.B." stud system of working the cars will be abandoned. The total amount spent on upkeep since the inauguration of the system has been £2,361 for 12 years, an average of £197 a year, against £90, the company's guarantee. Up to 1914, however, the average expenditure per annum was only £115. When the overhead system is completed the iron stud heads of the "G.B." equipment will be removed, and the holes filled.

In presenting the Walsall tramways accounts for the year ended March 31, Ald. Cope told the Corporation last week that the income from passenger traffic was the highest on record. Traffic revenue was £65,440 and total revenue £66,924 (or 19·46d. per mile), an increase over the previous year of £13,235. Working expenses were £45,921 (13·69d. per mile), an increase of £14,159. Gross profit was £21,003, and net profit £8,450 (against £11,496). Including the motor omnibuses and £6,620 brought forward, the amount available was £18,403, out of which £5,000 had been voted to relief of rates, and after payment of £1,151 for road charges £10,070 was placed to tramways reserve and renewal fund. The number of passengers carried (12,539,526) increased by over 2,000,000. The Tramways Committee proposes to build up a special depreciation fund. The Council must not expect any further contribution towards the rates for many years to come. The Committee had been compelled to decide on raising fares. The figures for the first quarter of the present year showed that the undertaking was making no profit, and it had been decided to raise all fares by ½d.

Imperial and Foreign Notes.

Mossel Bay (Cape Province) Municipal Council proposes to establish electricity supply works at an estimated cost of £30,000.

Extensions of the municipal electricity works at Worcester (Cape Province) are to be carried out at a cost of £10,000.

According to the "South African Mining & Engineering Journal," builders have started putting tubing in the walls of new houses, and it is expected that in a short time business generally in electrical goods will become brisk in South Africa.

Messrs. Baldwins, Ltd., of Swansea, recently acquired the plant of the Imperial Munitions Board in Toronto, including several electric furnaces. The whole of the plant is driven electrically, power being obtained from Niagara.

A "Times" correspondent states manufacturers of telephone and telegraph material will find a ready outlet for their goods in Madagascar. There are more than 1,200 miles of a telephone and telegraph system already in existence, and, as this is being extended from year to year, the possibilities of securing contracts for supplies of material on the part of our manufacturers are promising.

Miscellaneous.

Mr. W. A. J. Osborne, 119, Finsbury-pavement, London, E.C., has been appointed sole liquidator of the Globe Electric Company, Ltd., in place of the late Mr. G. E. Corfield.

The Committee stage of the Ways & Communications Bill has been passed by the House of Lords, and among the various amendments made was one altering the title of the new Minister to that of Minister o Transport.

In reply to a question in the House of Commons, Sir Auckland Geddes states that he is considering the question of introducing legislation of an interim character providing for the Control of Water-power Developments.

We have received a copy of "Cork: Its Trade and Commerce," issued by the Cork Chamber of Commerce and Shipping. The book contains some excellent illustrations, particulars of the commercial and industrial facilities offered by the city and surrounding districts, and a useful classified trade index in English, French and Spanish.

The sum of £170,000 was recently voted by the House of Commons to enable the Postmaster to complete the work already begun upon wireless telegraph stations in Oxfordshire and Egypt. This service is intended to be the first link in an Imperial wireless chain. It is hoped that a commercial wireless service will be in operation between those two points early next year.

As we go to press the Industrial Outlook is far from satisfactory, and the strike fever shows no signs of abating. Liverpool tramway men are out on a question of wages arising out of the 48 hours' week. The men of the City & South London Railway are on strike "in sympathy with the police." Owing to coal shortage due to the Yorkshire miners' strike, the supply of electricity for industrial purposes at Leeds has been suspended, but it will be resumed on the morning of Aug. 11. A few of the men in the electrical services of the L. & S.W. Rly. Co. are also out, but threatened strikes of the Salford and Blackpool tramway employees have, however, been averted.

On Saturday last Ashton Park, Preston, containing over 100 acres, was dedicated by the English Electric Company in memory of 160 employees at Messrs. Dick, Kerr & Company's works who fell in the war. Sir Charles Ellis mentioned that during the war the firm had produced 3,300,000 projectiles, utilising 94,000 tons of steel, 1,900 tons of copper and 15,000 tons of lead. Some 100 petrol electric locomotives were made for use in France, and 64 seaplanes. A considerable sum had been raised for war charities, including £1,486 by the Dick, Kerr Ladies' F.C., and £1,300 by the Minstrel Troupe.

It is interesting to learn that the new Government cable between Penzance and Halifax, Nova Scotia, was originally the German submarine telegraph between Emden and Coney Island, New York, *via* the Azores. It was "diverted" in July, 1917, and re-laid by the British authorities between Penzance and Halifax. It was used in the later stages of the war for all Government traffic between England and Canada, and also for that with Australia and New Zealand, *via* the line leased from the Canadian Pacific Railway. The cable is said to be a very good one and in excellent working order.

Admiral Sir Gordon Wilson Moore, who distributed the certificates at the Crystal Palace School of Practical Engineering on the 4th inst., reminded the pupils that they stood upon the threshold of a new world, organised, or about to be organised, upon a totally different footing, scientifically and commercially. In that organisation the engineering profession must thrust itself supreme, carrying with its science the vital spark to energise the great commercial world. The hope of every civilised country was in increased production. Herein lay the engineer's chance, for every little improvement helped labour in production, whether labour was willing or not.

The Court of Arbitration has decided against the Claim of the Electrical Trades Union that the advances given under Mr. Justice Sankey's report of March 20, 1919, should be extended to members of the union employed in the electrical fitting shop of the Clay Cross Company. The men involved are surface workers in the company's electrical fitting shop, and are only required to work in the mines under exceptional circumstances. They are in receipt of the advances granted under the engineering trade awards—viz., a war wage of 28s. 6d. a week, plus 12½ per cent., and the electricians who work permanently underground are paid in accordance with the colliery sliding scales.

The Committee appointed to investigate Mr. A. W. Gattie's Goods Clearing House Scheme and the practicability of the introduction of any of the suggested improvements into the existing transport system will sit and take evidence in public. The members are Sir James Fortescue-Flannery (chairman), Mr. A. W. Burgess, Mr. F. T. Hopkinson and Sir Philip Nash. The Committee will sit each week until the conclusion of the inquiry on Tuesdays and Wednesdays, beginning on Aug. 20. The meetings of the Committee are to be held at the Hotel Windsor, Victoria-street, S.W., and communications should be sent to the secretary, Mr. S. T Burgoyne, Forecourt Bungalow, Montagu House, Whitehall, S.W.1.

Tenders Invited and Accepted.

Athy Urban Council invites tenders by Aug. 18 for public electric lighting for three years. About 50 lamps will be required, and permission will be given for the use of overhead wires and poles.

Tenders are invited by the Victorian Railway Commissioners for the supply of an electric capstan for the Newport (Victoria) power house Tenders to the Secretary for Railways, Melbourne, by 11 a.m. Aug. 27.

Bradford Corporation invite tenders for the supply and erection of three water-tube boilers, superheaters, stokers, &c., and natural draught chimney-type cooling tower. Specifications, &c., from the city electrical engineer (Mr. Thos. Roles), and tenders to the Town Clerk (Mr. Frederick Stevens) by Aug. 15.

Torquay Council has placed an order for two transformers with the British Electric Transformer Company, at £219.

Sunderland Tramways Committee have accepted the tender of the English Electric Company for the delivery of six covered double-deck car bodies, with delivery at the beginning of next year.

For the electrical work at the new Sessions House the London County Council received nine tenders, varying from £4,990 to £8,325, and that of Alpha Mfg. Company (at £5,085 17s.) is recommended for acceptance.

Taunton Council has placed orders with the British Electric Transformer Company for a 75 kw. transformer, and with the Pirelli-Genera Electric Company for a year's cable.

Peterborough Council has accepted the tender of Gwynnes, Ltd., for a 9-in. centrifugal pump and 40-h.p. motor at £295. There were four other tenders, varying from £322 12s. to £355.

Chester Corporation has accepted the following tenders: Siemens Bros. Dynamo Works, converting plant and h.t. switchgear, £2,918; Brook, Hirst & Company, d.c. starting panel, £199 10s.; Callenders Cable & Construction Company, overhead transmission line and underground cable, £2,456.

Appointments Vacant and Filled.

A demonstrator of Physics is required for the University of Liverpool. Salary £200. Applications to the Registrar by Sept. 1.

A senior lecturer in Physics is required at the Portsmouth Municipal College. Salary £250; £10–£300, then by £25 each four years to £400.

A lecturer in Physics is required at King's College, Strand, London, W.C.2. Salary £250. Applications to the Secretary by Aug. 13.

An assistant lecturer in electrical engineering is required at Leeds University. Salary £300. Particulars from the Secretary and applications by Aug. 11.

Lecturers in mechanical and electrical engineering are required at the Loughborough Technical College. Salary £300; £25–£350. Applications to the Principal by Aug. 27.

The Governing Body of Battersea Polytechnic invite applications for the position of principal. Salary £1,250 per annum. Particulars from the Clerk, Battersea Polytechnic, S.W.11.

The Council of Armstrong College, Newcastle-on-Tyne, invites applications for the post of professor of experimental physics. Salary £600, rising by biennial increments of £50 to £800 per annum. Applications to the Secretary by Aug. 30.

Four assistant lecturers and demonstrators are required in the departments of engineering, electrical engineering and engineering design and drawing of the University of Liverpool. Salaries £250, £300, £250 and £250 respectively. Applications to the Registrar by Aug. 15.

A demonstrator in physics is required at the Municipal Technical Institute, West Ham. Salary £150, rising by annual increments of £10 to £180 per annum. Applications to the Principal, Romford-road, Stratford, E. 15, by August 24.

Mr. E. Moxon, assistant electrical engineer at Blackburn, has been appointed electrical engineer of South Shields.

On Tuesday Torquay Council appointed Mr. H F. G. Woods (resident engineer at the Yorkshire Electric Power Company's Barnsley station) as borough electrical engineer, at a commencing salary of £500. There were 105 applicants for the position.

Business Items.

The works and offices of Messrs. Allen West & Company, Ltd., of Brighton, are closed from Aug. 2 until Aug. 11 for the annual summer holidays.

Messrs. A. Verey & Company, wholesale suppliers of electrical and allied manufactures, have taken London offices at 52a, Bow-lane, Queen Victoria-street, E.C.4, at which address they will be pleased to receive manufacturers' catalogues.

The General Electric Company, Ltd., has issued an interesting booklet, 10 pages of which are devoted to an extract of the terms of the Peace Treaty and two to a useful summary of important events having a bearing on the great war. The inside and outside back cover are devoted to the G.E.C. Osram lamps and their economy and efficiency.

The Millns Electrical Company, 17, Whitefriars-street, E.C.4, have been appointed sole London agents for the Arora Company, of Loughborough, manufacturers of "Arora" electric fires, boiling plates, grills, ovens, &c., and arrangements are being made for large stocks of these goods to be carried in London.

Messrs. Drake & Gorham, Ltd., have disposed of their wholesale trade department to a separate company. In view of the goodwill attaching to the name, permission has been granted to the new company to continue its use, and it has therefore been registered as Drake & Gorham Wholesale, Ltd., with registered offices at 67, Long Acre, London, W.C.2.

Companies' Reports, &c.

The Bristol Tramways & Carriage Company has declared an interim dividend at rate of 3 per cent. (tax free) on the ordinary shares.

A quarterly dividend of 1s. 3d. per share (5 per cent. per annum) has been declared by the City of Buenos Ayres Tramways Company (1914), Ltd.

The directors of the Oldham, Ashton & Hyde Electric Tramway, Ltd., have declared an interim dividend at the rate of 5 per cent. per annum (6d. per share) on the ordinary shares for the past half-year.

The Montreal Light, Heat & Power Consolidated (operating the Montreal Light, Heat & Power Company) have declared a quarterly dividend at 2 per cent. on the paid-up capital stock.

The Westminster Electric Supply Corporation, Ltd., has declared an interim dividend at the rate of 7 per cent. per annum (less tax) for the half-year ended June 30.

The following Joint Stock Companies have been struck off the register: Electrical Indnstries Development Company, Electric Hiring Syndicate and Electro Chlorination Syndicate.

Notice is given that at the end of three months from July 22 the Birmingham Electrical Accessories Mfg. Company, Electric Saw Mills and Joinery Works, and the New Era Signs (U.S.A.), 1916, Ltd., will be Struck off the Register.

The directors of the Pernambuco Tramways & Power Company announce a dividend of 3½ per cent., less tax, on the preference shares for the past half-year. A sum of £10,000 has been placed to renewal and general reserve, £1,500 to amortisation account, £10,230 to capital reserve, £605 for exchange and £13,489 forward.

At the statutory meeting of the Chemical and Metallurgical Corporation, Ltd., on the 31st ult. it was announced that the Corporation had acquired for £25,000 in cash and £1,000,000 in ordinary shares the world's rights of Mr. Elmore's invention for the separation of the lead and zinc contents of zinc, lead ore and concentrates.

The net profit of the Trafford Power & Light Supply, Ltd., for the year ended March 31, after meeting interest charges, &c., and appropriating £7,500 for depreciation, was £4,995, and £14,074 was brought forward. A dividend of 5 per cent. is proposed, carrying forward £16,237, subject to excess profits duty.

The accounts of the Wemyss & District Tramways Company for 1918 show a profit of £7,530, and an available sum (including £828 brought forward) of £8,358. A further dividend of 6 per cent. has been paid on the ordinary shares, making 10 per cent. for the year, giving the 6 per cent. preference shares an extra distribution of 1½ per cent. A sum of £3,000 has been placed to reserve and £1,046 carried forward.

The report of the directors of the Compania Argentina de Electricidad, S.A., for 1918, states that, notwithstanding restrictions, the company was obliged to expend important amounts on extensions for public service, in addition to replacing incandescent public lamps by arc lamps in various districts, &c., an increased number of consumers were connected. Gross profit was lower than in the preceding year, due to the higher cost of production, and the year closed with a loss of $79,865. Added to the loss in 1917, the total loss at Dec. 31 last was $114,657.

The gross receipts of the tramways department of the Argentine Tramways & Power Company for the year ended Sept. 30, 1918, were $m/n410,009 (an increase of $m/n54,658) and of the light and power department $m/n180,006 (an increase of $m/n55,008). The net revenue was £17,699, compared with £13,959. Adding interest, profit on exchange and transfer fees, the total is £19,433. After charging interest and sinking tund on the debenture stock and London expenses, and adding £4,000 to reserve for renewals, there remains £2,620 to be carried forward.

The gross earnings of the Havana Electric Railway, Light & Power Company for 1918 were $8,176,544, against $6,989,599; operating expenses and taxes $4,376,655, against $3,385,469, net income being $3,799,889, against $3,604,129. With miscellaneous income ($140,894) the total available was $3,940,784, against $3,753,884. First charges absorbed $989,138, against $1,138,623, leaving a net profitof $2,951,645, against $2,615,260. The increase in gross earnings in the electric light and power department created a record, but the operating expenses were greater than even last year.

The report of the Compania Industrial de Electricidad (Argentina) for 1918 states that the Compania Americana de Luz y Traccion recently acquired the concessions and installations for the production of electric current and operating electric tramways in Asuncion, Paraguay. As the Campania Industrial holds shares in that company, the board considers it opportune to allow the shareholders to participate in that business, and proposes that the dividend for 1918 be paid in shares of the Luz y Traccion Company at their face value. The year's profit (including $2,289 brought in) was $91,498 gold, and after providing for amortisation and reserve funds, &c., a dividend of 5 per cent. was paid.

The report of the directors of the Yorkshire Electric Power Company for the half-year ended June 30, 1919, states that the period has been one of great difficulty to all industries, including those dependent on the company for a supply of electricity. The sudden cessation of munition work caused an immediate reduction of output, and the difficulties of resuming normal peace time activities have been increased by the uncertainty as to taxation and Government policy. The revenue for the half-year has, however, been greater than that for the corresponding period in 1918, and contracts have been made which will substantially increase the output in the near future. The cost of coal, labour and material has continued to increase, the net profit for the half-year being £19,229, compared with £23,683 for the same period in 1918 and £17,617 in 1917. The dividend for the half-year on the 6 per cent. cumulative preference capital has been paid. Many demands are being made upon the company for supplies of current, and further capital must be issued to meet the cost of the necessary extensions.

The profit of the Cordoba Light, Power & Traction Company for the 18 months to March 31 was £20,160, plus £8,629 brought forward. The issue of £500,000 6 per cent. promissory notes matured on Dec. 1, 1918, and the company exercised its option to renew for two years. In respect of the greater part of the notes, the rate or interest was increased to 6 per cent., tax free, by arrangement with the holders, in consideration of their agreeing to waive the premium on renewal. In view of the uncertainties of the situation, the directors are unable to recommend the payment of the dividend on the preference shares.

The report of the Kidderminster & District Electric Lighting & Traction Company states that during 1918 the amount expended on capital account was £1,475, leaving the capital expenditure for electric supply £60,128. In accordance with the resolution passed at an extraordinary general meeting in June last, the agreement anthorised to be entered into with the Shropshire, Worcestershire & Staffordshire Electric Power Company for the sale to them of the company's interests in the power station at Kidderminster has been executed, and the purchase price payable to the company (£32,911) has been received and will be applied towards the discharge of the company's liabilities. In addition, the Shropshire Company have also paid £11,658 to the Kidderminster & Stourport Electric Tramway Company for their interests in the power station and freehold land in Kidderminster. An agreement has been made with the power company to manage the company's undertaking and to pay all revenue charges, including the dividend on the preference shares as from Jan. 1, 1918, and a dividend of 2½ per cent. per annum on the ordinary shares of the company as from Jan. 1, 1920, and thereafter so long as the company remain the owners of the electric supply undertaking. The net revenue, including dividends and payment by Shropshire company, amounted to £6,016. After deducting administration and general expenses (£1,935), interest on loans (£1,196) and on debenture stock (£1,238), the balance has been appropriated in paying the preference dividend and £193 carried forward.

Sir George Touche, who presided over the adjourned 10th and 11th annual general meetings of the Cordoba Light, Power & Traction Company, Ltd., on the 30th ult., said the gross receipts of the combined businesses for the past year were £170,138, being higher than the receipts of any previous year in the company's history, but that record had been exceeded in the returns for the 12 months to May 31, 1919, when the combined gross receipts totalled £173,824. In both cases the results would have been better but for a strike of tramway employees in September and October, 1918. The expenses for the year to March 31, 1919, were £82,426, representing a decrease compared with those of 1918 of £17,316. The combined net receipts were £87,712, an increase of £25,402 over 1918. The improvement in the results for the last six months was at the rate of £38,000 per annum over those of the year to Sept. 30, 1917. In view of the uncertainties of the situation, the directors regretted that they were unable to recommend the payment of a dividend on the preference shares. While the company's own business showed undoubted indications of growth, the political and labour outlook was far from settled. The war had produced a spirit of unrest, the consequences of which could not be foreseen. The money markets in Europe were watching events in Argentina, and confidence had received a check owing to the revolutionary character of the strikes

In the report of the directors of the Direct United States Cable Company, Ltd., for the year ended March 31 last, it is stated that the preparation of the accounts has been deferred until the cost to the company of the unsuccessful expedition of the c.s. "Faraday" to repair the main cable in 1918 had been ascertained. In consequence of the repair of the main cable not having been completed by Sept. 22, 1918, the Western Union Telegraph Company applied the penal clause of the lease, and only paid half the rental for the six months to March 22, 1919. Since the latter date no rent has been received from the Western Union Company, which has served a notice purporting to determine the lease as from March 22, 1919. It was not possible for the main cable to be repaired during 1917 owing to the fact that there was no vessel available and that during the war the Admiralty took control of all cable ships and their allocation for repairs of cables. Notwithstanding representations made by the directors that they had first claim upon the services of the c.s. "Faraday," in the spring of 1918 the Admiralty acceded to the request of the Western Union Company that the "Faraday" should effect the repair of one of the cables operated by that company before proceeding upon the work of repairing the main cable of the Direct Company, and as a result it was not possible to effect the restoration of the latter during 1918. The directors have applied to the High Court under the Courts Emergency Powers Act for relief from the application of the penal clause of the lease. In consequence of the action of the Western Union Company in stopping payment of the rent, the directors were unable to pay the final dividend for the quarter ended March, 1919. In addition to paying a fixed rent for the cable, the lease provides that the Western Union Company should make a contribution towards Directors' fees and pay the administration expenses of the company. Up to March 31, 1919, the Western Union Telegraph Company had withheld £469 in respect of their contribution towards the directors' fees and £886 in respect of administration expenses. These items form part of the company's claim against the Western Union Company. The cost of maintaining the cables during the year amounted to £89.171. 9s. 10d. Of this sum £77,028. 2s. represents expenditure in which the company was involved in the abortive effort to repair the main cable in 1918. The directors are glad to be able to announce that the main cable was successfully repaired on the 28th ultimo, and is now being operated by the Western Union Company.

The B.T.H. Meeting.

It was reported at the meeting of the British Thomson-Houston Company, Ltd., last week that the profit for 1918, after deducting all expenses and charges other than interest on debentures and loans, and after making provision for estimated war taxation, was £317.016 (against £329.664 in 1917). The amount brought forward was £53,744 and with added adjustment of munitions levy and excess profits duty to end of 1916 (£11,841) made a total of £382,600 available for distribution. Interest on debentures and loans absorbed £107,946, and out of the balance of £247,654 the directors recommend that there be appropriated for depreciations and reserve £123.791 10s. 10d., and to carry forward £150,863. The capital reserve account has been increased from £237,959 to £245,555. The value of the shares and debentures of lighting, traction and other companies has been decreased from £90,000 to £60,000. The directors are considering the question of new capital required by the constant growth of the company's business and proposals dealing will be presented to the shareholders in due course. Of the 1.761 employees who joined H.M. Forces 241 were killed, 252 were wounded, 189 received commissions, 85 were awarded special honours, 27 were mentioned in despatches, and 12 were specially commended for services in the field. The company made liberal grants to dependents of the employees so serving.

After giving particulars of the members of the staff and employees who joined H.M. Forces, the chairman (Mr. H. C. Levis) gave an analysis of the accounts and an interesting account of the extensive war work of the company. Practically all the output of their factories was either directly for the Government or was done under the authority of Government certificates. The bulk of the output was composed of their regular products applied to war uses, but there were many things that were specially developed. Several of the latter will, however, continue to be manufactured as part of the regular product of the company. At Rugby they made transformers, double current generators, motor alternators and other appliances for wireless work; electric dynamometers for loading and testing aeroplane engines; motors with timing gear for enabling Lewis guns to be fired between aero propeller blades. Motors were supplied for all sorts of special purposes, such as for trench pumps, aeroplane speedometer testing, mobile repair workshops, operating gun lathes, &c. Then there were generating sets for searchlights, turbo fans for the Admiralty, high, intermediate and low-pressure turbines for naval patrol boats, and turbines for destroyers and other ships. Munitions were manufactured on a considerable scale. Their works management had a great deal to do with the initiation and successful starting of the co-operative scheme of shell making among the Leicester and District engineers, who were probably the first body in this country to produce shells, &c., outside the regular ordnance firms. He also believed that their company was the first private concern—outside of armament firms—to produce shells after the outbreak of the war. At their lamp works, in addition to all kinds of lamps for Government factories, for the Admiralty, Ministry of Munitions, &c., they manufactured a large quantity of appliances for wireless telegraphy, daylight signal lamps, &c. One of the most important things accomplished in the lamp works was the development of the manufacture of half-watt type for gas-filled lamps. Those were being produced in large and increasing quantities. In the illuminating engineering department a large number of special things were developed, such as gas and watertight fittings for shell-filling factories, and special reflectors and lighting devices for munition works.

One of the most important developments was the manufacture of magnetos at their Coventry works. Thousands of magnetos were supplied for aeroplanes, the whole of the works being devoted to that purpose. Marked success was achieved, and there were no more reliable or efficient magnetos manufactured than those made by them. Their magnetos were on the aeroplane which recently achieved the altitude record; they were on the aeroplanes which won first and second places in the recent Aerial Derby; and they were on airship R.34, which made the successful flight to America and back. They were able on many occasions to give technical assistance to the Government, as their engineering staff was always ready to help whenever the necessity arose. The company was completing the largest turbo-generator ever built in this country (30,000 kw.), and two of the largest electric equipments for steel-rolling mills every built anywhere. Their orders for the first half of 1919 were larger than for any similar period in the history of the company. He hesitated to say anything about the general situation; but, looking to the past history of the country, he could not help feeling that the present unrest was a passing phase, which would be settled by readjustments along reasonable lines. One thing must be fully recognised, and that was that this country must produce a larger output at reasonable cost, or we should not be able to sell in foreign markets, which would in turn further depress the foreign exchange and ultimately land us in disaster. Judging from inquiries received since the armistice was signed, there was a large amount of business in sight, but the placing of orders largely depended on whether the general conditions throughout the country became stable in the near future. If that was accomplished, and prices were reasonable, orders would come in an increasing volume. It could not be too often repeated that the greatest possible effort must be put forth if we are to hold our own in the markets of the world.

The report and accounts were then adopted.

New Companies.

ALLIED MACHINERY COMPANY, LTD. (157,513.)—Private company. Reg. July 30, capital £50,000 in £1 shares. Objects: To carry on the business of manufacturers of and dealers in machine tools, machinery, accessories, &c. Reg. office: 18, Birchin-lane, E.C.

BROMILOW & EDWARDS, LTD. (157,366.)—Private company; reg. July 23, capital £20,000 in £1 shares. To carry on the business of haulage contractors, motor and electrical engineers, &c. First directors are J. R. Bromilow (managing), W. Edwards, E. Edwards, Maurice Edwards and Miles Edwards. Reg. office, The Grange, Bark-street, Bolton.

HERRTAGE, LESTER & COMPANY, LTD. (157,233.)—Private company; reg. July 21, capital £2,000 in £1 shares. Objects: To carry on the business of electricians, electrical engineers and manufacturers, suppliers of electricity, manufacturers of and dealers in railway, tramway, electric and other apparatus, &c. First directors are G. W. Lester (managing director), E. J. Walker and C. W. Edwards. Reg. offices, 10, Bush-lane, E.C.

W. S. JEAL & EBURY ENGINEERING COMPANY, LTD. (157,202.)—Private company; reg. July 18, capital £20,000 in £1 shares. To acquire the business of manufacturers of and dealers in electrical accumulators and motor car equipment carried on by W. S. Jeal & Co., and to enter into certain agreements, &c. First directors are W. S. Jeal, G. Usmar, H. Jones and H. Ramoisy (Belgian).

MACQUAIRE. LTD. (157,338.)—Private company; reg. July 24, capital £10,000 in £1 shares. To acquire certain inventions relating to sparking plugs, to carry on the business of manufacturers of and dealers in sparking plugs, magnetos, ignition appliances, motors, &c.

L. ROBSON, LTD. (157,055).—Private company. Reg. July 15. Capital £2,000 in £1 shares. To enter into an agreement with Lancelot Robson, and to carry on business as electricians, plumbers, sanitary engineers, &c. L. Robson is the first director. Reg. office: 2a, Ward-street, West Hartlepool.

SERVICE ELECTRICAL COMPANY (LLANELLY), LTD. (157,248.)—Private company; reg. July 21, capital £5,000 in £1 shares. To carry on the business of manufacturers of and dealers in electric generators, motors, transformers, switchgear, electric light and other electrical apparatus, conduits, &c. Directors, L. Satchwell (managing director), D. H. John and J. Jones. Reg. office, New Dock, Llanelly.

Prices of Metals, Chemicals, &c.

Tuesday, Aug. 5.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£111 0 0	—	£1 0 0
Electro wire bars ...	,,	£125 0 0	—	—
H.C. wire, basis ...	per lb.	1s. 4⅜d.	0 13/16d.	—
Sheet	,,	1s. 3⅜d.	0⅜d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	per lb.	1s. 7⅜d.	0 13/16d.	—
Brass 60/40—				
Rod, basis	per lb.	0s. 11⅛d.	0¼d.	—
Sheet, basis	,,	1s. 2¾d.	0½d.	—
Wire, basis	,,	1s. 2½d.	0½d.	—
Pig Iron—				
Cleveland warrants	per ton	£164 0 0	—	—
Galvanised steel wire, basis	,,	32 10 0	—	£3 0 0
Lead Pig—				
English	,,	26 5 0	1 5 0	—
Foreign or colonial	,,	25 15 0	1 15 0	—
Tin—Ingot	,,	277 0 0	8 10 0	—
Wire, basis	per lb.	3s. 4d.	1½d.	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £21.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d. to £8.

Copper Sulphate.—Per ton £45.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 7d.

Shellac.—430s. October delivery at 435s. to 436s.

Rubber.—Para fine, 2s. 6d.; plantation grades, 1s. 11d. to 1s. 11½d. lb.

Thirty-Seven Years Ago.

[From The Electrician, Aug. 5, 1882.]

Electric Light in London.—The Metropolitan (Brush) Electric Light & Power Company, Ltd., have secured contracts to light up the Royal Mint, the premises of Messrs. Halling, Pearce & Stone and the Floral Hall, Covent Garden.

A New Secondary Battery.—We understand that an effort will be made to exhibit a FitzGerald-Crompton accumulator at the forthcoming meeting of the mechanical engineers at Leeds. This accumulator is said to be theoretically better than any yet before the public.

Electric Lights for the Navy.—H.M.S. "Thalia," which was recently fitted out at Portsmouth, has been fitted with a dynamo and two electric searchlights. She is to proceed to Egypt for service in the Suez Canal. The lights are worked from her fore bridge, and the machinery is fixed on the after part of the troop deck, abaft the funnel casing.

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Notes.

The Function of Technical Schools and Universities.

AT the present moment, when scientific and technical education is being much discussed, and plans for their extension are in preparation, it is worth while to consider seriously what the functions of the various institutions, colleges and universities should be, and especially how their activities should dovetail into one another. We perceive a tendency for institutions that are essentially technical schools or colleges, to assume almost the functions of a university; and simultaneously we find the older universities, in their zeal for applied science, taking up work that might, perhaps, be more fitly left to technical colleges. There is also a certain inclination towards amalgamation for mere "bigness," which we are not sure is always desirable in an educational institution. These remarks are suggested by the fact that in Germany the functions of technical schools are now being much discussed. There the so-called "technical school" has, perhaps, reached its greatest development, Charlottenburg being, of course, famous for its size and equipment. We see that Prof. RIEDLER, late professor of engineering at this institution, is dissatisfied with the present methods, and even goes so far as to indicate that a decay set in with the present century, that too much stress is laid on pure technique and encyclopædic knowledge and too little importance attached to general scientific methods and principles. We are inclined to think that this somewhat arid and soulless form of work had become characteristic of many German technical schools before the war. It is, perhaps, a natural consequence of the commercialisation of science in a narrow sense, and the modern tendency to "judge by results." We hope that the momentary stress laid on the material results of applied science, necessary as it may be to arouse the interest of the business man, will not go too far in this country. The pure spirit of scientific research, and the uncramped imaginative effort that gives, in the long run, the greatest benefit to humanity does not thrive in a commercial atmosphere. We hope that this greatest work will be pursued at our leading universities, and that they will not be compelled to adjust their methods to the "payment by results" tendency. Even at those institutions which are admittedly mainly technical, and even industrial, there should be room for the humanising element in education, and not too much emphasis should be placed on the purely material side of science.

Industrial Consumers' Sub-stations.

BY the above term is meant a sub-station located directly at or in close proximity to the consumer served, and we gather from the "Electrical Review" (U.S.A.) that this type of substation is becoming very usual in the United States. Some of these stations are picked up from transmission lines that are, in fact, also distributing lines. They may be supplied from two or more directions, and constitute part of ring or radial systems of distribution. They are essentially automatic, and so interlocked and safeguarded as to be more reliable than many private supplies, frequently operating without an attendant, or controllable from a distance. Such sub-stations are readily applicable to such consumers as steel mills, &c. So far, experience has been favourable, but the question of providing for heat-dissipation is one that demands careful study, and fuller data on such points as the ratio of transformer heat losses to cubic space for various temperature rises and materials of surfaces, and the design of transformer faults for various capacities and load-factors are needed. In view of the prospective further development of linking-up methods in this country the use of such consumers' sub-stations deserves attention.

Rural Transmission Lines.

THE war has accentuated the interest being taken in the supply of electricity to rural areas, and several Papers have been read on the subject in this country of late. In the United States, where the distribution of electricity in agricultural districts has made considerably greater progress than in this country, notwithstanding the much greater area to be covered and the relatively scattered demand, there has recently been much discussion on the subject, notably in connection with farm-lighting outfits, for which there has been a big demand for some years. In many cases the practice has been to favour individual lighting plants, but the view is gaining ground that such methods are not in the long run economical. As electrical undertakings develop, the tendency is for such outfits to be ultimately scrapped in favour of distributed supply. This involves an economic loss to the farmer, especially as such plant becomes somewhat unsaleable when a public supply is available. Now that the agricultural applications of electricity are becoming more familiar, there are much better prospects of securing a reasonably good load factor by collective bargaining with farmers, for an enterprising undertaking is often well advised to take courage, and lay down lines for a prospective growing demand. The experience in the States should convey a lesson to this country, which has admittedly been backward in rural electrical development. When the national electricity scheme develops there should be good opportunities in rural districts for concerns which are strong enough to look to the future and face only a small immediate return. It is certainly a matter which, in the interests of British agriculture, should be taken in hand as soon as possible.

Canadian Electrical Association.—At the recent annual Convention, Mr. A. Monro Grier, K.C., President of the Canadian Niagara Falls Power Company, was re-elected president of this Association, with Messrs. E. A. Dunlop, P. T. Davies and A. P. Doddridge as vice-presidents.

Canadian Engineering Standards Association.—This Association, which was formed early in the year, has now been incorporated by Dominion Charter. A sub-committee, with Mr. A. A. Dion as chairman, has been appointed to deal with electrical matters, and another sub-committee for the standardisation of incandescent lamps. Other sub-committees will be appointed from time to time.

Engineering Golfing Society.—The final round of the Match Play Tournament was decided on Aug. 5, when Mr. B. J. Hall defeated Mr. F. A. Nixon by 6 up and 4 to play in a 36-hole match on the Old Ford Manor links. The entries were not quite so numerous as before the war, but Mr. Hall has had to play six matches and in the fourth round only succeeded in securing victory over Mr. W. E. Lane at the 26th hole.

James Watt Centenary.—It is announced that the James Watt Centenary celebrations will take place in Birmingham on September 16, 17 and 18. It is proposed to collect funds to endow a professorship of engineering (to be known as the James Watt Chair) at the University of Birmingham for the promotion of research in "the fundamental principles underlying the production of power and the study of the conservation of the natural sources of energy"; to erect a James Watt memorial building and to publish a memorial volume.

Presentation of Franklin Medal to Sir James Dewar and Major-General George O. Squier.—On May 21st the President of the Franklin Institute announced that the Franklin Medals for the current year would be presented to Sir James Dewar and Major-General G. O. Squier. Dr. H. F. Keller gave a brief address eulogising Sir James Dewar's contributions to the fields of chemistry and physics, and Major-General McLachlan, a representative of the British Government, accepted the medal on Sir James's behalf. The medal presented to Major G. O. Squier was accepted, in his absence, by Dr. F. P. Keppel, Assistant Secretary of War. Subsequently, a short Paper, by Major-General Squier, on "Some Aspects of the U.S. Signal Service in the World War," was read by Col. M. McK. Saltzman.

Spontaneous Combustion.—In a Paper on the above subject read before the Royal Society of Arts, Prof. Watson Smith remarked that spontaneous combustion was most frequent in the case of stored coal; in fact, an elaborate inquiry conducted by the German Government, some years ago, declared that more ships were lost through such outbreaks on board than from any other cause. The presence of sulphur, iron and combustible gases adds to the liability to spontaneous combustion, and the Cardiff mines, yielding coal comparatively free from pyrites, have a good reputation in this respect. Prof. Watson Smith quoted many cases to show that outbreaks of fire due to spontaneous combustion were still more frequent than was generally credited and suggested a number of precautions that might properly be insisted upon by insurance companies.

Re-opening the Mines at Lens.—According to the "Revue Générale de l'Electricité," the fears that have been expressed regarding the length of time before the pits at Lens and its vicinity can be restarted are, unfortunately, proving well founded. It is stated that the pits at Lens are not only flooded to the ground level, but the water is pouring out, threatening to inundate the country side. The pumps required for the work, which are to be electrically driven by power from the generating station at Harnes, have been on order for some time. Under the best conditions it will take 18 months before the mines are freed from water, and the working of the higher seams of coal may commence towards the end of 1920. It is probable, however, that the complete restarting of the mines at Lens and Lieven will take about 10 years.

Gunpowder in Machine Shops.—The "Journal" of the Franklin Institute describes an ingenious device that has been in use in the machine shops of the Delaware and Hudson Railroad Company. Ordinary black sporting gunpowder is used to save time in blowing nuts and bolts, breaking up iron and steel to be scrapped, forcing locomotive pistons when bound by rust or corrosion, and breaking metal that has become cold in a furnace. The charge of powder is located in steel guns, varying in size from 5 in. to 12 in. overall length, and held by a steel plunger which is forced out when the powder is exploded. The apparatus may, however, assume various shapes according to the nature of the work. The gun is jacked up with the mouth about 1 in. distant from the object to be struck by the plunger. It is claimed that by this means much time and labour can be saved and it is often possible to direct a quick blow at an object which would be difficult to reach otherwise.

Central Station Heating.—A Technical Paper (No. 191), issued by the Bureau of Mines, U.S.A., contains an interesting résumé of the possibilities of central station heating by exhaust steam. It is remarked that many persons now in middle life can remember when the only central station services were gas and water. Subsequently electric light was added, but only in isolated cases has a combination service, giving both current and heat, been adopted. The first central station heating plant was put into service at Lockport, N.Y., in the late seventies. Not much information is available about the performance of plants, but it is noted that early companies charged a rate obviously too low at the existing price of coal. At present, rates show a very wide variation. From schedules of 28 cities of 25,000 to 40,000 inhabitants, the highest minimum is 1½ dollars (6s.) per 1,000 lb. of steam, and the lowest for maximum consumption 0·3 dollars (1s. 3d.). The average minimum and maximum rates are given as about 76·4 and 45·33 cents. respectively. It is to be noted that economy in the use of steam by consumers is just as important as economy in the use of electricity, and the method of charging needs careful study. It has been suggested that the water powers of Wisconsin might afford a source of electric heat able to replace coal to some extent. But it is considered that even in this case the cost would be prohibitive. In view of a prospective coal shortage in this country for some years to come the possibility of devising efficient and economical central steam-heating plants as a supplement to electrical supply, seems worth attention.

Regulation of Induction Motors.—In the "Elektrotechnische Zeitschrift," M. Osnos considers the regulation of induction and commutator motors in cascade by means of direct current. This method has been applied to the commutator motor, working separately, with success; but it is not so simple with motors, coupled in cascade. He first takes the Scherbius cascade. (1) In the first instance, a compensated polyphase series-motor is taken as the commutator motor, the direct-current regulating choking coil is connected to the commutator, current being supplied by a small direct-current generator, directly connected. The conditions for equilibrium of the cascade are considered, and from these are deduced the relations between the slip of the main motor and the self-induction of the choking coil. This plan is unsatisfactory, because large variations of the induction in the choking coil are needed for small differences in the slip. (2) The choking coil is then connected to the commutator motor through special slip rings; here it is found that for equilibrium, the self-induction of the choking coil must be equal to that of the stator of the commutator machine. But the main motor has then no steady speed at no load; it behaves like a series motor. (3) A much better plan is to couple the direct-current generator to the main motor, which then has the characteristics of a shunt motor. The regulation of the main motor then follows the same principles as that of a direct-current shunt motor, coupled to its exciter. The direct-current machine in fact takes to itself the functions of the exciter, and behaves to its main motor in exactly the same way, when its field is changed or resistance is inserted in its circuit. The author also considers the similar case of the Krämer cascade, and finds that exactly the same results are produced under the same conditions.

Water-power in Iceland.—A recent issue of the "Journal of the Royal Society of Arts" contains an account of the available water power in Iceland, and it is a matter for speculation how far this is likely to be developed in the near future. The greatest waterful on the River Dettiloss, owned by a British Company, has a fall of 300 ft., and is estimated to be capable of developing 220,000 H.P. On the glacier-fed Thorsa river, 124 miles long, there are no fewer than six falls, from which 1,114,000 H.P. can be obtained during the seven summer months. Only 697,000 H.P. are available in winter, but the mildness of the climate prevents any difficulty with ice. The estimated cost of harnessing this power, based on 50 per cent. above pre-war prices, is £11 9s. per horse-power unit, and the estimated net cost per horse-power year 10 per cent. of this, or about 22s. at the power station. The power can be transmitted to Reykjavik, with an overall loss of 15 per cent., and the cost of power in the town will, therefore, be about £2 per horse-power year of 8,760 hours. The power available in Reykjavik will be 590,000 H.P. during the five winter months, and 940,000 during the remainder of the year. There is an excellent ice-free harbour and every facility for the establishment of great electrochemical factories, but as the island has only 90,000 inhabitants it will be necessary to import labour. Large deposits of iron ore exist, but the quality of the ore so far analysed has been poor. Sulphur is found in enormous quantities. There are deposits of good lignite near Reykjavik. The voyage from Scotland occupies 48 hours by modern steamers. The distance to Halifax and to Gibraltar is about the same, and the town is, therefore, fairly central between Europe and America, and well suited for international trade.

Chemical Analysis by X-Rays.—A method of chemical analysis by X-rays, developed in the research laboratory of the General Electric Company, U.S.A., is described by Mr. A. W. Hill, in a communication to the "Journal" of the Franklin Institute. The substance to be examined is reduced to powder, placed in a small tube, and subjected to a beam of monochromatic X-rays, the diffraction pattern thus produced being photographed. The X-rays pass through an appropriate filter to give monochromatic, by which all but a single wave-length is absorbed, then through two narrow slits, confining them to a beam about 1 mm. wide, and then through the powdered material, which scatters or reflects a small proportion of them, and thence to the photographic film. An exposure of one to 20 hours may be required according to the amount of information desired. When the film is developed it shows, in addition to the over-exposed line in the centre where the direct beam strikes, a series of other lines on either side of the centre. These lines are caused by reflections from the tiny crystals in the powder, and their distance from the centre line depends upon the distance between the planes of atoms in the crystal. There is one line for every important set of planes in the crystal. Substances of similar chemical nature and crystal structure give similar patterns, but the magnification is different, being inversely proportional to the cube root of the molecular volume. Thus substances with different crystalline structure will give characteristic and different line-patterns. Information is also afforded by the relative brightness of the different lines. Naturally, familiarity with the process is needful in drawing conclusions from diagrams, but it has already been found quite practicable to recognise simple compounds and even to detect the component elements in some mixtures.

British Engineering Standards Association.—The first General Meeting was held on the 11th ult. at the Institution of Civil Engineers, when the Chairman, Sir Archibald Denny, in presenting the report of the work in hand and contemplated, made a brief review of the position. He said the Association now numbered some 360 Committees and Panels, manned by about 1,200 members. The chief work of the Association at present was the revision of the standard sections for structural steel, the standardisation of aircraft components, automobile parts, electrical machinery and apparatus—which section was expanding very materially as the electrical industry made greater demands for standards—railway materials, machine tools, limit gauges, screw threads, shipbuilding materials and the details in the construction of ships and their machinery, &c. The standardisation of details in the construction of ships and their machinery was the latest important problem handed to the Association. The organisation of that section was in a very advanced state. The successful operations of the Association in connection with the work carried out in the standardisation of aircraft materials and parts was familiar to many. The section was being put on to a Peace basis, and the Treasury had agreed to make a substantial grant on the same lines as during the war. With regard to overseas committees, the Association was establishing, in a number of foreign countries and Overseas Dominions, Local Standards Committees of British engineers and traders in order to disseminate British Standards and so assist British manufacturers in developing their foreign trade. In a short report, which has been issued to subscribers and others, it has been pointed out that, from one aspect, the whole overseas scheme of the Association might be looked upon as a means of advertising British engineering products. The Association had translated a number of its more important specifications into Spanish, Portuguese, Italian and French, and distributed them in considerable quantities to the various Local Committees. The Committees had been formed through the assistance of the Foreign Office and the Overseas Department of the Board of Trade. It had been a striking development on the part of the Government, who had subscribed £10,000 for the work, industry generally having subscribed £14,000. The South African Engineering Standards Committee would act as the representative Committee of the Association in the Dominion. The Canadian Committee, recently incorporated, was acting as the Association's representative in Canada, and would take every opportunity of familiarising Canadian engineers with British standards. In Australia an Engineering Standards Committee was on the point of formation, and there was every hope and indication of Australia working in close co-operation with the British Association and using British Standards wherever those were applicable. With regard to international work, Engineering Standards Committees were now being formed, on similar lines to those of the Association, in various foreign countries, the British Engineering Standards Association having been consulted in practically every case. The question of Anglo-American co-operation in particular had been considered in some detail. Prof. Comfort Adams, the Chairman, and Mr. H. M. Hobart, a member, had recently attended one of the meetings of the Main Committee as delegates of the American Engineering Standards Committee, and it had been decided to co-operate with American engineers as closely as possible in all matters relating to engineering standards. As they had a common language and common weights and measures, that seemed a natural and easy step towards international action. There was no doubt that British standards would be employed to a far wider degree than ever before. Constant demands for standardisation were coming from various Government Departments as well as from powerful industrial organisations, and there was a general feeling that some steps must be taken officially to encourage the use of British Standards throughout the country by Government Departments, municipalities and, indeed, by all specifying engineers.

A New Type of Electric Furnace.*

By AXEL SAHLIN.

Electric furnaces hitherto constructed may be divided into three groups, viz. :—

(*a*) Induction furnaces ; (*b*) furnaces with a free-burning arc ; and (*c*) furnaces relying on a direct arc between the metal and the bath.

The first-mentioned type is now only occasionally found. The free-burning arc furnaces have found favour. They have a decided advantage in giving means of heating cold furnaces without the introduction of any charge and by the arc only. But they have the disadvantage that as soon as the bath is formed the heat is transmitted to the surface only and no circulation is set up in the molten metal. Many furnaces of this type have suffered from weak mechanical construction, and some users have preferred direct-arc furnaces in spite of the attendant disadvantages.

The furnace which is the subject of this Paper has been designed with a view to embodying the advantages of both the direct-arc and the free-burning arc types.

Description.

The furnace is built as a circular ladle with contracted top and dished bottom. The shell is made of heavy steel plates, which are perforated by ⅜ in. drilled holes, 12 in. apart and serving as vents for moisture contained in the lining. The top rim is reinforced by a heavy flat hoop riveted to the shell plates. The steel casting trunnions are riveted to the shell and rest in bearings set so as to allow for expansion and alignment. To the overhanging end of one trunnion is keyed a crank which, turned by handwheel (or, for larger furnaces, by motor), serves to tilt the furnace to any desired angle.

The bottom of the furnace is made up of a layer of coke dust and tar rammed in, supporting double layers of brick. Above this are successive layers of burnt dolomite and tar for basic operation, or of ganister in case the acid process is adopted. Supported and resting on the firebrick, outside the hearth, is a circular lining backed by a heavy insulating layer of asbestos sheet and formed of circle bricks laid with ground joints and thin mortar. This lining may be made of magnesite brick for basic process, or of silica brick for acid process. In the lining are placed on the same vertical lines two holes for each pair of electrodes, and one door opening which serves both to charge the furnace and to pour the steel. For larger furnaces one tapping hole and two charging doors would be a better arrangement.

On top of the contracted top of the side lining rests the dome-shaped brick roof fitted in a circular steel frame, forming a rigid skewback. The roof can be removed by crane and replaced by another preheated roof. As the portion of the roof opposite to the arcs is more affected than the portion nearest to the electrodes (protected by the shadow of the latter), the roof is accordingly designed to be turned round to any desired angle. When the weakest portion is getting thin, the life of the roof can be prolonged by exposing to the fiercest heat the section of the roof hitherto more protected. The furnace may be charged through the top by removing the roof while the charge is put in place.

Electrodes.

The electrodes are of graphite or carbon, of cylindrical form, extended as they are burnt away by screwing a new section of electrode to the rear end of the electrode in operation. The joint is made by threaded dowels of graphite. The electrodes slide through water-cooled steel holders. The electrode cooler with its insulation is placed between the fixed upper and sliding lower jaws of a clamp which is pivoted to a frame bolted to the furnace shell. Both halves of the grips are water-cooled, and are fed through nipples connected to the water mains by rubber hose. Both grips are made with an extending wing, to which is bolted the bronze cable socket which receives the end of the cables, transmitting the current from the switchboard to the electrode. Both the swivelled guides are adjusted in a vertical sense, controlling at will the inclination of the electrodes.

Electric Arrangement and Wiring.

The number of electrodes proposed is as follows :—

For a furnace hearth :—

Up to 3 ft. 6 in. diameter	1 pair
From 3 ft. 6 in. to 5 ft. diameter	2 pairs
From 5 ft. to 7 ft. diameter	3 ,,
From 7 ft. to 9 ft. diameter	4 ,,
From 9 ft. to 11 ft. diameter	6 ,,

The electrodes should be preferably of graphite, 2 in. to 6 in. in diameter, according to the size of furnace and the amount of current. Each pair of electrodes enters the furnace in the same vertical plane, but at different and adjustable angles. The upper electrodes are supplied with current. The lower electrodes, as well as the furnace body are connected with the common of the transformer, or earthed. For a one-pair furnace, direct current or one-phase alternating current is used. For a two-pair furnace it is preferable to employ two-phase current, generally obtained by three-phase transformers arranged in Scott's coupling. For a three-pair furnace three-phase current is used, one phase being coupled to each upper electrode.

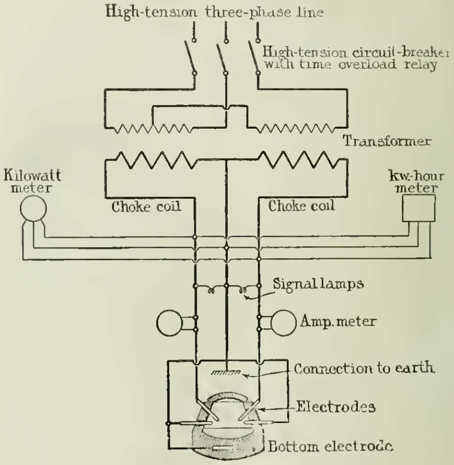

Fig. 1.—Diagram of Wiring of a Two-pair Sahlin Furnace.

For furnaces with more than three pairs of electrodes, groups of two pairs are coupled in parallel. The upper electrodes can be earthed, and the current can be supplied through the lower electrodes. A bottom electrode bedded in the hearth may also be used, and is useful when refining.

The pressure of the supply should preferably be transformed to 100 volts which, by plugs on the transformer, may be reduced at option to 80 or 70 volts.

The connections for a two-pair furnace are shown in Fig. 1. All the electrodes are distributed around the half of the circumference of the furnace opposite to the tapping hole and charging doors. For the smaller sizes of furnaces, the electrodes are fed forward by handwheels.

Operation.

Assuming that the furnace is to be used for melting and refining steel, the first operation is the heating of the furnace to the proper temperature. This is effected by turning on current and gradually advancing the points of the convergent electrodes of each pair until an arc is formed. So long as the points of the electrodes are at a certain distance from each other an arc is formed between the two electrodes. As they approach, this arc bends outward, forming a loop. If the distance is still further reduced, the loop breaks and the arc rushes forward, sweeping downward toward the surface of the metal like a broom. If the top electrode is advanced beyond the bottom electrode the broom is deflected downward. The form and direction of the arc can be modified by altering the angles of the electrodes and their relative position to each other. The free-burning arc heats the furnace while empty.

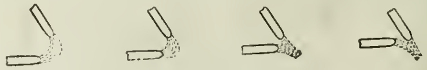

Fig. 2.—Direct Arcs observed with different Positions of Electrodes.

The second operation is the charging. When the furnace is heated, current is taken off, and the electrodes are drawn toward the back wall of the furnace to prevent their being injured, while the material to be melted is thrown or pushed into the furnace through the charging door, or eventually through the furnace top, the roof having been removed. The electrodes are then advanced. Numerous momentary arcs are formed between the upper electrodes and the charge, but as this latter is melted away in the vicinity of the electrodes, the regular free-burning "broom" arc is formed between the two electrodes, and the working of the furnace settles down to normal. The radiation and reflection caused by the free-burning arc are most effective for rapid melting. As, however, the bath is formed, this kind of arc reaches only the slag-covered surface of the metal, causing but little circulation in the interior of the bath. At this point, therefore, the free-burning arcs are broken by the retirement of the lower electrodes, and a direct arc is formed by the advancing of the upper inclined electrodes toward the surface of the slag. If the bottom electrode is employed, the current will penetrate toward this bottom electrode which is earthed. The furnace is now working on the lines of a Girod furnace, and creates an electric arc, which causes a rapid circulation in the bath and direct transfer of heat to the metal.

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* Abstract of a Paper read before the Institution of Electrical Engineers

In furnaces with more than one pair of electrodes, it is possible to have some of the electrodes produce a direct, and some a free-burning arc, thus making use of the effective radiating and reflecting action of the free-burning arc at the same time as the bath is agitated by the direct arcs.

Special Work.

For use as a heating furnace for very high temperatures such as are required for the production of graphite, calcining of magnesite, crystallising of bauxite, special crucible work, &c., it is proposed to suspend the furnace shell containing the side walls and roof with the electrodes and the electrode mechanism from four lifting rods, operated by electric motor, hydraulic cylinder, or windlass. The bottom of the furnace which for this work does not require any bottom electrode, would be placed on a truck. On this portable bottom would be placed the material to be heated. The loaded truck being placed beneath the furnace body, this would be lowered on to the truck enclosing the pile of material. A free-burning arc would now be started between the electrodes in each pair, and the furnace would be brought up to the required temperature. The material having been thoroughly heated or calcined, the furnace body would be lifted from the truck, which would be run away to give place to a second truck loaded with fresh material. The loaded trucks could be preheated in a gas-fired furnace before the bottom was placed under the electric furnace.

Advantages.

The furnace is of a very strong construction—rigid, simple and durable. All the surfaces of the brick linings are convex, and the walls will therefore be held in position. The surace of the melting room, confined by spherical and cylindrical walls, is the smallest possible for the largest volume, and the amount of brickwork is, therefore, reduced to a minimum. The electrodes are easily secured in place, adjusted, advanced, or retracted by means of hand-wheels. There are no bolts or nuts manipulated by wrenches used in the adjustment of the furnace, every operation being carried out by hand-wheels or cotters. The roof is solid, without any openings, removable and exchangeable in a minimum space of time. The furnace can be run either with free-burning arcs, with direct arcs, or with free-burning and direct arcs working simultaneously side by side. Changes are made without cutting off the current.

When the furnace is employed as a free-burning arc furnace no chemical reaction between carbon of the electrodes and the bath takes place. The overhanging length of the electrodes is comparatively short, and the arcs are formed fairly close to the circular furnace walls, being directed inward and downward toward the centre of the furnace.

The Sahlin furnace has not yet been placed on the market owing to the difficulty of obtaining a permit for its construction during the war, but a furnace is now being built in Great Britain intended for the production of steel ingots and castings.

The Recent Developments in Electric Welding.

The requirements of munition production, taking the words in the widest sense, brought about an immense increase in the use of the oxy-acetylene and other welding processes. The consequent demands upon the commercial output of carbide of calcium, oxygen, and oxygen cylinders exceeded the available supplies, and in order to secure the distribution of these supplies in due order of importance of the various products for which they were required, an Inter-Departmental Committee representative of interested Government Departments was appointed with Admiralty and Ministry of Munitions Executives to control the supply and distribution of carbide and oxygen respectively. Major Caldwell, R.E., was in charge of the particular section of the Materials and Priority Department of the Admiralty entrusted with this work, and in face of the difficulties he experienced in satisfying the urgent demands for the materials, he had to consider whether other welding processes were available to relieve the situation. Electric welding by both the resistance and the arc methods were naturally those to which he turned for assistance, and he succeeded in getting these processes adopted in many ways in which they had not previously been used to such an extent that the shortage of oxy-acetylene materials was substantially remedied. More than this, experimental work initiated by the department proved that electric welding was applicable to a good deal of work which is beyond the economic range of gas-welding methods, for example, that it can replace riveting in many structures. As is pretty well known, an experimental steel barge was built at Richborough in which arc welding took the place of riveting almost entirely, with a saving of time and cost, as compared with the older method. Incidentally, it may be mentioned that this experimental barge proved tighter and an easier tow than the sister riveted barges. At the same time that this experimental work was in progress in this country similar work was being done in the United States, especially with a view to facilitating the execution of the great merchant ship-building programme which that country had resolved on to mitigate the consequences of the German submarine piracy.

It seemed desirable to the naval authorities of both countries that there should be an interchange of information, and as one of the means to effect this Major Caldwell was sent by the Admiralty to the United States, so that he might tell the U.S. Navy what had been done here, and be able to report here what was being done in that country, to the advantage of both. He was lent by the Admiralty to the United States Shipping Board, Emergency Fleet Corporation, and his report on "Electric Welding and its Applications in the United States of America to Ship Construction" was addressed to that body. The report is not available to the public, as some portions of it are confidential, but we have been permitted to see and to refer to the portions which are not under that reservation. They show that there was a well-organised plan of investigation and experiment in operation, which had rendered results capable of immediate practical application and indicated the directions in which further investigation was calculated to result in further progress. As the report gave some account of the work done in Great Britain, it is a record of permanent value in the history of the art.

Both resistance and arc welding had, of course, been in use in both countries for many years. Resistance welding was well established, and the progress stimulated by war conditions was mostly, in reference to magnitude, a continuation of that which had gone on under peace conditions to a greater degree in the United States than on this side of the Atlantic. Arc welding, on the other hand, had been restricted in its applications, and metal arc welding especially was a comparatively new process about which not very much was known, but which had been better developed on this side than the other.

In view of the last-mentioned fact, and of the particular object in view of accelerating ship-building, the first report was a description of the arc-welding methods which had been found successful in shipbuilding in the United Kingdom, and contained suggestions, based on experience, for modifications in the structural details of ship design with the object of facilitating the use of electric welding in place of riveting and forging. It is pointed out that spot and line (or seam) welding by the resistance method and arc welding with metal electrodes can all be advantageously utilised in ship-building if the detailed designs are suitably modified. It is concluded that a saving of 25 per cent of the cost of labour, and a material reduction in the weight of hull can be realised by the adoption of such methods in place of the existing riveting methods.

Reports follow of visits to some two dozen shipyards and other establishments showing what had been done or was in progress of being done with electric welding in each of them. They show that the application of electric welding had received considerable attention, it was already extensive, and the managers took an intelligent and enterprising view of its future development and possibilities. They were glad to hear of what had been done elsewhere, and ready to try for themselves any promising novelties, either of processes or uses. Incidentally, these reports show how enthusiastically American industrial concerns joined in the national and allied endeavour to overcome the world shortage of shipping.

The Emergency Fleet Corporation had already formed an Electric Welding Committee to investigate all aspects of the question. Major Caldwell attended the first and some subsequent meetings of this Committee, and includes in his report the minutes of these meetings, his report to the Committees on the progress made in Britain, and some reports containing detailed suggestions on the design of ships for construction by welding. There is also a very full description of work done by arc welding in the yards of the Chester Shipbuilding Company, including the results of tests on the work, and estimates of the cost of a 1,000 ton barge, which had been built and had done twelve months' service with satisfactory results. The table of tests appended is from results obtained in the Bureau of Standards Laboratory, and includes comparisons of the strength of joints made by riveting, oxy-acetylene and arc welding. It can only be said that these tests are highly favourable to the welding methods.

There is also a report on the tests made on a watertight bulkhead door, made by the New York Shipbuilding Corporation, and reports of tests made on other welded structures produced by various manufacturers which give valuable guidance for the practical applications of electric welding, but cannot be referred to in detail. It must suffice to say that they show that electric welding can be relied upon to give satisfactory results in a large range of iron and steel structural work.

One example may, however, be mentioned as of special interest in connection with American developments of resistance welding. This is a 50 ton open goods truck ("gondola car"), made in 1911 by the American Car and Foundry Company, of St. Louis, Missouri, of which the entire superstructure was spot welded. The plate used varied from ¼ in. to ¾ in., and the welder used had a transformer of 85 k.v.a. capacity, and a welding gap of 66 in. This car has been in use in coal traffic since it was built; it was involved in a train wreck after five years' service, which bent some members, but only parted one spot weld. Examination shows that the welded joints have stood the strains, and the car, still in service, gives as good results as a riveted car. In view of the shortage of rolling stock and the desirability of economy of time and labour in making good the deficiency, this example seems worthy of some attention by the railway authorities and rolling stock builders here. There is no apparent reason why the method should not be equally good for steel passenger coaches.

Returning to shipbuilding, Lloyd's Register and the American Bureau have recommended the use of electric welding for certain services, and the British Admiralty allows such use for certain services in ships built to its order. The United States Navy Department has made a similar list, and the Admiralty is using certain applications in its own dockyards. Details of all these are set out in the report, and the actual methods adopted for several particular jobs in the dockyards are described in detail.

A characteristically American piece of work is a proposed standard system of nomenclature and symbols for describing different kinds of welds, strap, butt, lap, &c., with their principal varieties and combinations. This is due to naval constructor H. G. Knox, of the United States Navy Yard, and provides a technical shorthand, which is a necessary adjunct of the generalised use of the methods. It shows much ingenuity, and will commend itself to the practical designer and shipbuilder.

Whilst much progress has been made in electric arc welding, it has to be admitted that it has been largely due to the process of trial and error that knowledge has been acquired of the essential conditions of making good reliable welds. Individual inventors and investigators have no doubt obtained a good deal of information of this kind by their own work; individual operators know how to make good welds, and the best of them know whether the weld they have just made is a good, sound one, or otherwise. But the physics of the metal arc, the metallurgy and chemical reactions of the metals, fluxes, and the atmosphere at arc temperatures, and during the cooling period are in need of a good deal more elucidation before it can be said that the process has a sound basis of scientific knowledge as distinguished from empirical knowledge, perfectly reliable as far as it goes, but not a sure guide for progress, and also somewhat expensive to extend by trial and error.

The Electric Welding Committee recognised this by setting up a Research Committee, of which Mr. H. M. Hobart was and is the Chairman. Major Caldwell's report contains a large amount of information on research work carried out by a number of bodies, firms and individuals on the scientific side, which will be found of great interest. Some of these investigations justify certain conclusions which are of immediate practical value, but it is clear from a perusual that they require to be co-ordinated, compared and edited to see how far they agree, what points they leave in doubt from apparent conflict of evidence, and on what points of interest they show no light. This work and investigation on its own account is being undertaken by the Research Committee, and some important conclusions, especially as to the relation between the quality of the welds and the current strengths used, have been recently published.

The investigations included in the report cover the use of bare and flux-covered electrodes, on which point it may be said that the use of coated electrodes has advanced far more in Great Britain than in America, the use of continuous and alternating currents, the best voltage and current conditions in relation to the size of electrodes and the thickness of the plate—which are themselves inter-related: the rate of welding, the rate of deposition of metal, the strength of welds; views by the naked eye and microscopic appearance of welds. The reports include a large number of highly instructive photo-micrographs of weld sections. There can be little doubt that the microscopic examination of the structure is one of the most valuable methods of investigation. So much is known already of the micro-structure of steel that experts can form an accurate opinion whether the steel represented by the sample examined will fill the conditions of a specification as to strength, &c., they can say whether the heat treatment it has been subjected to is correct for the purpose for which it is intended, and if not, what further treatment is required. To a quite considerable extent they can judge of the chemical composition of the sample, detect segregations and identify their nature. This applies particularly to steels of which the general character and processes of manufacture are known. The metal deposited in welding has gone through processes of fusion and cooling different to those occurring in steel manufacture, so that something has to be learned about the significance of the structure found in relation to strength, &c. Hence the value of collections of photo-micrographs of welds made in various materials under various defined conditions and giving certain test results.

The question of testing completed welds by methods which do not involve their destruction is very important. Not very much is to be found on the subject in Major Caldwell's report, but sufficient to show that it is not ignored.

The report is a valuable compilation of up-to-date information and experience on the whole subject of electric welding, with special but no means exclusive, application to ship-building, as the art stood early in 1918. It may be hoped that it will be made available to the public interested before it becomes of only historical interest. But progress in the art is rapid. We can say that we know more about it in 1919 than we did in 1918.

Unfortunately, the Committee set up by the Admiralty to initiate and co-ordinate research in this country was dissolved soon after the cessation of hostilities, and there is at present no body charged with the conduct of such research. This is a pity, because it was made evident that there are many willing helpers and ample resources in the way of equipment available, so that quite a promising beginning was made within a very short time. No doubt individual persons and firms will go on with their own work, but much more rapid progress would follow with economy of time and labour, if such individual research work were co-ordinated and directed by a competent body commanding the confidence of these workers.

Data on the Life of Electric Trucks.—In a recent note by Mr. A. J. Marshall in the "Electric Review and Western Electrician" some interesting data are presented showing the long useful life attained in practice with electric trucks in New York City. Of 3,288 trucks in use in the metropolitan district, 3,055 are over two years old, and in 179 cases the life has now exceeded 10 years. The average life is expected ultimately to reach this figure, as compared with about five years for petrol-driven motor trucks. At present it is estimated that about 10 per cent. of existing street automobile trucks in New York are electric, and it is contended that they can be maintained in use, on an average, 280 days out of a possible 309 during the year, or, eliminating painting and serious accidents, for 295 days—a better result than has yet been obtained with petrol-driven trucks.

Oscillations During the Discharge of an Induction Coil.

By E. TAYLOR JONES, D.Sc.

In the preceding articles we have regarded the secondary circuit as open and as having no discharge passing between its terminals. In these circumstances the potential at the secondary terminals shows, as we have seen, fluctuations corresponding with the two frequencies of the coupled system. The current also in each circuit varies with the same two periodicities. When, however, the secondary discharge takes place the conditions are changed, and the variations of secondary potential and current undergo a modification, the character of which depends upon the nature of the discharge.

SPARK DISCHARGE.

It is well known that the ordinary induction-coil discharge through air at atmospheric pressure usually consists of an initial spark followed by a series of discharges all in the same direction.* This may be seen by examining the spark in a rotating mirror. Fig. 1 is a photograph obtained in this way of a 10 cm. spark between platinum points connected with the secondary terminals of the 18-in. coil. The primary capacity on this occasion was 5 mfd., the primary current i_0 at "break" 9·7 amperes, being about double the least value (i_m) required to produce the spark. The initial spark is followed by a series of broad and much fainter bands, representing what may be called a pulsating arc. The current goes through maxima and minima without changing sign.

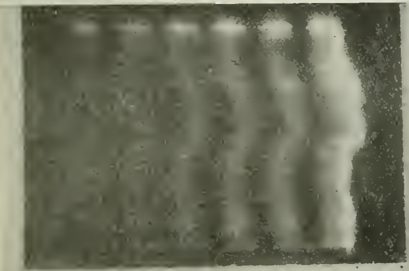
Fig. 1.

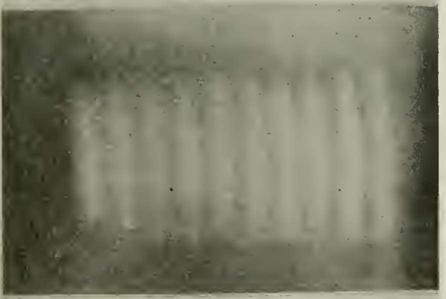
Fig. 2.

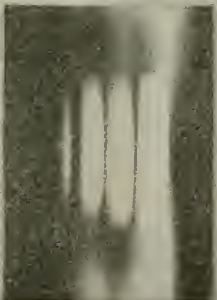
Fig. 3.

The frequency of the pulses in this case is about 407, a value which agrees approximately with the frequency of the system regarded as having its secondary short-circuited by the arc. The expression for this frequency—obtained by putting $C_2 = \infty$ in the expression for the frequencies—is $1/2\pi\sqrt{[L_1C_1(1-k^2)]}$. With k^2 taken as 0·839—the value for nearly uniformly distributed currents in the secondary—this expression gives for the calculated frequency the value 403.

The discharge pulses are seen to better advantage and are more suitable for photographic purposes when a short spectrum tube (containing air at reduced pressure) in series with the spark-gap is examined in the rotating mirror. The bands are then straight and much brighter, and the unidirectional character of the pulses is very clearly shown by the blue cathode glow occurring at only one end of the tube. Fig. 2 shows a photograph of such a tube when in series with a 2·79 cm. spark between ball electrodes ($i_0=6·27$ amperes, $i_m=2·5$ ampere). The primary capacity on this occasion was 3 mfd., and the calculated frequency 520. The observed frequency, measured on the photograph, is about 545. Similar approximate agreement between the calculated and observed frequencies was found in other cases in which different spark lengths and primary capacities were employed.

For a given spark-length the number of pulses increases with the primary current, and for a given current increasing the spark-length reduces the number of pulses. In the case of Fig. 2 the arc becomes suddenly extinguished after the 10th pulse, the potential then falling and remaining below the least value required to maintain the arc. When the spark-gap is only a few millimetres wide, and the primary current is largely in excess of the minimum, the bands become finally merged into one unbroken band of diminishing intensity, representing a continuous or aperiodic arc.

The view of the matter suggested by the present experiments is (1) that the initial spark represents the escape of the static electricity accumulated on and near the secondary terminals at the moment when the discharge begins: (2) that the secondary current (beginning with the value which it has at this moment) flows through the arc as an aperiodic decaying current; and (3) that superposed upon this aperiodic current is an oscillatory current having the period of the system. It is clear that on this view the arc should become alternating if the secondary current immediately before the discharge begins is sufficiently reduced, and this is found to be the case. In the oscillations preceding the discharge the secondary current is zero at the moment of maximum potential ($i_2=C_2\frac{dV_2}{dt}=0$), so that if the primary current is adjusted to a value equal to, or only slightly exceeding, the minimum required to produce the spark, the discharge begins with practically no current flowing in the secondary coil. Two or three pulses are then generally observed, and these are found to be alternating—*i.e.*, a negative band has appeared between the first two positive bands. This effect is shown in Fig. 3, a photograph of the spectrum tube when in series with a 6·5 cm. spark between ball electrodes ($i_0=5$ amperes, $i_m=4·3$ amperes, $C_1=3$ mfd.). The alternating character of the discharge is here shown chiefly by the manner in which the luminosity of the narrow part of the tube is connected with that surrounding the electrodes, this connection being much more marked at the negative than at the positive end. On the ground glass plate it is also shown by the difference of colour, the cathode glow appearing alternately at the upper and lower ends of the tube. The luminous bands of Fig. 3 should not be mistaken for the alternating bands shown by the tube when no discharge is crossing the gap, and generally seen after the spark or arc:

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* B. Walter, "Ann. de Phys.," 66, p. 636 (1898).

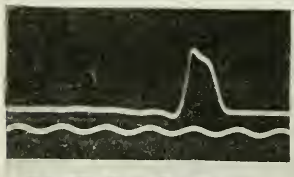
discharge has ceased. These latter are very faint, being due to the capacity current of the electrodes, and show the two oscillations of the coil with open secondary (compare Fig. 3). As the primary current is increased, the second or reversed band becomes narrower and ultimately disappears. A trace of a narrow reversed pulse is seen between the first two positive pulses of Fig. 1, where it is shown only by the glow at the negative electrode.[*]

In Fig. 4 is shown the electrometer curve photographed simultaneously and on the same plate with Fig. 3. The tension of the electrometer strip was somewhat reduced for this plate, in the hope that appreciable deflections would be obtained during the arc pulses. The result shows that, whereas the potential falls abruptly at the initial discharge, it varies much more gradually in the succeeding pulses, which are therefore of the nature of continuous oscillations rather than of sudden discharges.

SPARK DISCHARGE WITH SECONDARY CONDENSER.

When the spark electrodes are connected with the plates of a condenser (as, for example, when the coil is used for exciting a Tesla coil or a radio-telegraphic transmitter), the potential of this condenser rises, immediately after "break," in accordance with the two oscillation frequencies of the system, which now includes the condenser. The time which the condenser takes to rise to the sparking potential depends upon the periods and phases of the oscillations and upon the primary current i_0 at break.

FIG. 4.



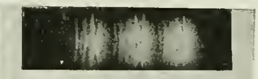


FIG. 6

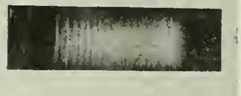


FIG. 7

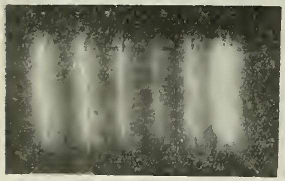


FIG. 5.

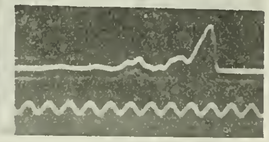


FIG. 9.

If the primary current moderately exceeds the minimum i_m the discharge, instead of consisting of a spark followed by an arc, as is the case when the condenser is absent, now takes the form of a series of sparks. An example is given in Fig. 5, showing the discharge at one interruption of the primary current, between platinum points, in parallel with the spark being a glass plate condenser of capacity 0·00022 mfd. It is clear that if an arc is formed at all it is insufficient to prevent the potential from rising to the high value required to produce a spark. At the same time the frequency of the discharges may still be approximately calculated on the assumption that the secondary circuit is short-circuited—*i.e.*, from the expression $1/2\pi\sqrt{[L_1C_1(1-k^2)]}$. Thus, the mean frequency for the six discharges shown in Fig. 5 (C_1=3 mfd.) is 515, which, though rather less than the frequency of the arc pulses when the condenser is absent, does not differ greatly from the calculated value (520).[*] Similar agreement is found in other cases when different primary capacities are connected across the interrupter. The frequency of these discharges does not appear to vary to any great extent with the capacity of the condenser connected with the spark electrodes. The discharges are unidirectional, as may be seen on connecting a spectrum tube in series with the spark-gap.

The potential is usually highest in the first and last of the sparks, which are also usually the brightest. The sparks frequently become multiple, especially if they are rather short, so that they appear in the rotating mirror as a number of groups. Thus, in Fig. 5 the first spark is double, but there are sometimes a considerable number of sparks in a group. Fig. 6 shows this grouping in the case of a 4 mm. spark in parallel with an oil condenser of about 0·00019 mfd. capacity. If the primary condenser is disconnected the grouping disappears, as shown in Fig. 7. The frequency of the sparks in a group is increased by reducing the capacity connected with the spark terminals, is diminished by increasing the spark-length, and does not seem to be affected by varying the secondary self-inductance (*e.g.*, by drawing out the primary and core along the axis of the secondary). The frequency is, of course, much less than that of the high-frequency oscillations of the circuit formed by the condenser, its connecting wires, and the spark-gap; each spark, presumably, contains a train of these oscillations.

The total number of sparks occurring in a single discharge of the induction coil (*i.e.*, at a single interruption of the primary current) increases with the primary current up to a certain point, when it suddenly becomes reduced to a small number, sometimes only one or two. These are then seen to be followed by a very faint pulsating arc. At this transient stage the discharge may take the form either (1) of a (sometimes large) number of sparks,[†] or (2) a small number of sparks followed by a faint pulsating arc. The arc frequently shows a few sparks at its end as well as at its beginning. The former kind of discharge is the more suitable for exciting a Tesla coil, from the secondary of which fuller and brighter sparks—they are also evidently multiple—can be drawn when the exciting discharge is of the form (1) than when it is (2). As the primary current i_0 is increased the arc becomes brighter, and the appearance in the rotating mirror becomes similar to that of Fig. 1, the period of the arc pulses also being given by the same expression.

The presence of the condenser connected with the spark terminals thus has the effect of retarding the development of an arc, which only appears when the primary current is several times (five or six in the present experiments) as great as the minimum required to produce the spark, though it is difficult to determine whether it does not exist before in a feeble state underlying the series of grouped sparks by which its appearance is masked.

DISCHARGE THROUGH AN X-RAY TUBE.

The modification which the discharge causes in the secondary oscillations is usually much smaller in the case of an X-ray tube than in the case of the spark discharge in air at atmospheric pressure. This is because the quantity of electricity passing in the discharge is generally much smaller, and the duration of the discharge is less, in the former case than in the spark, which, as we have seen, is generally accompanied by an arc lasting for a considerable time.

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[*] The theory of the pulsating discharge appears to have been first considered by Colley ("Ann. de Phys.," 44, p. 109, 1891) in connection with his experiments on the discharge through a Geissler tube connected with the secondary terminals of an induction coil. The view of the matter described above differs in several points from that of Colley, notably in regard to the period of the pulses, which in Colley's theory is $2\pi\sqrt{L_1C_1}$ if the resistance of the primary circuit is neglected. Colley's theory is, however, only applicable when the coefficient of coupling of the induction coil is by some means reduced to a very small value.

[*] In this case the two frequencies of the induction coil with the secondary condenser and with the secondary circuit otherwise *open* are $n_1=156$, $n_2=702$. The frequency of the secondary alone, *i.e.*, $1/2\pi\sqrt{(L_2C_2)}$, is 218; that of the primary alone, $1/2\pi\sqrt{(L_1C_1)}$, 209.

[†] About 60 sparks were counted in one photograph.

The quantity of electricity passing in a discharge may be measured by a suitable ballistic galvanometer connected in the secondary circuit. For approximate measurements a moving-coil milliampere meter (of the kind used for measuring the mean current in a rapid succession of discharges) may serve the purpose, provided its period is long in comparison with the time occupied by the discharge. Fig 8 shows the curves obtained in this way for two X-ray tubes, representing the discharge at a single break of various primary currents. The pointer of the milliampere meter was observed through a telescope, and its deflections were measured on a fine scale in the focal plane. The scale was calibrated for ballistic measurements by means of two air-core coils of known mutual inductance. The ordinate of the curve represents the discharge through the tube in microcoulombs, the abscissa the primary current at break in amperes.

Tube *A* was a Macalaster-Wiggin tungsten target tube (7 in. bulb), *B* a Cox Record tube of older design (5 in. bulb). Both tubes were fairly "soft" at the time the curves were taken.

When connected with the terminals of tube A, the electrometer gave the curve shown in Fig. 9 (i_0=8·4 amperes). The maximum P.D. attained by the terminals of the tube is approximately 80,000 volts (without the tube and with no other discharge occurring the secondary terminals would have risen to about 200,000 volts). From this value the potential falls gradually, with small fluctuations, to about 36,000 volts, then rising to 43,000 before falling, again gradually and with fluctuations, to 36,000, and then rapidly to zero. After this there is no further discharge, the potential varying with the usual two frequencies of the coil with open secondary. The discharge appears to begin before the maximum potential is reached, probably at about 65,000 volts. If we take 50,000 volts as the mean potential during the discharge, we can form a rough estimate of the energy of the discharge. From curve *A*, Fig. 8, we find that the quantity of electricity passing in the discharge (i_0=8·4 amperes) is 68 microcoulombs. Thus the energy is $50{,}000 \times 68 \times 10^{-6} = 3{\cdot}4$ joules. The initial energy $\frac{1}{2}L_1 i_0^2$ being 6·8 joules, the efficiency of discharge is approximately 50 per cent. The efficiency of the X-ray-producing discharge is probably only a small fraction of this.

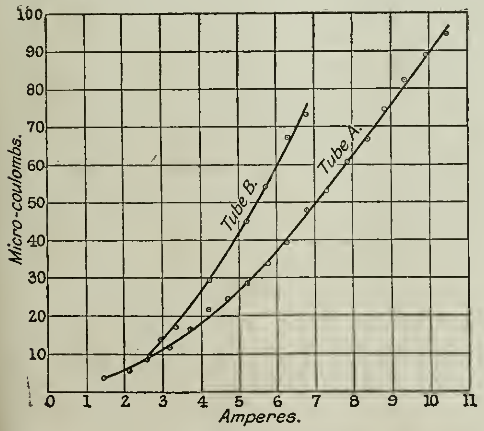
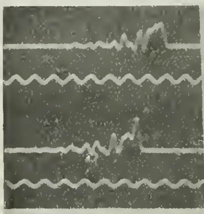


Fig. 8.

The potential curve was not always precisely of the form shown in Fig. 9, but it always showed the same general features—the gradual fall of potential and the lengthening of the time occupied by the first, or positive, wave—when the tube was fairly soft and the primary current greatly exceeded the least value required to produce the discharge.* Sometimes the fluctuations were more marked, and frequently (especially at stronger currents) the curve showed a marked indentation near the summit. In some of the curves the second rise is less marked, its place being occasionally taken by a nearly horizontal portion showing fluctuations.

When the tube had been hardened by running for some time with a motor interrupter the curve was of quite a different character. In Fig. 10 are shown three curves taken with the tube in this state and at currents of 1·5, 5·8 and 7·1 amperes respectively. The primary capacity in the experiments of Figs. 9 and 10 was 3 mfd. The terminal potential curve, while generally following the form observed when the tube is removed, now shows in the first half-wave marked indentations, indicating that the discharge—or a portion of it—takes the form of a series of pulses, in which the potential falls very rapidly. The number of these indentations increases with the primary current, their frequency being of the order 5,000 per second at the highest current. It may also be noted that the amplitude of the oscillations, and therefore the energy remaining in the system, after the discharge has ceased diminishes as the primary current increases. Thus, the efficiency of the discharge increases with the primary current.

Fig. 11.



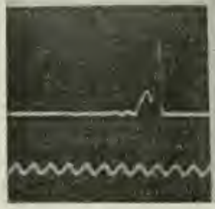


Fig. 12.

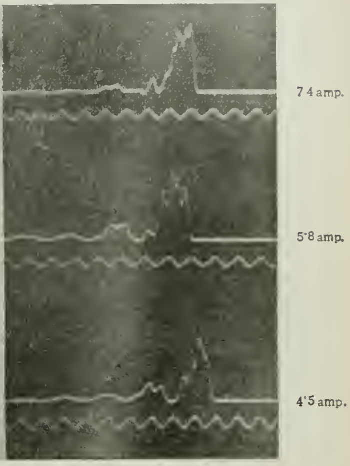


Fig. 10.

(*To be concluded.*)

Two Large Electric Generators.—According to the "Electrical World," the Westinghouse Electric & Mfg. Company, of Pittsburg, and the Canadian Westinghouse Company, at Hamilton, Ontario, are engaged in the construction of two water-wheel type electric generators which will be among the largest in the world. The units are nominally rated at 45,000 k.v.a., 12,000 volts, three-phase, 25 cycles, 187 revs. per min., with a maximum continuous rating of 50,000 k.v.a. The machines are of the vertical shaft type, equipped with two guide bearings and a Kingsbury thrust bearing, which carries the combined load of the generator and turbine rotating parts, and the unbalanced water-thrust, amounting roughly to a million pounds. The generator is designed to work at a relatively low temperature, but field and armature coils are insulated throughout with mica and asbestos materials, guaranteed for a total operating temperature of 150°C. These two units are the first of a number proposed for installation at the Queenstown development of the Hydro-Electric Power Commission of Ontario.

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* On the present occasion the tube glowed very faintly at 1 ampere.

The Operation of Large Direct-Current Motors Without Starting Resistances.*

By W. LINKE.

In 1912 Trettin discussed the starting of large direct-current motors without series resistances. He deals with the differential equation, which arises out of the starting conditions, taking account of the self-induction of the armature, the moment of inertia of the masses to be accelerated, the resistances of the circuit, and the external load. He draws the conclusion that it is possible to start large shunt-wound motors without starting resistances. This plan has only been practically exploited in certain special cases, and a further examination of the question is therefore desirable.

It has long been known that on closing the circuit the rush of current is less than that due to a simple short-circuit. This depends on the self-induction, the moment of inertia of the moving parts and on the torque; but it was not known exactly how great this difference is. Trettin, however, examined the whole question by an accurate mathematical investigation. The first case, discussed by Trettin, relates to a 215-kw. motor, on 240 volts. The resistance is 0·025 ohm when the motor is put on 110 volts. If the armature is held at rest, the current would be 4,400 amperes. Whereas it was found that on 110 volts only 3,380 amperes passed, *i.e.*, 0·77 times the short-circuit current. Next it was put on 240 volts by connection to a suitable dynamo; the total resistance of the new circuit is now 0·04 ohm. The stationary short-circuit current is 3,250 amperes; calculation and experiment showed that there was an actual current-rush of 2,800 amperes, which is 0·86 of the short-circuit current. These are favourable cases; and if the motor were loaded the current-rush would more nearly approach the short-circuit value. The self-induction of the armature exercises very little effect; and the same is the case with the load on the motor. The extreme variations of the current-rush seem to be between 75 and 100 per cent. of the short-circuit value.

The author's experiments began with a 60-kw. motor for 440 volts, normal current about 150 amperes. The one-hour rating of this machine was 250 amperes. The resistance of armature and auxiliary poles was 0·12 ohm; internal voltage-drop about 4 per cent. It was first connected to a 1,000-kw. dynamo; the total resistance of the circuits then was 0·155 ohm. Oscillograms (not here reproduced) are given showing the results when the dynamo was excited to 220, 300, 370 and 440 volts. On 220 volts, the current-rush was 772 amperes, *i.e.*, five times the normal full-load current, and the start was effected without any sparking. On 300 volts the current-rush was 1,130 amperes, *i.e.*, 7·5 times the normal full-load current; there was very slight, quite harmless, sparking. On 370 volts the rush was 10 times the normal full-load current, and there was really serious sparking; and on 440 volts a current equal to 14 times the normal full-load current passed, and the machine flashed over. A normal motor cannot, therefore, be connected to its normal voltage, unless there is some unusual resistance in the connecting conductors.

In the next series of tests the motor was always connected to 220 volts, but differences were made in the moments of inertia of the rotating masses, and in the load on the motor. In this case the total resistance of the circuit was somewhat lower than before, and amounted to 0·13 ohm. When connected to 220 volts the oscillogram shows a current-rush of 855 amperes. It was then mechanically coupled to a precisely similar motor and started again on 220 volts. Here the moment of inertia of the parts to be accelerated is doubled, and the current-rush amounted to 1,050 amperes, which is 25 per cent. in excess of the amount recorded in the previous experiment. It was then coupled to a large fly-wheel, whose moment of inertia was 50 times that of the motor. The current-rush then amounted to 1,420 amperes, which is 85 per cent. of the stationary short-circuit current. Here there was heavy sparking, which was much too serious for practical work; in the previous experiment the sparking was slight, and would not have been injurious. The current-rush in the last case continued for several seconds, and these tests show that the moment of inertia of the rotating masses exerts a considerable influence on the course of events.

In the next case the motor was variably loaded in a series of tests; the motor was therefore coupled to a separately excited dynamo, the current from which passed through a constant resistance. In the first case the dynamo (which formed the load) was unloaded; in the second, the load was about one third of the normal load of the motor; and in the third the motor had about five-sixths of its normal load. The oscillograms show that the current-rush was almost exactly the same in all three cases, viz., 1,065 amperes; and this variation of load exercised very little effect on the time over which the current-rush lasted. Theoretically Trettin found exactly the same result.

Thus it will be seen that high current-rushes can be commutated by a motor without difficulty. For instance, a rush equal to four times the hourly rating causes scarcely any sparking. Trettin considers this is due to the fact that it lasts too short a time for the carbon brushes to become heated. The author, however, thinks it is due to the fact that the speed of the motor and the reaction-voltage in the short-circuited coil during the current-rush are comparatively small; and this view is confirmed by certain facts noticed in the course of these tests. Trettin, however, certainly drew attention to the undoubted fact that in exceptional cases it is possible to dispense with starting resistances if one is prepared to put up with a fairly considerable rush of current. But this applies only to a very limited series of cases. In any case it is quite possible that in the long run these rushes of current may exercise an injurious effect on dynamo or battery, or on the mechanical stability of the motor or driving gear.

The author now proposes to show that, with a starting resistance, that is inserted and cut out in one operation, it is possible to reduce the rush to the normal value of the current; and further this single-stage resistance can be kept so small that its cost and weight is almost negligible, when compared with the cost of the motor. Let us suppose a starting resistance to be provided which will reduce the initial current-rush to a point where it does not exceed the normal working current. Then in a fraction of a second the motor will reach fairly high speeds; so that after this very short interval the resistance can be short-circuited without any risk of the secondary current-rush exceeding the normal value of the working current.

Various oscillograms are given in the original Paper, illustrating this proposal. The first shows the same motor as before, connected to half its full voltage through a resistance which reduces the rush of current to 240 amperes. The resistance amounts to 0·66 ohm, and is short-circuited after one-tenth of a second, when a secondary rush of current takes place, amounting to 290 amperes. The next oscillogram shows the motor connected to its full voltage through 1·55 ohm. The first current rush is 225 amperes; the resistance is cut out at the end of 0·7 second and there is a second rush of 222 amperes. The next two oscillograms relate to the starting of the motor, while it is connected to a dynamo, which forms the load, its current passing through a given resistance. Here it is seen that if the load is heavy the resistance must be inserted for a greater length of time than if the load is light. In any case, up to one-half of full load, a one-stage resistance is sufficient and can be short-circuited within a second. A further instance is given in which the starting resistance was sufficient to make the current-rush equal to 85 per cent. of the hourly-rating current; it was cut out at the end of 0·3 second, when there was a second current-rush slightly greater than the first, but still well below the hourly-rating current. A further oscillogram is given of this case, in which the resistance was only cut out at the end of 0·6 second, with the intention of determining the temperature-rise. The resistance consisted of iron spirals, containing 4·9 kg. of active material; it was no larger than a small cigar box. The voltage and current through the resistance were determined; and from the known constants of the case it was calculated that the temperature-rise was 12·2°C. The mean of three thermometers gave a temperature-rise of 11°C. The motor was then re-started 15 times at intervals of half a minute. At the end of this time the rise of temperature in the resistance was found to be 120°C. A cooling curve for this resistance was constructed, from which it appears that if the motor is started at intervals of a minute, the temperature-rise of the resistance will never exceed 120°C., however often the process is repeated.

From these instances we see that if the starting conditions are favourable (*e.g.*, the moment of inertia of the rotating parts is not too great and the load on the motor is not too heavy), the resistance need only be inserted for a period between a quarter and half a second to reduce the rush of current within quite reasonable limits. A simple method of carrying this out consists in employing a switch with two contacts. A knife-switch is shown in a drawing in the original Paper; the act of closing the switch short-circuits the resistance, which is connected between the two open contacts of the switch, these open contacts being closed in succession by the motion of the switch handle. The construction of the switch can be of such a design that a sufficient interval naturally elapses between the closing of the two open contacts; in other words, the resistance is left in circuit for a sufficient period before being short-circuited. Of course, in such a simple device something depends on the personal element; the switch would be intended to be closed with care and caution and with no unusual speed. It may be objected that a careless attendant might close the switch too suddenly, in which case the whole purpose of the arrangement would be lost. Some oscillograms are therefore given, showing the results of closing the switch as suddenly as possible by a powerful man. In this case, the switch was closed in one-tenth of a second, but even in this case the secondary current-rush, which was greater than the first, did not exceed 60 per cent. of the rush which would have taken place if the motor had been switched into circuit without any starting resistance; and the conditions for this test were somewhat unfavourable owing to the high moment of inertia. When this moment of inertia was somewhat reduced it was found impossible to close the switch quickly enough to raise the current-rush above the hourly-rating current.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 46, 1918.

Another instance may be given of a large machine, consisting of a 750-kw. motor-generator, which was started on the direct-current side with a one-step resistance. On the direct-current side it took 1,500 amperes at 500 volts; the ohmic resistance was 0·0057 ohm. The voltage-drop in the machine was 8·5 volts, or 1·7 per cent. The total resistance in circuit including conductors and dynamo was 0·0105 ohm. The conditions were very unfavourable, and it was impossible on account of sparking to put the motor direct on even 150 volts. But when a resistance of 0·48 ohm was inserted it could be put direct on 500 volts. The first rush amounted to 1,060 amperes, which is two-thirds of the normal current: when the resistance was short-circuited at the end of 20 seconds there was another kick, amounting to 570 amperes. The resistance consisted of 45 kg. of active material and the temperature-rise was 90°C. The ordinary starter for a machine of this kind would require about 200 kg. of active resistance material. If the conditions of the network allow a current-rush equal to two-thirds of the normal current, it is evident that great saving in the way of the starter can be effected by these means, by reducing the weight of material by 75 per cent. and doing away with the complication of a series of contacts. Moreover, it produces a certain indirect economy in the shape of the smaller space which is required to house it. It is plain that the method is specially suitable to a restricted type of case, where the motor is started under light load, and where the moment of inertia of the rotating parts is not relatively high; moreover, the conditions of the network must be otherwise suitable

Costing in Relation to Scientific Management.

At one of the conferences on scientific management arranged by the Industrial Reconstruction Council, Mr. J. H. Boyd, Director of Costs and Efficiency Methods, Ministry of Munitions, recently read a Paper on the above subject.

In the course of his lecture, Mr. Boyd said there might be some divergence of opinion as to the cause of the industrial unrest through which this country was passing, but there could be no difference of opinion as to the necessity for endeavouring to find a cure. Scientific management was one of the most important factors in that cure, and there was much ground to be covered before one got a grip of what was meant by that term. He had only to deal with the preparation of cost records and their use to the manager. He had decided to deal with the subject on more or less theoretical lines, and he promised not to make any claim for a system of which he had not experience, or investigated, or actually seen carried out in practice. Briefly, he thought the question of costs was the basis on which scientific management must be built. The recording of cost entered very largely into the whole structure of a business, and, finally, the cost records supplied the proof. So long as money remained the medium of exchange, so long must all that was done in business be eventually expressed in terms of money. That was the principal point regarding costs. The manager might be an excellent technical man, but he did not build his reputation on his ability to do a particular technical operation personally, and it was desirable to show his directors and visitors that all he was doing was leading to increased output and reducing costs. The manager must be the guiding hand of the whole venture, and not the personal supervisor of details. Others must handle the details, and put the facts before him clearly and concisely, so that he might know that the work in his factory was going ahead efficiently right from the foreman down to the latest joined apprentice. A costing system, properly based, properly run and efficiently used by the manager, would produce all he required for purposes of control. By looking round in a factory one might see that an improvement was required, but could not gauge the extent of the value to be placed on the improvement. A costs system was designed to obtain information regarding not only money, but output, prices of material, efficiency of performance, and all those facts must be known before one could get a good start in any reconstruction of a business. Having laid the foundation by means of careful study of the various elements, it was necessary to have records to show the effect of the introduction of the new methods and to ensure that the suggestions for improvement were being carried out. The records must be designed to record progress on the spot. The manager should have cost information brought to him frequently—every morning would not be too often if things had been going very badly—either in the form of brief statements or graphs, so that he could keep in constant touch with the progress of his reconstruction.

Having established the system of controlling the results, the man responsible could cap all his efforts by producing those results. The introduction of a costing system into a business would in itself eliminate waste in wages and material, by simply making it necessary to record why and when expenditure had been incurred. The word "costs" did not convey anything very definite in itself. He liked to look at the building up of costs in the form of a sum in additional arithmetic. Wages and material were the fundamental costs (costs which could be charged with accuracy against a particular operation); direct costs were costs that could be charged with accuracy against any particular kind of work although not against a particular operation. Those two classes of costs gave prime cost. Departmental overhead charges had to be added. These could not be charged to particular pieces of work, but were a general charge over the work of a department. By adding administration overhead charges the total cost was arrived at. It did not matter what terms were used, so long as their meaning were clear.

What one did not get from ordinary systems of financial costs was whether the money spent had been wisely spent. That was where the cost accounting came in. From the central point of view, it was useless to know only the bulk expenditure. Expenditure had to be split up and identified with specific units of work, and the information should be available as the expenditure was being made or immediately after. A motor-car firm in keen competition would not derive much satisfaction from finding they had spent too much on wages and material after they had made 100 cars. The cost of parts should be watched, so that when they were assembled there would not be the necessity of having to reduce the cost or sell at a loss. The only point at which cost of manufacture could be reduced was on the spot. Costs must be built up from fundamental costs to total cost. Work must be carefully examined, and separate records of cost prepared for each operation or group of operations, and related to proper units of work. There was a tendency to concentrate on the fundamental costs, control them by units of work, and accept the other costs as necessary evils, but those overhead charges were in themselves subject to control by careful study of the service rendered by them and being assured that one was getting a high efficiency from the service rendered. Costs records were "business news," keeping the manager informed of what was happening day by day. Statistics were not a method of control, but business history. If the manager were imagined to be a traveller in a foreign country a costs system was the map that directed him on the way to reach a certain point, warning him of dangerous rocks. It enabled him to make a diagnosis of his business, and then have the diseased parts cut out. It indicated the necessity for action, and also showed whether the necessary action had been taken, and whether it was having a good result. When the necessity for recording the reasons for expenditure had been established in conjunction with the study of better methods of fixing standards and planning work and in all the other elements included in scientific management one got that combination which he hoped in the future would simply be called management.

As an example, where the introduction of a costing system did good in itself, on certain work on which tractors were used the acreage per tractor per day was trebled when job cards, &c., were introduced, and cost of maintenance was reduced by about 50 per cent., due to the fact that the reason for the repair had to be given and the cost recorded. A manager who was running his business by personal supervision would probably say there was practically no idle time in the factory. But if the idle time were recorded it would probably be much in excess of what had been imagined. Workmen were disposed to charge idle time against some job, but if the standards were properly set and cost records properly prepared that wrong allocation of time could be easily safeguarded. Idle time, like will-o'-the-wisp, might flit from point to point and might never be caught, but it would eventually almost disappear. The fixing of standards would show how time could be fully utilised, and records would show that what had been planned was being carried through. The manager's estimates would be free from uncertainty, if based on figures obtained red-hot from the factory.

He heard of a big firm recently basing its price upon a foreman's statement as to what he could do the job for. That was pure guesswork, which was fatal in a business. During the last three weeks he had been in most of the big manufacturing centres in England and Scotland. Some industries were alive and going ahead, but generally there was a big field for improvement. In a business where capital and revenue costs were being dealt with a costing system was absolutely necessary. In public utility undertakings there must be some system of recording those costs, and having them properly allocated to capital or revenue account. Even if adjustments were dictated by policy, it was better to have the allocation made on a sound basis in the first instance. Many managers had suffered through that question of policy, and if he had his cost records properly prepared he could produce data to show how far the responsibility was really his. Depreciation was a difficult point in any business. Any method that involved detailed calculation was generally avoided, and some get-there-quickly method adopted. Where there was a varied plant, and where the costs must be consulted, the method of calculation of depreciation should be the subject of very serious consideration. Costs records were absolutely necessary to build up depreciation properly. Beware the so-called " so much per cent. per annum " method based on so-called past experience, without any records. Many times during the lifetime of a business the question arose as to whether the book value of capital was really represented by assets. The usual method of taking that was by making an inventory, an expensive and not always satisfactory method. A well-designed costs system would maintain a running inventory. It would record all additions to or subtractions from the plant, and tie up with the quantities the relative values. In businesses where a physical survey would present difficulties an inventory kept automatically up to date was well worth considering, and it could be accomplished by means of cost records. A cost system should not confine itself to dealing with expenditure of money. It might be made to embrace all records necessary to the manager for purposes of control. Where piecework rates or payment by results were in force, output per worker must be known for wages calculations, and where standards had been fixed output records must be made to arrive at the efficiency per man per machine, &c., as compared with the standard. Those records might be quite separate from any question of cost, but it was advisable to have them incorporated in the costs system. A manager might be entirely satisfied with output as output, but when he found he was considerably increasing his cost to obtain that output he might have to slow down.

If workers knew the records they compiled were used to build up their wages they would take some interest in them. It was a good thing, therefore, to have the output record on the job card or time sheet. The real question behind the fixing of standards was the question of cost, the record of efficiency was one of efficiency in cost, and it should be included in the costs records. The costs return to the manager should include wages and material, output, the standard set, the efficiency of output compared with the standard, the cost per unit of output, and then any other information regarding the class of labour employed, the hours, and so on. Now, he wanted to look at the question from the men's point of view. In the recent evidence submitted to the Coal Commission there were shoals of figures, but there was an element of uncertainty running through them. A Government witness said had his department had figures six months ago which they had now something like £25,000,000 would have been saved. In the same way to-day's figures would be useless six months hence. There was that difference between statistics and costs. Statistics did not necessarily convey any idea of cost, while costs meant what the work was costing to-day, and after having served their use as costs could be used to build up statistics, and were more valuable for that purpose because they were proved figures at the time they were produced. The worker often did not grasp what statistics meant, but if he were shown something of which he himself had produced the fundamentals, and then shown what had been added to those figures to arrive at the total, he could comprehend it. The relationship between the worker and the manager was still in a state of evolution, and it was up to everybody interested in scientific management to prevent its becoming a revolution. To get into sympathetic touch with the worker the manager must be prepared to produce his cost figures in such a shape that they could be understood by the worker or his representative. It was useless talking up in the air when discussing wages and their effect on cost, or shorter hours and their effect on output.

Sir Robert Horne, the Minister of Labour, mentioned recently that the men in a certain industry did not believe it when they were told the industry would not stand increased cost. If the managers had their costs properly built up they could place before the men the real facts as they were happening to-day, and the men, he felt fairly confident, would at once know that what they were shown was true. He mentioned also a few of the things for which the country was striving to-day—to make the conditions of the workers better, to give them shorter hours, more leisure, a larger share in the fruits of industry and a measure of industrial control. That was what was called scientific management. He went on to say employers were prepared to meet their men with a broader mind, and that this new spirit would lead to a system of Industrial Councils on which workmen and employers would be represented, and where they would sit round a common table and come to a common decision for their common interests. All the good intentions underlying Industrial Councils would be fruitless unless the facts and figures with which the workmen and employers were dealing were fully understood and accepted as far as wages, hours, costs and output were concerned. Those figures could be obtained by accurately recording the cost on each specific kind of work, so that the employer might talk to each man about his own particular job, and show what each unit of work in that job was costing to-day. When a worker was shown the price at which certain things were sold, and he considered what he was paid for making the article, he did not realise what lay between fundamental and total costs, and he (the lecturer) did not know that any serious endeavour had been made to make it clear to him. Each business must be carefully studied, and a system of recording costs adapted to its needs.

DISCUSSION.

Mr. Crossley Jones asked the lecturer to give an idea of the best method of fixing standards.

Mr. M. B. Carlin (Bar-Lock Typewriter Company) asked whether it was the lecturer's experience that figures were placed before the workers in the way he suggested. It seemed to him quite a new departure.

Mr. J. F. Butterworth said graphic control as used in America consisted of a chart placed in the manager's office, in which the various machines in the plant were stated. A machine lying idle was marked on the chart by a small red flag. The manager wanted to know how and why as quickly as possible. A few years ago American railways asked the Senate to allow them to increase their rates 15 or 20 per cent. People who were preaching scientific management, headed by Louis Brandeis, put before the Commission in Washington dealing with the matter proof that if the railways applied scientific methods to their running there would be no necessity to increase their rates, as their present methods resulted in a loss of over £5,000,000 a day. The railway companies Bill was therefore thrown out. An engineer who came over here fresh from the inquiry at Washington went through the locomotive shops of some of our railways, and told him he was astounded to find no less than a difference of some 30 to 40 per cent. in the idle plant in various shops. The idle plant varied from 17 to 52 per cent. That showed a case for inquiry. He agreed as to the difficulty of depreciation, but if proper standards were adopted, such standards *ipso facto* meant that the man and also the machine should be kept up to the work if the output were to be kept up. If machines were examined and repaired at certain intervals depreciation would become a decreasing item. In some businesses in America it was found to pay to employ one timekeeper for every 32 men. There were gangs of men, each gang being composed of different nationalities. After certain work was done, the gang were told by the timekeeper what they had done, and the other gangs tried to overtake them.

Mr. J. W. Carley (Alfred Cauldry & Company, Ltd., printers, &c.) said some men would do as much in four hours as others would do in six. How would that be dealt with under the costing system ?

Mr. Hickley (Erith Oil Works) asked whether Mr. Boyd had experienced an attitude of suspicion on the part of the worker and the union leaders towards cost records;

Mr. Grant thought the records would not be of much use without a scientific method of rate fixing, which the lecturer seemed to have missed.

Mr. Kirkwood asked to what extent cost systems were in operation in this country. Mr. Edward M. Hurry said that in the United States not 10 per cent. of the manufacturers carried on a sound costs system.

Mr. W. R. Clemens asked what agreement the lecturer had found between the costs records and the final financial accounts in the establishments he had visited in the North of England and in Scotland? The cost account did not always include the overhead charges.

Mr. Elbourne said there was running through the Paper a tone of special pleading for the function of the accountant in charge of the costs accounts. In any work, costs were but an element of statistics, and to discredit statistics in general because of the absence of money values was also special pleading. That was part of the propaganda to claim for the accounnant functions which could only be carried by the engineer plus the accountant. For accountants to say they would point out the weak spots and where to attack, and so on, was all nonsense. He was afraid there was an attempt to make scientific management an elaborate fault-finding method, whereas what was wanted was means for co-ordination. Overhead management was just as much "fundamental" as the wages of the worker. He thought the terms "direct costs," "secondary costs," and "on costs" might be adopted.

Mr. Whitfield also asked whether the lecturer had had experience of placing costs before the workers, and if so what were the results?

Mr. Charters asked whether the lecturer suggested that employees should be actually allowed in the offices of the firm when cost records were being prepared?

The Chairman said managers did put figures before workmen, who were rightly suspicious of them. A man who had another man watching him with a watch in his hand, wanted to know what was in the wind, and was afraid he would soon want a new job. He had had a copy of cost figures supplied to him, but in an interview with the commercial manager, the chairman of the company and others, they all denied the accuracy of the figures. One lie that went round the country was that 75 per cent. of the cost in the iron and steel trade was cost of labour, and the Iron and Steel Institute said the men earned £20 a week, and that was why we could not compete with Germany or America. The secretary of the Steel Smelters' Union replied that the smelter had to produce a ton of steel for 8d. Details of the cost should be given to the workmen before they would respect the employers and their figures. When the men saw the employers' books they were so elaborate that no ordinary mortal could see what they were driving at. Notwithstanding that, he was for scientific management and costing systems.

Mr. Atkinson said he was at present introducing a costing system into one of the raw material industries, and he found the ignorance was appalling. In the case he was dealing with they had 20 different works, and in some cases they had one furnace or one machine working in a department, and the whole of the cost came on that one machine, out of, perhaps, 10 or 12. When only one was going it had to bear the whole of the overhead charges. When employers and workers were discussing questions between them, and it was found one firm was paying 20 per cent. profit and another nothing, it was difficult to get the workmen to understand the situation.

The Lecturer, replying to the discussion, said there were three kinds of accountants, the financial accountant, the stores accountant and the costs accountant. He had been handling costs for the last 20 years, and had never been used to anything but the engineering or the management side. The engineer was an executive officer, who had to do certain jobs, and the costs accountant was there to do all he could to help the engineer by showing him the result of the work he was doing. The figures on which the standards were based, the planning of the work and that kind of thing was, in fact, produced by engineers, and the accountant got the combination between the engineering side and the money side which made costing really effective. The costs accountant was probably two-thirds technical and one-third accountant, and he did not usurp any executive powers from the engineer or anybody else. The terms used in costing was simply a question of usage. He had mentioned terms which he had used and understood. With regard to standards, he recommended those interested to get copies of the report of the first lecture of that series. He knew that a suspicion on the part of workers did exist regarding cost figures. He pleaded that the thing should be put down as A, B and C. One could not expect the workmen to understand figures fired at them. He wanted to encourage the workmen to believe, and to do so by being honest. He had used figures in dealing with workers, with extremely satisfactory results. If standards could be transformed into money the workmen could realise them. He was a believer in graphs, as he could pick up points more quickly from them than from a statement of figures, but there should be a statement alongside the graph. He agreed that depreciation should be included in the standards. The standards had to be eventually translated into money. He advised doing that via the costs accounts. The full value of the costing system could only be obtained when used in conjunction with the introduction of standards and planning of work, but in a factory where time sheets or job cards had not been used a certain amount of elimination of waste would be secured by the costs system before the standards were fixed. Rate fixing was properly dealt with in lecture No. 3, and did not come within the scope of the present lecture. In the tour he had made in this country he found efficient systems were very rare. It was absolutely necessary to tie up the cost accounts with the financial accounts. To check idle time on machines, one should take the number of machines, consider the kind of work done, fix the standards, record the output, and compare the two together.

Trade Prospects in India.

The post-war prospects of British Trade in India are discussed by H.M. Trade Commissioner at Calcutta in the last issue of the "Board of Trade Journal." It is stated that the export of American iron and steel products to India increased by 700 per cent. in the past four years and that this competition will probably continue after the war. In addition, the Indian steel industry has greatly expanded during the period of the war, and it will have an adverse effect upon the demand for British goods. Prior to the war, British machinery was paramount in India. With the exception of a certain amount of flour and rice-milling machinery, electrical plant, &c., which came from Germany, and relatively small quantities of mining and oil-crushing machinery drawn from the United States, British manufacturers held the field owing to the very large regular shipments of textile plant, electrical machinery, prime movers, boilers and plant for every industrial purpose. During the war British shipments have been maintained to a remarkable extent, but the competition of the United States and Japan has received a stimulus which will be found difficult to meet. The competition of the United States is most serions and is likely to be permanent. American manufacturers have obtained a foothold from which it will be difficult to dislodge them, particularly as regards electrical machinery, mining machinery and machine tools. American engineers have secured a strong position in the nascent Indian steel and hydro-electric enterprises, and British makers will find a difficult task before them to regain the ground which has been lost during the war.

SELLING ORGANISATION WANTED.

With the extension of industries in India, which is likely to be one of the dominant features of the next decade, there should be an enormous opening in the country for machinery of all kinds, and particularly for machine tools. In the past many large British manufacturers have been content to be represented in India by mercantile agents, and have left the whole of their business to these firms. So far as the principal lines of machinery are concerned, British manufacturers, who already have a large interest in the market, would be well advised to open an office and selling organisation in India and to develop their own business. In cases where the trade to be obtained does not warrant a manufacturer going to the extent of maintaining his own organisation, it would be advisable for him to co-operate with, say, half-a-dozen other manufacturers of non-competing articles and to form a group-selling organisation in India. There are two outstanding facts which should be borne in mind by the British machinery maker: (1) That the tendency will be more and more to cut away from the London connection and to call for more and more tenders in this country; and (2) that if British manufacturers are to continue to retain the same proportion of orders which they have secured in the past, they will be obliged to open their own branches in India and operate them with a trained staff; and also, in the case of manufacturers of large plant, with a competent staff.

In railway plant and rolling stock the United Kingdom has very little to fear at present from foreign competition. The existing system of purchases in London by the India Office Stores Department for State-worked lines, and by the London offices and consulting engineers for company-worked railways, is of the greatest advantage to British manufacturers. The competition which will become increasingly acute in the future is that from India itself. Considerable contracts for wagons have already been awarded locally, and more than one prominent engineering firm in India is paying close attention to this trade.

The recommendations of the Industrial Commission, which advocated the appointment of a Controller-General of Stores in India, will, if adopted, bring about an entirely altered situation, which will require to be carefully studied by the home manufacturer in his own interests. Under the proposed scheme, all indents for public works and Government railway stores will be carefully scrutinised by the Stores Controller in India, who will call for tenders and place contracts for such articles as can be made in the country, and will then forward the balance of the indents to London for placement in the usual manner. British manufacturers of railway plant with large vested interests in the import trade of India should take early steps to open their own offices in the country.

The trade in mill and engineering stores for the jute and cotton mills, engineering works, collieries and the various small industries of all kinds which are springing up in India, is already of considerable dimensions, and is certain to materially increase in future. A very large proportion of the requirements of these industries, particularly in Bengal, where the firms of managing agents are usually British, is purchased through the London offices of the managing agents, but there is a tendency to purchase in Calcutta from local merchants who specialise in this type of business and are able to sell from stock.

From the above it will be seen that British manufacturers and exporters will have to face much more intense and sustained foreign competition in the future than they have experienced in the past. That from the United States will be in machinery, metals and hardware, and from Japan in textiles, metals, electrical accessories, cables, and the numerous articles which make up the bazaar trade. In order to compete successfully the British manufacturer must bring down his costs of production to a competitive level, maintain his unexcelled quality, and take a much more active interest in the distribution of his products than he has done hitherto. In the case of machinery, plant and articles for which there is a constant and large demand, he would be well advised to conduct his own distribution in the country. In any case, wherever possible, he should visit the country, and realise for himself that the India of to-day is a very different place, presenting much more difficult and complex problems than the India of pre-war times.

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A Misguided Government Publication.

There has recently come on the market what is known as the "Technical Supplement to the Review of the Foreign Press," issued by the General Staff of the War Office. This publication was started during the war by a very natural process of evolution. It had been found desirable to have a review of the foreign press, and as time went on there also sprang up a demand in various technical departments of the Government for information as to what was appearing in the foreign technical press. Such information was therefore collected, and gradually became sufficient in volume to be printed every fortnight. In due course it was issued to the technical journals of this country, though public reference very naturally was not made to the publication itself. Later on, reference was permitted; and now we have reached the stage where the Supplement not only may be mentioned, but must be acknowledged when quotations are made therefrom, though it is difficult to see why the taxpayer should not have the free use of that for which he has paid.

Now, there is no question that this publication served a very useful purpose during the time of war. Foreign journals were not readily accessible, and consequently there was no ready means of knowing what was appearing in them; but what justification is there for such a publication at the present time? Similar work is being done, and has been done for years, by many of the engineering and technical societies. For example, there is "Science Abstracts," and there are abstracts published by the Institution of Civil Engineers; the field of chemistry is excellently covered by the Society of Chemical Industry and by the Chemical Society, and there are many others besides. Why then should this further publication be continued in competition with others, and why should it be proposed (indeed, we understand it has already been decided) to make it a permanent work, not merely issued by the War Office, but sold by the Stationery Office or through any bookseller at sixpence every fortnight. There is undoubtedly an active campaign in an attempt to push the Supplement, and we received a circular at the Government expense only the other day stating its objects. Presumably it will be said that such work can be done more cheaply and more efficiently by the Government, more particularly when such matters as circularising are not taken into account. In a leading article in "The Times" of the 6th inst., we read that the War Office proposes permanently to employ 120 experts to prepare a weekly review of the foreign press. We do not know how many of these will be concerned with the "Technical Supplement," but we do not doubt that there will be a suffiicent number to render the publication costly, whereas it is common knowledge that "Science Abstracts" is run with an editor and a couple of typists. The abstractors, who in this case are undoubtedly experts, at present number 74, and they do the work for little more than the privilege of receiving Papers in which they are interested. The result is that "Science Abstracts," like many other publications of scientific societies, is turned out cheaply, and it has the advantage of extending over many years. The value of such work depends largely on continuity; yet the Government comes along to duplicate all this existing work with a publication which is now only in its fourth volume.

Although the "Technical Supplement" nominally deals only with the foreign press, we notice that it does now deal to some extent with the journals of this country. This is no doubt essential, but even so, if we refer, for example, to electrical engineering, we find the ground is not nearly so comprehensive as that covered by "Science Abstracts," nor can it be said that the work is well done. Thus, in the current issue we notice an abstract on Storage Batteries, in which we are solemnly told that "the storage battery consists of one or more cells, each containing positive and negative plates immersed in an electrolyte, which, in the case of lead storage batteries, is H_2SO_4 and H_2O. The electrolyte combines with the lead peroxide of the positive and metallic lead of the negative plates, forming lead sulphate and reducing the gravity of the electrolyte from, say, 1·275 to 1·175, or lower for a full discharge. In recharging the battery D.C. is passed through in reverse direction to the current discharge, the plates returning to their original consistency and the acid to its original strength. . . . Batteries should not be over-discharged, and the maximum drop in gravity should not exceed 0·125. . . . If the rate of re-charging is too rapid, the excess of current will decompose the water of the electrolyte, which will give off bubbles of gas forming a dangerous explosive compound with the air and wasting the active material in the positive plates." We ask: Is this seriously worth sixpence? In another abstract on a traction system we read that "in each sub-station the primary current after admission passes through the lighting arresters and then through the switches, which distribute it to successive sub-stations . . . where static 3-phase transformers reduce the tension from 45,000 v. to 450-500 v. The current then passes into the converters, which rectify it, and raise the tension to from 600-650 v." Later, we learn something of the system of suspension of the "secondary aerial." Abstracts of this kind make one wonder whether the experts have gone away for a holiday, and whether the work is being done simply by the War Office clerks! The function of an expert is not merely to include what is useful, but to exclude what is absurd to commonplace.

If, now, this Supplement is not required, and the work is not well done, then what is the explanation of this persistent effort to place a Government publication in competition with existing well-known publications run by private enterprise? There is little doubt it is due to the fact that those who found Government jobs during the war wish to continue their activities and retain their positions. This, however, should not be a sufficient reason for any Government, which has to face the serious financial conditions of the present day, to pursue such a policy. If the Government wish to assist technical effort in this direction they should help those societies which already have the work in hand. It will cost them far less and the result will be far more satisfactory. The present case is only one of many which swell the present orgy of extravagance and make the ordinary citizen feel hopeless over the continued war expenditure of £4,500,000 a day. The sooner the Government realises the need for cutting away from all war expedients that are not required in times of peace, and realises the need for efficient effort alone, the better it will be for the nation.

Electric Welding: Its Theory, Practice, Application and Economics.*

By H. S. MARQUAND.

(*Continued from page* 141.)

Summary.—In the present article the author deals with the preparation of welds and then passes on to certain properties of iron and mild steels which have a marked bearing on the methods adopted. The welding of copper and copper alloys has not received very much attention, but electric welding is nevertheless applicable to such work. Finally, examples are given of various types of welding.

Fig. 72 is a drawing of a broken cast-steel crankshaft which is one of several successfully welded with the metallic electrode by the author's firm. The dotted lines show the shaft preparatory to welding.

Electric welding has done much to lessen the cost and time for repairs, but perhaps in no sphere is this more manifest than in marine engineering, and in boiler repair work generally.

The following illustrations are a few examples of repairs effected by the author's company which were carried out to the satisfaction of the Surveyors of the Board of Trade, Lloyd's Register and the various classifications and boiler insurance soceities, which is the best guarantee of their reliability and efficiency.

Fig. 73 illustrates repairs effected to the main boilers of a large cargo vessel. The fractures, extending circumferentially in the radius flange of the front ends of the boilers, were cut out to the full section of the plating, Veed out and welded up as shown, partly from the water side and partly from the outside. The landings were then built out and extended over the fracture, so as to strengthen the whole flange; also the wasted and defective plating of, and in the way of, the manholes was built up solid as shown, and the doors re-fitted.

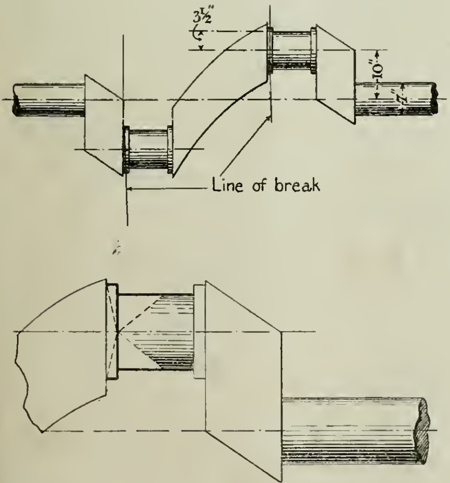

Fig. 72.—Cast Steel Crankshaft Broken Off Between the Web Repaired by the Electric-Arc Welding Process.

Dotted Line represents the Ends prepared for Welding.

In boiler work and general repair work the metallic arc system reigns supreme, as work can be done in situ and in any position so long as there is sufficient room for an operator to work.

An expert welder can carry out extraordinary repairs in places which seem almost impossible. Recently the writer's company reclaimed four large Lancashire boilers at a colliery in the Forest of Dean. The boilers had been worked with very bad water, with the result that in four years the expansion rings and flanges on the water side of all the sections of the furnaces had wasted away to such an extent that the boilers were condemned absolutely by the insurance society.

In addition, the furnace plating had pitted and wasted in the narrow spaces very deep. The radius flanges on the water side of the front, end and back end shell plates in way of the furnace ends had grooved abnormally.

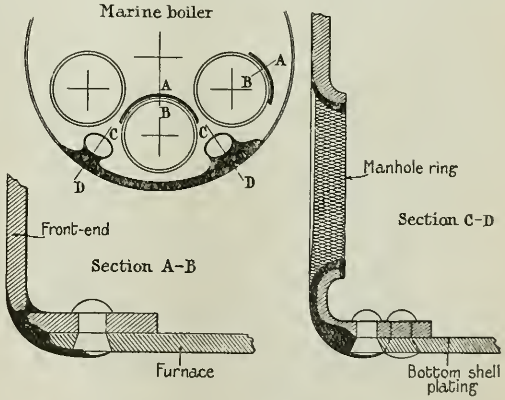

Fig. 73

Serious wastage had taken place in all parts of the water spaces. These boilers were repaired in situ entirely by the electric arc process, with no removals whatsoever, at a cost of between £300 and £500 each. The work took three months. On completion, a cold water test of two and a half times working pressure (200 lb. steam) was put on the boilers by the insurance surveyors; and, after a thorough internal and external examination each boiler was passed for full working pressure.

A new boiler was quoted at £1,800 and delivery uncertain.

A great variety of work on boilers, land and marine, is being carried out every day. This work consists of welding up defective and wasted landings and caulking edges, cutting out and welding up solid lap fractures in seams, fractures in furnace plating, fractures in shell plating, which commonly occur in the radius flange of the front end plate round the furnace fronts (Fig. 74. *See* page 176).

(*To be continued.*)

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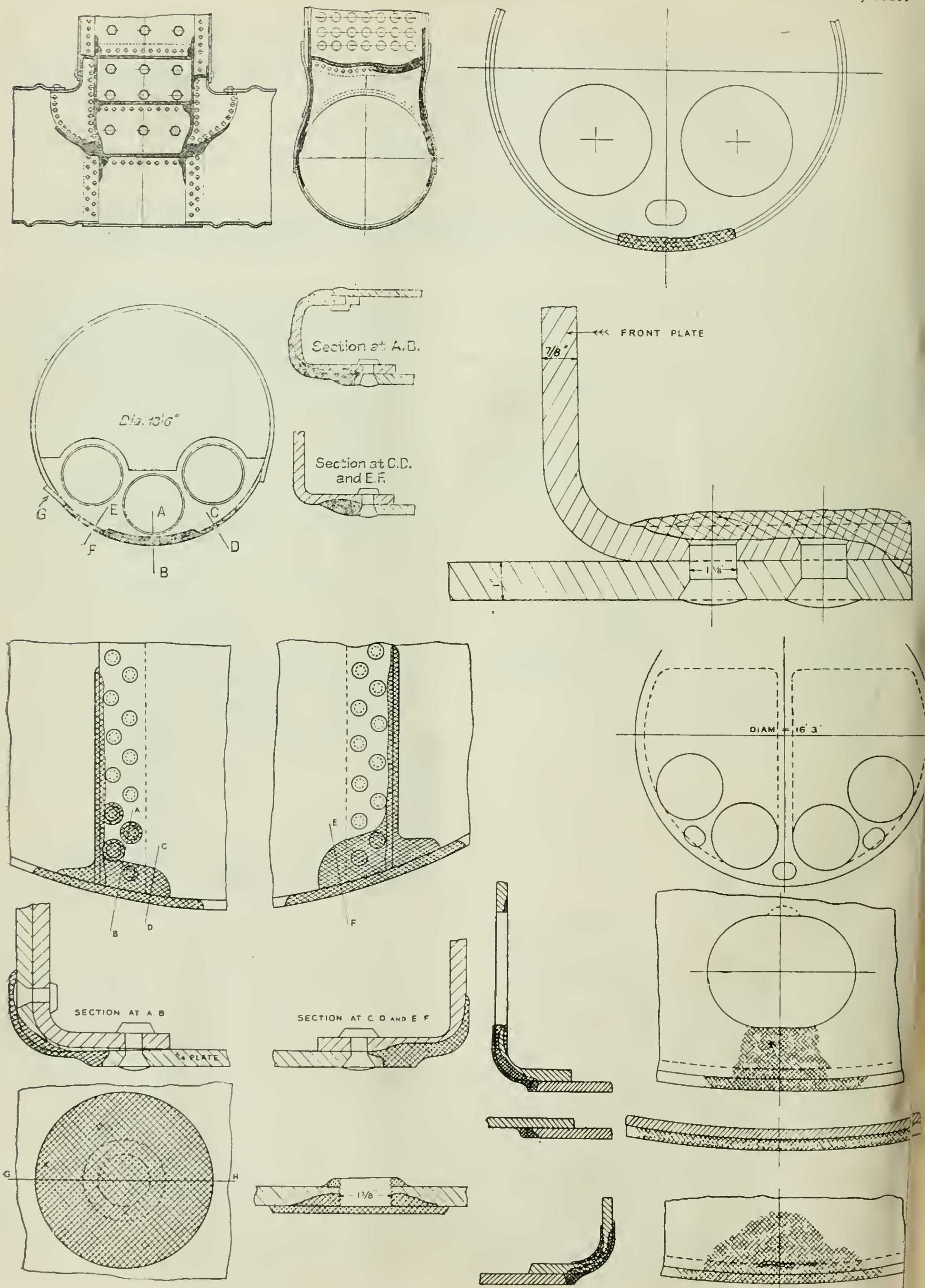

Fig. 74.—Drawings showing various Welds in Connection with work on Land and Marine Boilers.

The British Scientific Products Exhibition.—IV.

Miscellaneous.

The Concordia Electric Wire Company showed a large variety of enamelled, silk, cotton and asbestos covered copper wires, flexible and high resistance wires of various alloys, as well as insulating materials, varnishes, silk, linen and paper tapes, shavings and compounds Their products included charcoal iron binding wire and fuse wires, so that almost anything required by the instrument and armature winder can be supplied. The asbestin covering looked like a considerable advance in heat-proof coverings. Messrs. Gent & Company had some electrically-controlled clocks and mine signal apparatus that were worth more than passing attention by the managers of large factories and institutions where the distribution of accurate time is of importance to discipline and efficiency. The master clock or controller is a seconds pendulum with electric maintaining movement, which sends out impulses every half minute from a scape wheel. These impulses drive all the clocks, time registers and time signalling arrangements. The "programme ringer" will operate any number of bells, buzzers, syrens, &c., for starting and stopping times. It is set by inserting pins in holes round a wheel, which is marked at every minute of the 24 hours, at the corresponding time the signals are given. If all the works, office clocks, and time registers are driven by the same controller there can be no irritating claims or complaints of clocks being wrong. The apparatus shown included the movement for a four-dial turret clock, with a very pretty "waiting train" arrangement. The clock is driven from an independent source, and has an electrically-maintained pendulum. The half-minute control impulses only have to remove a detent from the turret clock gear, which detent comes into action when the scape wheel has made a half-minute run. The turret pendulum is apparently adjusted to be a shade fast, and is corrected by the action described every half minute. The 25 ft. dial turret clock on the Royal Liver Building at Liverpool is controlled in this way, clear proof that the arrangement is of ample power for anything needed. The Telephone & Microphone Company showed a number of microphone telephone sets for the partially deaf. Small size, lightness and unobtrusive appearance have been carefully studied in the design. The apparatus should be examined by those who find their hearing less acute than is convenient, or who have friends afflicted. The telephone and microphone have not hitherto been made so useful to the deaf as they should have been.

The Rapid Magnetting Company only showed prints of its machines, and samples of the separation effected of feebly magnetic ores, &c. These included wolfram, tin, monazite sand, zinc blende, corundum, &c. The process greatly accelerates these separations, refractory to other methods. Those who have seen (and they need not be very old to have seen it) a woman removing iron from swarf with a horseshoe magnet will recognise the great advances made in recent years in this application of magnetism. As there is a considerable variation in the permeability of many non-ferrous minerals and earths the methods are likely to have further application. Messrs. Fuller's showed a number of patterns of their well-known "block" accumulators, and a convenient charging rack for miners' lamp cells. This rack takes 80 cells on a floor space about 5 ft. by 2 ft. 6 in. by 7 ft. high, including an instrument board at the top. Each cell is pushed on to a porcelain platform, contact springs come on to its terminals, and provided that care is taken to bring the clearly marked word "Front" outwards, the polarity is right. The lamp in which these cells are used has the lamp over the battery container. This may suit the coal getter best, but for some other purposes the lamp would be most conveniently placed below the container. The same firm showed ignition accumulators of the plate type, and dry cells of various sizes, some of them for ignition purposes. Messrs. Fullers now manufacture electrical carbon, and showed arc lamp and battery carbons, plates, &c., in great variety. Covered wires and cables up to quite large sizes were among their exhibits. It is understood that the manufacture of large cables and carbons represented war-time developments. There were a considerable number of magnetos for car and aero engines on view. Messrs. Vickers showed some in operation on six and eight plugs. The Runbaken Magneto Company, Ltd., besides magnetos, showed a magnetiser for treating magnets which have become weak from age or accident. This was simply a horseshoe electromagnet on a suitable stand, which can be excited from any continuous-current supply. It would no doubt be found useful in garages and repair depots, where a person of sufficient knowledge is available, but good permanent magnetising may not always result.

Isenthal & Company showed some of their well-known rheostats of various types. The switchboard patterns with worm driven contacts looked very substantial.

Messrs. Johnson, Matthey & Co., had a show of rare and precious metals, salts and alloys. Of electrical interest were the iridium targets mounted in massive copper for X-ray tubes. No solder or flux is used in their construction in the interests of permanency. There were also iridio-platinum sparking contacts, platinum silver and other resistance wires, and a model of a standard iridio-platinum metre which has a world-wide influence on length standards, as the master standard of La Commission International du Metre. Barium-platino cyanide and a fluorescent screen made with it were on view. Sanders, Rehders & Company showed their well-known "Sarco" flue-gas recorder, and a small portable set for accurate CO_2 determinations, the "Sarco" steam meter, which is a fairly novel instrument, and should be of great value in keeping a watch on steam consumption. More novel yet, and of great possibilities, was a recording gas calorimeter. This instrument records on a chart the calorific value of a gas supply continuously. The principle is that a carefully measured quantity of gas is burnt under a vessel filled with oil. The oil temperature is indicated at any moment by its volume, and changes of volume move a float which controls the chart pen This rough description will suggest that there are detailed arrangements necessary for oil circulation and so forth, which seemed to be well provided for. It is hardly necessary to point the utility of the instrument in controlling the working of gas producers, checking the value of waste gases, &c. Increased use of gas for the production of electrical energy is foreshadowed, so that electrical men who wished to be ready would have done well to take note of apparatus of this kind. There were other CO_2 recorders on view, but they seemed to be of well-known types.

"Stainless Steel" was, of course, shown in numerous forms, manufactured and in process. Demonstration samples in bottles of salt water and vinegar showed that these liquids do not even dull its polish. There should be a great future for this material. From a set of test pieces with varying heat treatment records, it appeared that this steel retains its strength under treatments which destroy the strength of ordinary steels, a quality which may also be of value in various ways.

The National Physical Laboratory exhibited some very fine photo-micrographs of steel, copper and aluminium alloys illustrating the effect of heat treatment, good and bad. Some of these represented "season cracking," which was shown to be a rupture or pulling apart of adjacent crystals as the result of prolonged applications of stress. Generally metals rupture across crystals, not on the crystal faces. The information on this and other points should be useful to manufacturers of metals and metal goods generally. Heat treatment and stresses set up in manufacturing processes have a great effect on the strength and reliability of the products. These effects are daily becoming less mysterious and more under control.

The exhibit of the Aeronautical Inspection Department would require a whole issue of The Electrician and then some for reasonable description. The great number of instruments which have been developed for aeronautical purposes is a revelation even to some who thought they knew something about instrument making. It is impossible to mention the majority of them. Of electrical interest were the wireless telegraph and telephone sets, marvels of compactness and lightness. Lieut.-Col. Cusins' recent lecture to the I.E.E. gave some account of these, and the principles on which they are founded. The thermionic valve is conspicuous in this war development. Remembering that before the war wireless reception on an aeroplane was considered impracticable, the advance to telephonic speech reception, as well as transmission is a big leap. Among other equipment the tendency was noted to use electric revolution indicators, flexible drivers not being reliable, compasses designed to annul as far as possible the effects of vibration, &c., a somewhat different problem to the ship's compass, gyroscopic turn indicators driven by three-phase motors, directly by the air-stream, and indirectly by gearing from an air-screw, and electrically-heated clothing for the crew. An airship telegraph used the well-known principle of two position switch control of lamps, &c. A three-core cable runs between the pilots and the engineers' stations, with a bell or light signal at each place. Normally the circuit is open. The pilot, by turning over his switch, closes it and gives the signal. The engineer to acknowledge the signal turns over his switch, and opens the circuit, showing to the pilot that the signal is received. Neither has to touch the switches again until the next signal is given.

It remains to be said that there were some very fine exhibits of other than electrical apparatus. Notably the optical and chemical exhibits. Messrs. Chance, Adam Hilger and others showed that neither in making nor applying optical glasses need there be any future dependence upon foreign manufacturers. Chemical manufacturers too numerous to mention showed that the same thing was true in respect to an enormous variety of chemical products, especially those of the organic class, including dyes and drugs.

It was somewhat unfortunate for anyone who wanted to make a close study of any department that the space available in the Central Hall was far too small, the show cases were crowded together and by no means well illuminated in many cases. The popularity of the exhibition was also too great for leisured examination—at least at the hours when most people found it possible to spare time for such things. But altogether it was a fine show, one of which there was no reason to be ashamed, rather reason to be surprised that so many firms contributed so liberally, with articles of the finest finish, after the stress of five war years.

In our reference to instruments, Messrs. Nalder Bros. & Thompson's exhibit was inadvertently omitted. It was notable for a case of their instruments, uncovered and with the essential parts of the movement dissected. These dissected instruments were of the moving-iron, d'Arsonval moving coil, and dynamometer moving coil-type respectively, so that anyone could see how they were made inside. The induction dynamometer type was novel. The moving coil is the secondary of a transformer, so that there are no connections to it. One advantage is that in such things as synchronisers and power-factor meters no resistances in circuit with the moving coils are required for circuits up to 600 volts. The elimination of connecting strips, springs, &c., is another, especially in portable instruments or any which have to be shipped abroad. Portable standard sets with volt and ammeters, shunts, &c., were shown in convenient cases, some designed for high accuracy, and others for less exact work. Some electrostatic insulation test sets were worthy of notice. They are lighter than permanent magnet sets, and unaffected by external fields. A very venerable production of this firm was shown in a modernised form—viz , an automatic battery charging switch.

Heating and Cooking Notes.

Addressing the members of the Batti-Wallah Society concerning the activities of the Electrical Development Association, Mr. J. W. Beauchamp reminded electrical manufacturers that it was useless for the E.D.A. to promote a demand for electricity unless the manufacturers prepared themselves for the production of the necessary apparatus. Present evidence seems to point to there being no lack of suitable heating and cooking apparatus, for not only have the old established firms shown increased activity since the armistice, but several new-comers to this field have entered into progressive peace-time efforts. Messrs. Belling & Company have laid themselves out to produce household cooking and heating apparatus in large quantities and have produced several new types of apparatus. The Carron Company have still further developed their restaurant and canteen equipment. The British Electric Transformer Company, makers of the well-known "Tricity" appliances, are opening large show-rooms adjoining "Tricity House." These show-rooms will be furnished and equipped as a private house and "Tricity" apparatus will be installed therein and demonstrated to the public. It is proposed to demonstrat only, no sales being made, so that contractors and supply authorities will be encouraged to send clients to inspect the apparatus in actual use. The Jackson Electric Stove Company, Ltd., have interesting developments in hand, details of which cannot yet be announced. All this is healthy evidence of progress, but why is it limited to heating and cooking apparatus ? With the development of electricity supply and removal of war restrictions combined with an increased difficulty of obtaining domestic help there will come a demand for other household appliances such as vacuum cleaners, dish washers, knife cleaners, potato peelers, washing machines, &c. Such appliances have long since obtained an established footing in the United States and provide not only a profit to the manufacturer but a day load for the supply authority. Are we going to be content to import these articles or will some of our enterprising electrical manufacturers prepare to meet the demand by making these articles ?

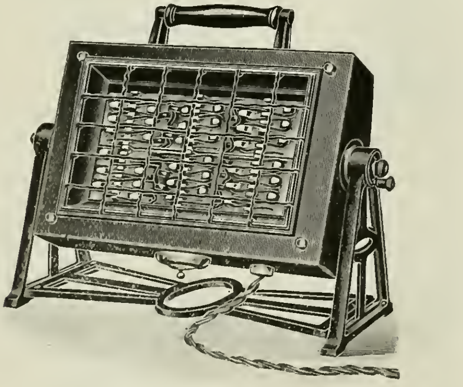

Fig. 1.

An Adaptable Electric Fire.

With a view to providing a portable electric fire which would be of maximum utility, the Imperial Engineering Company, of 61, Darlington-street, Wolverhampton, have placed on the market the fire shown in the accompanying illustrations. Radiant type elements are housed in a cast metal box type frame which is suspended on spindles mounted on a cast frame. A spring controlled plunger locking device fixes the element frame in either of the three positions shown in the illustrations. Fig. 1 shows the apparatus in use as an ordinary electric fire of a portable character. In Fig. 2 the element frame is in a horizontal position and the apparatus can be used as a boiling plate, whilst in Fig. 3 the position is reversed and the apparatus can be used as a grill. This piece of apparatus should form a useful introductory medium for heating and cooking apparatus. As a fire it is useful in a bedroom in the morning and evening, or could be employed in the drawing room or study for piano practice or reading in comfort on chilly days. When not required for use as a fire it can be usefully employed for cooking purposes.

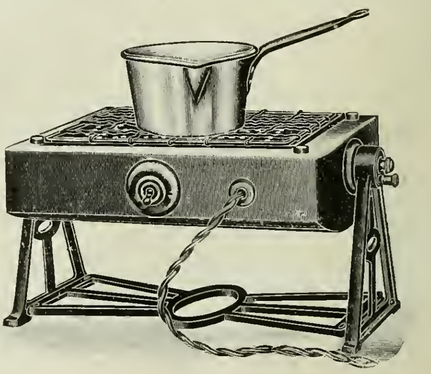

Fig. 2.

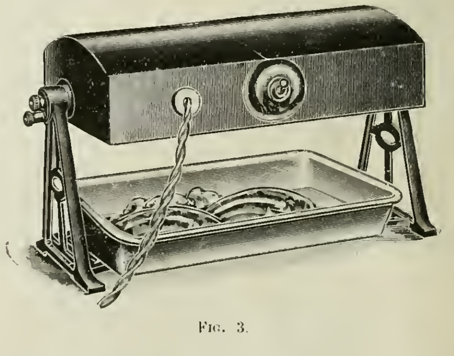

Fig. 3.

The apparatus is well designed and should give useful service. A stout wire guard protects the elements from accidental contact or mechanical damage. The elements can be easily replaced on the removal of two nuts. Bare metal is used for the connection wires and these are rigidly supported on porcelain insulators. A tumbler switch is mounted on the back of the element frame and allows one element to be switched off and flexes provided ready for connection to a plug top. The elements are two in number and consume 500 watts each. The same firm are also producing an electric toaster, and a 500-watt single element heater for use in offices and workshops. The latter is illustrated in Fig. 4.

Messrs. Quead, Ltd., of 47, Marylebone-lane, W. 1, have produced a one-bar "Industrial Fire" for use in offices and factories. It consists of a Quead Fire Bar mounted on a strong iron base and protected by a perforated steel cover. The element can be supplied wound to consume either 600 or 1,000 watts as desired. Four holes are provided in the base to facilitate wall mounting. This type of heater is very suitable for use under desks in offices, or stores, on trams or in crane cabins. Also in large rooms where a more even distribution of heat can be obtained by distributing such small power units around the room.

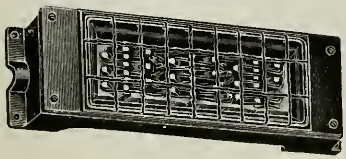

Fig. 4.

Correspondence.

HIGH VOLTAGE TESTING.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : In specifying conditions for carrying out official high voltage tests on electrical plant, it is a common practice to require the employment of testing plant exceeding a certain kilovolt-ampere capacity, and in many cases this presents difficulties to manufacturers. Such apparatus is seldom readily portable, and, further, where the pressure is of the order of a few thousand volts, it is sometimes possible to carry out the test under conditions practically eliminating risk to life by limiting the output by means of series resistance, or in other ways.

It is thought that the above requirement was framed, in the first place, to prevent the use of testing plant having insufficient output to supply the capacity and normal leakage currents taken by the plant under test. If the voltage falls away due to the flow of current two objectionable conditions may arise. Firstly, the means employed to indicate voltage may no longer be reliable, and secondly, a defective part which might break down during test if the current and consequent heating were maintained, may not be damaged, and may thus pass test if the current falls off.

It is suggested that provided the testing plant is large enough to enable the pressure across the specimen to be maintained the test will be adequate, even though there is a large internal drop in the testing plant. If the voltage is measured direct across the part to which the test is applied, as, for example, by an electrostatic voltmeter, there can be no question of the accuracy of measurement, and if the voltage is maintained it follows that the current in the part tested will also be maintained.

If so large a current is taken that the voltage cannot be maintained, the test cannot be considered as passed. That no damage may have been caused is then purely incidental, but may save loss of good material.

This subject is attracting attention in certain quarters, and it would be of assistance if your readers could show cause why a test so conducted should not be considered adequate and satisfactory. The suggestion is that the only requirement necessary as to the size of the testing plant is that it should be large enough to maintain the specified voltage across the part tested for the full period of the test. The voltage should be measured directly across the part tested, unless the size of the testing plant is such that there is no falling off in pressure due to bad regulation during the period of the test.—I am, &c., E. B. Wedmore.

London, August 8.

THE DEVELOPMENT OF THE POULSEN ARC SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : Mr. Gandil in his letter published in your number of July 25 affirms that he is not aware that I organised the American Company and also says that under agreements dated Sept. 12, 1911, the Poulsen-Pedersen patents were acquired for the U.S.A. He is either misinformed or loath to allow me the credit for foreseeing in 1909 that the Poulsen system was capable of being developed into the system which is the vogue to-day, as witness the 20,000 kw. of Poulsen arc generators which I estimate to be now in use.

I have before me the original contract, dated Aug. 27, 1909, between the Danish owners of the Poulsen-Pedersen patents and myself, giving me an option to purchase these patents for the U.S.A. ; and the articles of incorporation of the Poulsen Wireless Telegraph & Telephone Company, of America, a company organised by me, dated Oct. 6, 1909. I know of no prior organisation formed to work the Poulsen-Pedersen patents in the U.S.A.

The above-mentioned original contract was modified several times before the final transfer of the Poulsen-Pedersen patents, and I have the originals of these contracts before me, as also was the American Company itself, both as to capitalisation and the name employed. This does not change the fact that I did organise the original American Company and was identified, as a director and chief engineer, with all the reorganisations and changes of ownership until I severed my connection with the Company in July 1913. Up to that time, and for some time later, I was the largest individual shareholder of all the various companies, except, perhaps, the Danish vendors.

My visit to Knockroe was of the briefest description and I was certainly given to understand that the arc was furnished by Lorenz of Berlin. As to knowing that the arc was Danish and not German, from the mere fact of taking measurements, I can only say that I did not take "most careful" measurements, but that a glance at it showed the difference between it and the Danish arcs with which I was, up to that time, acquainted. The chamber, as I remember it, was of the order of dimensions of the Danish 5-kw. purchased by me and its field coils were wound with fine wire, being separately excited. The anode tip was even smaller than, *e.g.*, the one used by me to-day for 3 kw.

Mr. Gandil "presumes" that as a result of my visit to Knockroe I was able to build a successful 30-kw. arc, worked at 50 kw., to demonstrate to the U.S. Naval authorities. It would be interesting to place the two arcs side by side and see how closely they resemble one another. Having seen both, I can say that there was no comparison between the dimensions of their vital parts, *e.g.*, chamber, anode, cathode, pole pieces, and that the field coils of my 30-kw. arc were not separately excited.—I am, &c.,

Paris, August 7. C. F. Elwell.

"PAPERS ON THE DESIGN OF A.C. MACHINERY."

TO THE EDITOR OF THE ELECTRICIAN.

Sir : Prof. Miles Walker has ably exposed one of the fallacies of Arnold's method of calculating leakage (as re-written by Dr. S. P. Smith in the recent excellent book with the above title).

There is, however, an additional error, this being in the method of calculating end winding leakage. It is apparently assumed by the author that all the flux linking with the stator overhang is leakage flux. This is by no means the case. It is only the flux which fails to cut the rotor winding which is leakage flux ; that is, the flux which gets out sideways and endways between the stator and rotor windings.

If the rotor winding be approximately a reflection of the stator winding, the upper limit of integration for the overhang leakage flux should be the distance between the stator and rotor end windings (the centre lines being taken for this purpose), and not the dimensions of the stator (or rotor) coil alone as given by the author unless these dimensions happen to be less than the distance between the windings, which is hardly likely to be the case.

On the other hand, contrary to your reviewer's criticism, the writer would like to compliment Dr. Smith on the method he has adopted of considering the action of an induction motor from the point of view of two separate stationary alternating fields.

The usual method of treatment of a rotating field undoubtedly causes the majority of students—and qualified engineers, too—to consider a line of force to be a physical entity which can be taken hold of (by a coil, for example) and pulled bodily along in space, producing an E.M.F. in any conductor it passes over. When dealing with heteropolar machines this false physical conception causes little difficulty except in special cases, but the moment homopolar machines are considered, it produces an entirely erroneous idea of the action of the machine, which is generally accompanied by a good deal of confusion of thought.

An E.M.F. can be produced by induction, or by motion of a conductor in a field, but it can never, never be produced by taking hold of a line of force and moving it across a conductor. The ordinary rotating field theory practically assumes this impossibility, but the method criticised by your reviewer does not offend against the above fundamental truths, and is a great help towards clearness of thought.—I am, &c.,

Newcastle-on-Tyne, Aug. 6. Laurence H. A. Carr.

Telephony at the Theatre.

An interesting telephone system has recently been installed at the Princess Theatre, Crayford, by the Western Electric Company, Ltd. The system was originally produced by the company in America with a view to enabling people suffering from deafness to hear the service, and for want of a better name it has been termed the Church Telephone. In fact, this title is a misnomer, because the possible commercial applications of the system extend far beyond the parish church. Essentially the apparatus consists of three sensitive telephone transmitters mounted on a base and connected in parallel, from which a twin wire is taken to a receiver jack, and at a convenient point a battery of two cells is placed in series with one wire of the twin cable. To use the apparatus it is only necessary to insert the plug of the receiver into the jack and listen. On withdrawing the plug the battery is disconnected and audition ceases. Several receivers can be used off one transmitter system, but it is not advisable for more than six receivers to be in action at one and the same time. The receivers are of the simple watch type, fitted with a telescopic handle for convenience in holding the instrument to the ear. The jack is of the single type and mounted in a neat, inconspicuous wooden case. The best results are obtained when the transmitter is fixed 3 ft. or 4 ft. in front of the speaker, but it is not essential for the speaker to talk actually towards or directly at the transmitter. Where it is not possible to fix the transmitter in front of the speaker quite good results can be obtained with other positions by increasing the battery strength. The bottom of the transmitter base is padded with felt to reduce vibration, and where vibration is likely to be excessive this can be replaced by rubber. In the actual installation under notice the transmitter is mounted in the centre of the orchestra rail, almost behind the conductor and the receiver is fixed in the manager's office at the entrance to the theatre. Quite successful demonstrations were made and remarkably clear effects obtained when very subdued conversation was taking place on the stage. Further tests were made during an organ recital and again the sounds were quite clearly and truthfully reproduced without "shrieking" taking place on the high notes. There was also installed a loud speaking receiver device which removed the necessity of placing the receiver to the ear. This latter modification, however, will need further experimental work before it reaches perfection, though the initial results were distinctly encouraging. As installed the system allows the manager to know the position of the progress of the play without leaving his room or telephoning to the stage manager. By simply plugging in the jack and listening he can hear what is happening on the stage at any time. The system can also be used for other purposes; *e.g.*, by wiring the auditorium persons with defective hearing could be enabled to hear better, and receivers could be hired in the same way as opera glasses. In lecture halls, churches, &c., the system could be utilised to add to the comfort of the audience, whilst the loud speaking device when developed would probably prove of utility in connection with train dispatching. The theatre is also fitted with an elaborate system of Western Interphones. The theatre itself is really the outcome of a desire on the part of Messrs. Vickers, Ltd., to provide amusement for their employees at the Crayford Works, though it is open to the public and run as an ordinary theatre. The results so far seem to indicate that it will become a self-supporting institution.

Weagant's Anti-Static Method in Wireless Telegraphy.

In our last issue we concluded a description of Mr. Weagant's method of eliminating atmospherics. We are now permitted to give a brief account of the discussion which followed the reading of this Paper before the Institute of Radio Engineers.

Prof. Michael I. Pupin remarked that he had been the advocate for some time of the adjustment of phases, and as we were dealing in wireless telegraphy and wireless telephony with wave propagation, it went without saying that in wave propagation we could accomplish a great many effects by the proper treatment of phases, a feature which was not possible in ordinary transmission not depending upon wave propagation.

The effects of loops pointing in the direction of the station which transmitted, and properly adjusted as to their length, provided at the point of symmetry with a suitable receiving apparatus, could be adjusted so as to get a good signal, because you arranged the phases in a suitable way, which at the same time could be made to neutralise the static effect, if the static effect was not propagated in the same way as the signal; thisseemed to be obvious when you were told about it, and that was what he liked about the scheme. A scheme, which appealed to one as obvious after being told about it, was the right scheme, as a rule.

It was very easily understood, and everyone would say "why, of course that would work"; but it was rather difficult to understand why an electric wave due to the propagation of a grinding "stray" or a grinding static should affect a long conductor, several thousand feet long, in such a way that the motions of electricity in all its parts were affected in the same phase.

Mr. Weagant explains it by assuming that the wave was propagated vertically downward, and perpendicularly to the surface of the earth, as the wave was due to heterogeneously polarised oscillators. Well, these oscillators must be not only heterogeneously polarised, but they must be somewhere above, because if they were at a distance, say, 1,000 miles away, or even 500 or 300 or even 200 miles away, then their waves would not affect all parts of a long antenna alike. It was not easily seen how these oscillators started waves (which, after a while, must become spherical), which, as far as the receiver was concerned, appeared as if they came from above.

Well, that is the difficulty. What of it? It might be that these oscillators threw out spherical waves which were reflected back and forth between the conducting upper layer of the atmosphere and the earth, an assumption which had been advanced by other men and accepted, and that the "strays" which bothered you most were the "strays" from the last deflection of the upper layer.

Of course, one idea about the static problem, and he must confess that it was his idea too, was this: To use a device of the ordinary dimensions that you could conveniently place in any little room, and reduce the static by some means or another, enabling the sender to use about one one-hundredth part of the energy he was usually using. Then, instead of using anywhere from 100 kw. to 200 kw., he could use from 1 kw. to 2 kw.

Mr. Alfred N. Goldsmith remarked that the auditors of Mr. Weagant's Paper had probably felt the complexity of the methods used, to some extent, particularly at a first hearing. The general impression must be that an ingeniously elaborate electrical means for utilising the new law which had been found to govern the action of most of the strays which interfered with the reception, namely, "grinders," is employed. However, the salient feature of the methods used to eliminate grinders was based on the simultaneity and equality of effects produced by strays on two similar systems properly oriented and in the same horizontal plane. This simultaneous action was the keynote to the situation and, however it might arise, had been the furnace in which the powerful weapon against strays had been forged. The treatment of strays of the "click" class, which were, incidentally, much less serious so far as interference with reception was concerned, had been based on a combination of directional and electrical features ingeniously adapted to desired end.

Mr. Ernst F. W. Alexanderson felt that what was encouraging, in a very great degree, in Mr. Weagant's Paper, was that he had given them a key to the solution by announcing that he has found a new law of nature.

Mr. David Sarnoff said that, in his judgment, the elimination of static interference marked the most important practical advance in the radio art since Marconi's original invention.

The Electric Furnace in Australia.

In an article on electric steel furnaces, the "Industrial Australian & Mining Standard" says the first ELECTRIC STEEL PLANT IN AUSTRALIA, which has been in operation for some time, and was erected by the Australian Electric Steel Company, at Alexandria, near Sydney, comprises two Electro-Metals furnaces each of 2 tons capacity, from which ingots have been turned out up to 12 in. × 24 in., and these have been forged into railway axles. The Victorian Railway Commissioners intend to instal electric furnaces at their Newport workshops. The Victorian Iron Rolling Company, of Melbourne, is installing a 6-ton electric furnace and proposes to take current from the city mains. The Commonwealth Steel Products Company is also erecting a complete plant for the manufacture of electric steel in the Newcastle (N.S.W.) district, and about 1,500 H.P. of energy will be required.

Patents and Designs Bill.

On the 6th inst. the Standing Committee of the House of Commons, presided over by Mr. W. Nicholson, commenced the consideration of this Bill.

On Clause 1, which contains provisions to prevent the abuse of monopoly rights, Sir E. Pollock offered to meet criticism by an amendment to sub-section 8, which enacts that the monopoly rights under a patent shall be deemed to have been abused if any trade or industry in the United Kingdom or any person or class of persons engaged therein is unfairly prejudiced by the conditions attached by the patentee to the purchase, hire, or use of the patented article, or to the using or working of the patented process. The amendment, which proposed to insert after the word "hire" the word "licence," was carried.

An amendment limiting the maximum royalty payable to a patentee to 2½ per cent. of the selling price of the articles to which the patents relate, was rejected, and the amended clause was then agreed to.

On Clause 6 Sir Croydon Marks moved an amendment extending the term limiting the duration of patents from 14 to 18 years, instead of to 16 years, as provided in the Bill.

Sir Ernest pollock opposed and said that in many cases the war had been a godsend to patentees. The Bill gave a patentee the right to apply for an extension if damage could be shown, and such extension could be granted up to a limit of five years, making 21 years in all.

The amendment was withdrawn.

On Clause 8 the Solicitor-General gave an undertaking that an amendment would be brought up later providing that an independent tribunal would decide the amount to be paid to a patentee whose invention is used by a Government Department. He also undertook to introduce an amendment to Clause 15, so as to give a right of appeal with respect to the registration of designs binding the Crown.

The Bill as amended was reported to the House, and was read a third time on the following day.

Trade Marks Bill.

The committee stage of this Bill was also finished in one sitting by a Standing Committee of the House of Commons on the 7th inst.

On Clause 1, which provides for the division of the register into two parts—Part A comprising trade marks on the present register, and Part B providing for the registration of marks which have been bona fide used in the United Kingdom for two years, Col. Gretton said the question of the B register was important. There were numbers of trade marks not registerable under the present Act, of which the owners had proprietary rights. Such marks could not be registered in many countries, because they were not registered in this country. If the B trade marks were regarded as of inferior category, there was danger of that part of the Bill failing.

The Solicitor-General said he hoped that registration, which would now be offered to both classes of trade marks, would facilitate their adoption or recognition abroad.

Mr. Hood moved an amendment to Clause 6, which provides that where a trade mark is a name or only a practicable name of a patented article, all rights to exclusive use shall cease upon expiration of the patent. He moved the omission of the words "a name or."

The Solicitor-General said that the clause was intended to apply mainly to chemical substances made by the Germans.

The amendment was withdrawn, and after some minor amendments the Bill was reported to the House.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1917 Specifications.

128,983 Marconi's Wireless Telegraph Co. & Franklin. Wireless telegraph transmitters.
Each of the three elements—the condenser, the inductance and the spark-gap - is arranged symmetrically upon a common axis.
129,014 B.T.-H. Co. (G.E. Co.) Electric furnaces.
129,019 Lemercier. Electrically heated gloves and other flexible articles, such as boots, clothing, carpets and the like.
129,022 Cornu. Mercury vapour lamps.
The mercury of the cathode is incapable of displacement, and the mercury of the anode, which is cooled by a condensation chamber, is capable of slow displacement by passing through a valve intending to damp its oscillations, the pressure inside the lamp being always, even in a cold state, greater than atmospheric pressure.
129,027 Spear & Jackson & Marriott. Electrode holder for electric furnaces.
129,039 B.T.-H. Co. (G.E. Co.) Electric furnace control apparatus.
129,045 Francis. Cord terminals or connectors adapted for connecting electrical conductors.

1918 Specifications.

117,263 Gambs. Electric generator for motor vehicles.
118,416 Jorgensen. Combination night light and electrical heating apparatus.
129,051 Edison-Swan Electric Co., Hiatt & Davis. Valves of wireless transmission systems.
129,060 Ropinson. Electric motors for use on continuous current or alternating-current circuits.
129,068 B.T.-H. Co., Taylor & Whitcher. Alternating-current dynamo-electric machines.
129,083 Jenkins & C. I. Synd. Electrolytic cells.
129,084 Shepherd. Electrical generators and electrical motors. (Cognate application, 21,363 '18.)
129,086 Patelski. Electric railway systems.
129,092 Corbino & Trabacchi. Apparatus for obtaining high-tension one-direction currents from three-phase currents.
Comprises an induction coil the primary of which is wound for three-phase currents, a mercury interrupter switch connected to the primary and rotated at synchronous speed, or a simple multiple thereof so as to send through the primary a succession of current impulses from the three phases, and a high-tension rotary selector switch arranged between the secondary and the utilising apparatus.
129,103 Mossay & Mossay & Co. Control of electrically-propelled trucks or like vehicles.
129,104 Price. Electric batteries.
129,112 Williams & Simon, Ltd. Electric motors for operating cranes and hoisting appliances.
129,155 Alloy Welding Processes, Ltd., & Jones. Means for holding electrodes used in soldering and depositing metals by the electric arc.
129,163 Cardwell. Printing telegraphs or the like.
129,166 Poole. Electromagnetic separator.
129,198 Siemens Bros. Dynamo Works, Howard & Morphew. Electrical transformers.

1919 Specifications.

124,205 Hojgaard. Electric contact device.
129,221 Burton & Burton. Terminal electrical connections suitable for sparking plugs for internal combustion engines.
129,238 Jackson & Mellersh. (Taylor.) Radio-oscillation generators.
Comprises a cathode, an anode of less width than the cathode, and magnetic poles for producing a magnetic flux in the gap between the anode and the cathode, arranged in close relation to the cathode, the distance between the anode and the poles being greater than the distance between the anode and the cathode.

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

June 23, 1919.

15,751 Cutler. Electric water heaters.
15,755 Myers. Electric gramophone drive.
15,758, 15,759 & 15,760 Lauth. Electric cooking or heating vessels and apparatus.
15,770 Palmer. Dry-cell batteries.
15,789 West & Co. & Breeze. Electric contactor switches.

June 24, 1919.

15,823 Jacombs. Electro-deposition of metals.
15,832 Jagger. Coupling for electrical conduits.
15,880 B.T.-H. Co. (G.E. Co.) Incandescent lamps.
15,891 West & Co. & Breeze. Housings and casings for switchgear.
15,895 Telephone Mfg. Co. & Palmer. Telephone transmitters, &c.
15,905 Coles. Regulating switches.
15,910 Price & Clarke. Field telegraph and telephone exchanges.

June 25, 1919.

15,932 Flint. Magnetic indicator.
15,972 Dingley & Major. Contact breakers for magnetos.

June 26, 1919.

16,077 Cohen. Electrically-heated clothes-pressing machines.
16,088 & 16,089 Lauth. Electrically-heated liquid heaters.
16,090 Lauth. Electric-heating and cooking apparatus.
16,091 Lauth. Electric-heating and cooking of fatty products.
16,118 Selvatico. Electric-heating elements.
16,125 B.T.-H. Co. (G.E. Co.) Incandescent lamps.
16,126 B.T.-H. Co. (G.E. Co.) Dynamos.
16,134 Bayer. Storage battery separators.
16,140 Wrinch & Miller. Electric-heating apparatus.
16,154 Withers (National Electro Products, Ltd.) Apparatus for electrolyzing liquids.

June 27, 1919.

16,165 Goldstein & Levi. Telephones.
16,173 Hall. Switchgear, &c.
16,188 Woodburn. Electric welding.
16,201 Norton. Operating mechanism of oil-break switches.
16,228 Crowther. Transformers.
16,230 B.T.-H. Co. (G.E. Co.) Incandescent lamps.
16,232 McCarthy, Martin & Steele. Electric welding.
16,248 British Westinghouse Electric & Mfg. Co. & Wood. Electrical measuring instruments.
16,255 Jensen & Tilney. Electrical terminals, &c.
16,256 Callender's Cable & Construction Co. & Kay. Fault localising for underground cables.

June 28, 1919.

16,268 Tucker. Composition for insulating and waterproofing electrical elements.
16,302 Campbell, Gifford & Waite. Electrodes for furnaces.
16,306 Senrat. Grating for transmission of Morse characters.
16,310 Montgomery. Method of obtaining low-voltage current from lighting circuit.

June 30, 1919.

16,353 Efandem Co. & Owen. Double-ended electric lamp holders.
16,373 Kelly. Appliance for inserting switch, &c., in electric circuits.
16,389 Gibbons. Locking electrical switch.
16,399 General Electric Co. & Ide. Holders for electric lamps, &c.
16,404 Holslag. Arc welding, &c., and electrodes therefor.
16,413 Twiss. Electric cables for power transmission.
16,434 Walker. Electric contact devices.
16,443 Buchanan-Wollaston. Instrument for signalling automatically by electrical means.
16,463 Reckits. Telephone transmitters.

July 2, 1919.

16,468 Richards. Means of locking incandescent lamps in holders.
16,478 McDougald & Poyntz. Wireless transmitting and receiving apparatus.
16,491 Marks (Taft-Pierce Mfg., Co.) Magnetic chucks.
16,510 Twiss. Clamps for supporting lines of wires, &c.
16,515 Nodon. Electro-treatment of vegetable matters.
16,518 Jones. Electric sun blind.
16,538 British Electric Plant Co. & Maudling. Dynamos.
16,566 O'Sullivan. Electric illumination of dental mouth mirrors.
16,570 Angold. Automatic protector of cable ends.
16,600 Siemens Bros. & Co. & Pettigrew. Telephone exchanges.
16,629 Calvert. Incandescent lamps.

July 3, 1919.

16,630 Low. Electrically-driven air compressors.
16,635 Palmer & Richardson. Electrical indicating devices for taxicabs, &c.
16,652 Meissner. Spark-gap device.
16,674 Ford. Apparatus for electric step-by-step signalling systems. (3 7 18, U.S.)
16,688 Mason. Electric switch for prevention of stealing of motor vehicles.
16,689 Mackie. Dynamos.
16,691 Erskine-Murray. Electro-magnetic wave transmitting and receiving systems.
16,705 Igranic Electric Co. & Wright. Coil winding machines.
16,712 Furnival. Microphones or telephone transmitters.
16,722 Harrison & Waistell. Arc lamps.

July 4, 1919.

16,728 Graham, Rickets & Sanftleben. Signalling systems for telephone circuits, &c.
16,733 Nobbs & Railing. Electrical cooking apparatus.
16,751 O'Brien. Electric burglar alarm.
16,769 Erskine-Murray. Radio navigational apparatus, &c.
16,770 Erskine-Murray, Crowther & Robinson. Radio navigational apparatus, &c.
16,771 Erskine-Murray & Robinson. Radio navigational apparatus, &c.
16,775 Automatic Telephone Mfg., Co. & Flynn. Selective signalling systems.
16,780 Smith. Connecting telegraph and telephone line wires to insulators.
16,786 Mason. Electric plug connectors for preventing theft of motor vehicles, &c.

Commercial Topics.

Domestic Applications of Electricity.

We desire to draw special attention to the steps taken by the Ministry of Health for converting large houses in the Greater London area into flats. We hope that electrical contractors, as well as electric supply authorities, will be ready to take advantage of this house conversion work. Much of it should afford them possibilities for lighting and cooking business, whilst knowledge of the fact that electricity would be employed should assist architects in cutting and adapting existing houses.

* * * *

Non-Ferrous Mining.

The President of the Board of Trade has appointed a Departmental Committee to investigate and report upon the present position and economic possibilities of non-ferrous mining in the United Kingdom and to make recommendations as to such Government action as may be expedient. The members of the Committee are: Mr. H. B. Betterton, M.P. (chairman), Mr. H. F. Collins, Mr. J. Harris, Dr. F. H Hatch, Sir Lionel Phillips, Bart., Mr. R. A. Thomas, and Mr. James Wignall, M.P. The secretary is Mr. W. Palmer, Gwydyr House, Whitehall, London, S.W.1.

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The Department of Overseas Trade.

The work of this Department has been the subject of much adverse comment of late, and in a letter to the Prime Minister, Mr. E. Manville, President of the Association of Chambers of Commerce, states (on behalf of the Association), "we believe that there is no subject more important to the welfare of this country than the development of our overseas trade, and we take this opportunity of impressing upon you our great disappointment at the continued lack of that Government support which is essential if this Department is to be of service to the nation. Further, we consider that no measure of real success can be hoped for until the obstructions which undoubtedly exist in the Government departments concerned are removed and replaced by more whole-hearted support."

We are afraid that the Foreign Office has not got a proper appreciation of the importance of the export trade, and we hope that steps will be taken to remove all inter-departmental jealousy and friction so as to enable the new Department to make progress with its work.

* * * *

British Industrial Exhibitions in Brazil.

The British Chamber of Commerce of Sao Paulo and Southern Brazil is organising a series of exhibitions of British manufactures. Each exhibition will be devoted to one industry and will be open for three months. Exhibitors who desire to send with their samples, catalogues, price lists, &c., should note that literature must be in Portuguese, weights and measures in the metric system, and prices given in Brazilian currency. It is also advisable that exhibitors should confine their exhibits, so far as possible, to samples of goods which they are in a position to supply without delay. The first exhibition, which opens on Sept. 1 1919, is confined exclusively to the textile trades, but the second of the series, which should be opened on or about Dec. 1, 1919, will be devoted to the hardware and allied trades. The space allowable for any single manufacturer is limited to 12 square metres, with a minimum of 4 square metres. Details as to methods of packing and marking, &c., are contained in a booklet which may be obtained from the Department of Overseas Trade, 4, Queen Anne's Gate-buildings, London, S.W. 1.

* * * *

The Import Restrictions.

Lord Emmott has contributed an important article on this subject to the current number of "Ways and Means," in which he challenges the legality of the restrictions, and gives an interesting account of his experiences while a member of the Advisory Committee on Import and Export Restrictions and of the War Trade Department. The restrictions upon imports became necessary owing to the shortage of shipping and to the necessity of maintaining our exchanges. During the war no one cared to question the legality of a step which was considered necessary in the interests of the country. Nevertheless, we have not the slightest doubt that Lord Emmott is right in his contention that the restrictions are, and have been from the outset, illegal, for they are based on a section of the Customs Consolidation Act of 1876, which enacts that the "importation of arms, ammunition, gunpowder or any other goods may be prohibited by Proclamation." Now, it is an elementary canon of legal construction that the meaning of the phrase "or any other goods" is limited by the preceding words, "arms, ammunition, gunpowder," so that only arms, ammunition or goods capable of being used for naval or military purposes can be prohibited. In addition, when the Customs Consolidation Act was passed it was only intended to confer powers for controlling the movement of miltary or naval stores. It is, therefore, clear that the Government have no legal sanction for what they profess to do, viz., to prohibit the import of hundreds of articles which do not come within the category mentioned above, and we hope that some importing firm will take measures to test the legality of their action. Of course, we do not desire to raise the question of the necessity of restricting imports; we only wish to deal with the legal position, and we regret that the Government did not see fit at the outset to deal with the matter in a legitimate manner. If Government departments do not show respect for the law, it is not surprising that the workers and others are not too scrupulous in their obedience to it.

Electricity Supply.

A revised scale of charges has been adopted by FALKIRK Town Council which represents approximately 15 per cent. on the present rates.

BERMONDSEY (London) Borough Council has increased the charges for electrical energy by a further 10 per cent.

The arc lamps in the EALING main road are to be abolished and ½-watt lamps substituted. The change will effect a saving of nearly £500 a year.

RATHMINES Urban Council has raised the price of electric current for lighting to 8d. per unit.

It is proposed to form a local company in KILRUSH (co. Clare), with a capital of about £3,500, for the purpose of establishing electricity works.

Mr. S. Cameron Gibson, electrical engineer at NUNEATON electricity works, late Commander R.N.V.R., has accepted the captaincy of the local fire brigade.

BLACKPOOL Corporation has increased the salary of the borough electrical engineer and tramways manager, Mr. Chas. Furness, from £900 to £1,250 per annum.

BODMIN Council has given permission to the Bodmin Electric Light & Power Company to use overhead wires and poles for the distribution of electricity in the district.

In consequence of the increase in the price of coal, BOLTON Electricity Committee have raised the price of electric current to all consumers by 0·2d per unit.

CARMARTHEN Electric Supply Company has asked the Board of Trade to allow an increase in the maximum charge for electric energy from 7d. to 10d. per unit.

The Lighting Committee of the ISLINGTON (London) Borough Council recommend a further increase in the charges of electricity owing to the recent increase in the cost of coal.

The STRATHCLYDE ELECTRICITY SUPPLY COMPANY has increased its charges for electric current by a further 15 per cent. from Sept. 30, making a total increase on pre-war rates of 30 per cent.

Mr. Bridgeman stated in the House of Commons on Monday that only 7 million tons of COAL were USED by ELECTRICITY WORKS in 1917 out of the 183 million tons of coal available for home consumption.

CLACTON Electricity Committee has fixed the charge of current for public lighting at 6d. per unit, and the contract repair of the battery at the electricity works has been placed with the D P. Battery Company.

CANNOCK Urban Council, which possesses a provisional order, will consider at an early date the matter of providing electric supply for the district. Walsall Corporation is also desirous of securing powers to give a supply in Cannock, including power to one of the collieries.

Application has been made to the Board of Trade by the CHARING CROSS, WEST END & CITY ELECTRIC SUPPLY COMPANY to permit an increase in the maximum price of electricity from 6d. to 8d. per unit.

A motor-car and two motor bicycles with sidecars are being purchased for the ACCRINGTON electricity department. The chairman of the committee (Councillor Higham) states that, owing to the cost of labour, it was not economical for workmen to walk or even to wait for tramcars.

ACCRINGTON Electricity Committee has received sanction to a loan of £10,000 for mains and feeders and £5,000 for transformers. The Ministry has approved of the scheme for new generating plant up to an expenditure of £70,000, but formal sanction has been deferred until tenders have been obtained.

Owing to the 6s. increase in the price of coal, DUNDEE Electricity Committee has made a further increase of 10 per cent. in the price of electric current. The cost of coal has increased from 12s. 6d. per ton in 1914 to £1 8s. 6d. per ton at present time, but the heat value of the coal has recently gone down by about 13 per cent.

The Board of Trade have notified the Crompton, Royton and Lees Urban Councils, who applied for an order to enable Oldham Corporation to supply current to the districts, that they are not prepared to entertain the application pending the decision of Parliament in regard to the Electricity (Supply) Bill.

ARMAGH Urban Council are inviting plans and estimates for an electric supply scheme for the district. A prize of £20 will be paid by the Council to the Engineer who submits the most suitable scheme, and should the installation be proceeded with within two years, the prize-winner will be appointed engineer. Plans are to be sent to the Town Clerk by Sept. 1.

DOUGLAS Corporation and a private company recently asked the Manx Legislative Council for authority to supply electricity for power and lighting, but it was suggested that current should be obtained from the Manx Electric Railway Company's station and that the promoters should confine themselves to the work of distribution. The Council had decided, after consideration of a report by Mr. Dykes (Messrs. Handcock, Dykes & Trotter), to adopt the principle of a municipal controlled supply, but the Tynwald have now sanctioned the Douglas Electric Company's scheme.

The accounts of the BURTON-ON-TRENT electricity department for the year ended March 31, 1919, show income £34,955 (compared with £27,203 in previous year), gross profit was £13,497 (£11,108), interest required £3,053 (£2,751), repayment of loans £3,722 (£3,723), and the net surplus was £5,258 (£3,313), the highest on record. Cost per unit sold was 1·054d. (0·857d.), or 1·473d. (1·304d.), including interest and repayment of loans. Units sold were 4,837,740 (4,394,969). Load factor was 26·3 (25) per cent.

The City electrical engineer (Major H. Richardson) has informed Dundee Electricity Committee that the constantly rising price of coal made the question of the definite settlement of the advisability of using the Tummel Valley water power imperative. The cost of the scheme would amount to a million sterling at least. The Committee has, therefore, asked for an interim report from Major Richardson, and a subcommittee is to suggest the names of experts who might be consulted in the event of the scheme being proceeded with.

In a report to the Hull Electricity Committee by the acting city electrical engineer (Mr. J. F. Magoris) on the effect of the recent increase of 6s. per ton in the price of coal, it is stated that the increase will necessitate an extra annual expenditure of some £17,000. In addition, the 47-hour week and other awards will require a further outlay per annum of some £5,000, contingencies in the nature of extra expenditure due to the present coal strike represent at a minimum £1,565, leaving an extra charge to be covered at the rate of some £23,539. After making due provision for the extra revenue as the result of coal clauses, it will be necessary to increase the tariff by not less than 1d. per unit for flat rate lighting, and an additional increase of 32½ per cent. on all other units. The total increases above pre-war tariffs under this arrangement become for flat rate lighting 2¾d. (68 per cent.), and for other purposes, 100 per cent. The increases to date in cost of commodities used by the department are: Coal, 190 per cent.; labour, 150 per cent.; materials, 150 to 200 per cent. In spite of the large increase in the number of connections, for power particularly, which have been made recently, their effect has to a considerable extent been nullified by the eight hours' day, and the other situations which have arisen, so that the output at present is 10 per cent. below that of the corresponding period of last year. The increases of tariff will come into force as from the next periodical readings of the meters.

A demand for a large supply to Melton District will be afforded, subject to an agreement for a term of years and to the Corporation obtaining the necessary Board of Trade or other Order and the sanction of the Ministry of Health to the borrowing of the necessary monies. It is also proposed to supply the Tuberculosis Hospital, Cottingham, and application has been made for sanction to borrow £6,000, the estimated cost of the overhead equipment and transformers. An order to be placed with Messrs. Siemens Bros. for carrying out the work on the basis of time and material plus percentage addition. The minimum annual revenue from the line for the first five years is not less than £1,300.

Electric Traction.

Hackney (London) Borough Council has decided to purchase four electric vehicles, at a cost of £7,300.

Coventry Tramways Committee proposes to apply for Parliamentary powers to extend the municipal tramway system.

Derby Tramway Committee has decided to purchase four new tramcars at an estimated cost of £7,290.

Halifax Tramways Committee recommends the construction of tramways to Stainland.

Ipswich Corporation has decided to improve the tramway service by doubling certain sections of the track and re-laying other sections.

The London General Omnibus Co., is introducing a new and larger type of motor omnibus, with wider platforms and improved stairs. The omnibus will be lighted electrically and there is an electric bell for stopping.

York Corporation has asked the Board of Trade for increased borrowing powers under the Light Railways Order, including £10,000 for additional tramcars and some £6,000 for overhead work, &c.

Edinburgh Corporation has decided to apply for authority to construct tramway extensions and for power to run motor omnibuses on any route within five miles of the city boundary.

In order to improve the Brighton tramway track it will be necessary to spend £10,000 per annum for the next seven years, in addition to the whole of the present reserve and renewals fund, now standing at £22,533.

Lanarkshire County Council obtained powers in 1912 to purchase the local tramways, and they have asked the Lanarkshire Tramways Company to state the price at which they would sell their undertaking.

The strike of the Liverpool tramway employees terminated on Saturday, and the service was resumed on Sunday. The questions of wages and hours are to be considered at a meeting of the Tramways Committee on the 29th inst., and in the meantime the men have agreed to go back to work.

Glasgow Tramways Committee recommend the promotion of Mr Lachlan M'Kinnon, present traffic superintendent, to the position of deputy general manager, at a salary of £1,000 per annum. Silver badges have been presented to 99 men of the uniformed staff who have completed 25 years' service in the Glasgow Corporation Tramways Department.

The accounts of the Brighton tramways department for the year ended March 31, 1919, show revenue £86,988 (compared with £80,222 in previous year), gross profit £21,912 (£32,214), and after providing for interest, sinking fund, &c., the net balance was £5,092 (£15,427). Revenue per car-mile was 21·95d. (16·71d.). Passengers carried were 18,498,267 (16,942,512) and car-miles run 951,072 (1,152,006).

Out of a total of 1,130 women and girls employed by the Manchester Tramways Department during the war only 24 women conductors now remain on the books and, in addition, there are about a dozen trolley girls. It is expected that all women labour will be dispensed with in a fortnight. Similar reports are current from many municipal areas in Lancashire.

Miscellaneous.

A Commercial Radio-telegraph Service has been established between Canada and the Bermudas.

The Council of the City and Guilds of London Institute have awarded diplomas of "Associate" to the following students who completed a full course of instruction in engineering at the close of the recent session: J. de Agniar, R. H. Barfield, J. A. A. Best, C. Grad, A. G. Griffith, T. J. Griffiths, F. St. A. Hartley, G. H. Hopewell, E. W. A. Janmoulle (Siemens Medal), A. D. de Lemos, K. P. P. Menon, R. B. McC. Potter, J. H. Reyner (Henrici Medal), C. J. H. Trutch, S. Vaughan, A. C. Warren (Henrici Medal), H. C. Wilkinson, E. W. Workman, and R. G. P. Wyatt (Bramwell Medal).

A Conference was held on Saturday at the Ministry of Health between Dr. Addison and the London Housing Board (Sir Tudor Walters, Sir Kingsley Wood, and Mr. Strauss, and the Mayors and Town Clerks of the Metropolitan Borough Councils) for the purpose of adopting special measures for the conversion of houses into working-class flats. The Minister put before the Conference a number of proposals for expediting measures and for taking special action so as to secure as much additional accommodation as possible before the winter. The proposals, which provide for the fullest co-operation between the Ministry and the Borough Councils, were warmly received by the meeting, and steps have been taken to put them into immediate operation.

In the report of the Committee appointed by the Newspaper Conference and the Empire Press Union, suggestions are made for the organisation of a Commercial Cable Service. Steps should be taken to improve the existing cable services by reducing the length of Government messages and otherwise relieving the congestion on the wires. Every possible assistance should be given by the Government to cable companies to enable them to repair their lines. An adequate system of wireless should be established as soon as possible. A second submarine cable should be laid without delay as part of the All-Red Route from Bamfield to Norfolk Island, and certainly in the first instance from Bamfield to Fanning Island. Subventions should be granted to reduce rates, the deferred Press rate should be resumed, &c.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during June, 1919, and (*b*) the aggregate figures from Jan. 1 to June 30, with increase or decrease compared with corresponding periods of 1918:—

Electrical machinery, (*a*) £51,755 (increase £11,266), (*b*) £288,059 (decrease £120,153); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £20,339) increase £14,222), (*b*) £115,245 (increase £48,280); and electrical machinery unenumerated, (*a*) £31,416 (decrease £2,956), (*b*) £172,814 (decrease £168,433); telegraph and telephone cables other than submarine, (*a*) £475 (increase £475), (*b*) £7,853 (increase £6,007); telegraph and telephone apparatus, (*a*) £37,711 (increase £28,743), (*b*) £135,600 (increase £111,937); other electrical wires and cables, rubber insulated, (*a*) nil (decrease £55), (*b*) £2,966 (increase £2,309); with other insulations, (*a*) nil (decrease £272), (*b*) £9,003 (increase £8,276); carbons, (*a*) £1,171 (decrease £2,247), (*b*) £14,084 (decrease £8,418); glow lamps, (*a*) £15,798 (increase £4,045), (*b*) £205,296 (increase £141,572); parts of arc lamps and searchlights (other than carbons), (*a*) £3,197 (decrease £438), (*b*) £36,604 (decrease £6,435); primary and secondary batteries, (*a*) £7,049 (increase £2,854), (*b*) £25,380 (decrease £67,083); meters and measuring instruments, (*a*) £2,035 (decrease £305), (*b*) £19,255 (increase £11,408); switchboards, (*a*) nil, (*b*) £256 (increase £690); electrical goods and apparatus unenumerated, (*a*) £8,916 (decrease £72,270), (*b*) £209,150 (decrease £48,883). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £76,352 (decrease £39,470), (*b*) £666,147 (increase £151,380).

Exports.—The exports of electrical machinery, material, &c., (*a*) during June, 1919, and (*b*) from Jan. 1 to June 30, with increase or decrease compared with corresponding periods of 1918, were as follows:—

Electrical machinery, (*a*) £125,371 (increase £10,832), (*b*) £627,514 (increase £79,106); including railway and tramway motors, (*a*) £1,494 (decrease £3,528), (*b*) £24,873 (increase £4,771); other generators and motors, except for aeroplanes, motor cars and cycles, (*a*) £80,605 (increase £7,476), (*b*) £359,709 (increase £32,676); and electrical machinery unenumerated, (*a*) £43,272 (increase £6,884), (*b*) £242,932 (increase £41,659); telegraph and telephone cables, submarine, (*a*) £38,990 (increase £21,790), (*b*) £242,063 (decrease £100,168); other than submarine, (*a*) £46,581 (increase £7,331), (*b*) £175,259 (increase £36,819); telegraph and telephone apparatus, (*a*) £30,318 (increase £16,519), (*b*) £156,629 (increase £56,517) other electrical wires and cables, rubber insulated, (*a*) £96,028 (increase £89,366), (*b*) £288,491 (increase £254,968); with other insulation, (*a*) £104,030 (increase £99,506), (*b*) £324,967 (increase £288,243); carbons, (*a*) £285 (decrease £224), (*b*) £3,437 (increase £408); glow lamps, (*a*) £17,111 (increase £10,838), (*b*) £66,628 (increase £24,452); arc lamps and searchlights, (*a*) £163 (decrease £1,389), (*b*) £6,552 (decrease £5,177); parts of arc lamps and searchlights (other than carbons), (*a*) £350 (decrease £1,465), (*b*) £7,311 (decrease £3,419); primary and secondary batteries, (*a*) £33,675 (increase £24,191), (*b*) £241,425 (increase £188,832); meters and measuring instruments, (*a*) £11,553 (increase £1,194), (*b*) £95,725 (increase £36,193); transformers, (*a*) £3,012 (decrease £1,000), (*b*) £21,581 (increase £7,046); switchboards, (*a*) £3,196 (increase £208), (*b*) £17,005 (decrease £627); electrical goods and apparatus unenumerated, (*a*) £107,452 (increase £73,885), (*b*) £531,426 (increase £318,937). Total of electrical goods and apparatus, other than machinery, (*a*) £492,744 (increase £340,750), (*b*) £2,178,499 (increase £1,103,024).

Imperial and Foreign Notes.

The Acting Governor of Cyprus has granted a trading charter to Limasol Electric Light Company.

The Winnipeg River Power Company has commenced work in connection with the construction of a big power plant at Lac du Bonnet Falls, on the Winnipeg River, 75 miles north-east of Winnipeg. The ultimate capacity will be six units of 28,000 h.p., and the project, which will be completed in three years, will cost about £1,400,000.

The accounts of Launceston (Tasmania) electric light and power undertaking for the year ended June 30, 1918, show total revenue £25,447 (against £23,957 in previous year), gross profit £13,962 (£12,678), and net profit £4,086 (£3,048). Units generated were 4,170,700 (3,943,450) and sold 3,323,695 (3,129,988). Load factor was 33·82 (33·57) per cent. The revenue of the tramways department was £25,064 (£23,139), gross profit was £3,751 (£5,624), and the net result was a deficit of £1,283 (compared with a profit of £632). Passengers carried were 3,011,764 (2,733,539), and car-miles run 393,320 (390,038). Traffic revenue per car-mile was 15·248d. (14·168d.).

It is announced that an American syndicate has been formed to lay a Submarine Cable between America and Norway. There is also a project for laying a submarine cable in the Pacific between Japan and the United States.

The Board of Trade announce that the Supreme Economic Council in Paris have decided to withdraw the Relief Mission in September. Traders should, therefore, make their own arrangements for forwarding goods to Poland, although for the time being they may continue to consign them to the British Relief Administration at Danzic.

In the "Bulletin" of the British Chamber of Commerce in Brazil it is stated that the Brazilian Government have asked the sanction of Congress to invite tenders for the Electrification of the main line of the Central Railway from the Central Station to Barra do Pirahy, including the ascent of the Serra, and also of the suburban lines serving Rio de Janeiro. It is considered urgently necessary in view of the growth of the city that a greater and more rapid railway service be provided at low rates. The cost of electrification is estimated at 5,593 contos (£340,000), and that of rolling stock, power stations, &c., at 17,230 contos (£1,050,000).

According to a report from H.M. Minister at Stockholm, the Swedish Railway Administration is making preparations for the electrification of the Stockholm and Gothenburg Railway, and a Bill providing for a grant for this purpose is to be laid before the Riksdag next session.

The power required for the electrification (30,000 k.w.) will be obtained from the Trollhattan and Motalastrom Falls—about 15,000 k.w. from each: about 14 transformer stations will be erected along the railway. The cost of the electrification is estimated at about 90 million kronor, but the real expenditure is estimated at about 60 million kronor. The work will be commenced next year provided the necessary grants are made by the Riksdag. The present stations will be retained, and the ordinary railway personnel will be eked out with persons specially trained in electric traffic. The journey between Stockholm and Gothenburg, which now takes about 11 hours, should, after the electrification, be performed in less than six hours.

Appointments Vacant and Filled.

Sunderland Electricity Committee require a chief clerk in the electricity department. Applications to the Town Clerk by Aug. 21.

A lecturer in electrical engineering is required for the Woolwich Polytechnic. Salary £315, rising to £490 per annum.

Dr. S. Smiles, O.B.E., F.R.S., has been appointed to the chair of organic chemistry at Armstrong College, Newcastle-on-Tyne.

An assistant lecturer and demonstrator in physics is wanted for the University of Liverpool. Applications to the Registrar by Sept. 1

A lecturer in physics is required at the Wigan District Engineering. and Mining Technical College. Salary £300. Applications to the Principal by Aug. 25.

Lecturers in electrical and mechanical engineering and mathematics are required at the Technical College, Loughborough. Salary £300–£25–£350. Applications to the Principal by Aug. 27.

Chesterfield Corporation require a general manager of their electricity and tramways undertakings. Salary £600 per annum. Applications to the Town Clerk by Aug. 23.

A demonstrator is required for the electrical engineering laboratories of the City and Guilds Technical College, Leonard-street, Finsbury, E.C. Applications to Prof. Eccles by Aug. 31.

A telegraph and telephone construction foreman is required for the Government of Ceylon. Salary £300—£25—£400. Applications to the Crown Agents for the Colonies, 4, Millbank, London, S.W. 1.

Applications are invited for the University Professorship of Physics in the Benares Hindu University. Salary Rs. 500-50-750. Applications to the Pro-Vice-Chancellor, Benares, India, by Oct. 15.

The Council of Armstrong College, Newcastle-on-Tyne, invites applications for the post of professor of experimental physics. Salary £600, rising by biennial increments of £50 to £800 per annum. Applications to the Secretary by Aug. 30.

A demonstrator in physics is required at the Municipal Technical Institute, West Ham. Salary £150, rising by annual increments of £10 to £180 per annum. Applications to the Principal, Romford-road, Stratford, E. 15, by August 24.

It is proposed to make an appointment to the Chair of Electrotechnical surveying in the Lwow Polytechnic High School and applications will be received until the end of September. The professor will take charge of an electro-technical laboratory and give a course of lectures on surveying methods. Applications to the Rector of the Polytechnic High School, Lwow, Poland.

Bradford Education Committee has selected Mr. W. H. N. James, A.R.C.Sc., for the position of head of the electrical engineering department of the Bradford Technical College, at £500 per annum and bonus.

Mr. James Dobson, general manager of the Gravesend and Northfleet Tramways, has been appointed general manager of the Southampton Corporation Tramways, in place of Mr W. T. Robson, who recently resigned on account of ill-health.

Mr. J. A. B. Horsley, A.M.I.E.E., has been appointed an electrical inspector of mines under the Coal Mines Act, and an inspector of factories and workshops for the purposes of the Factories and Workshops Act, 1901

Mr. J. Williams has resigned his position as chemist and superintendent of the Testing Department of the Yorkshire Electric Power Company, a post he has occupied for the last six years, and has been appointed technical assistant to the Borough Electrical Engineer, Salford. Previous to this, Mr. Williams was assistant engineer in the operation department of the Company for 1¾ years.

Tenders Invited and Accepted.

Motherwell Council require tenders for electric lighting work in connection with the North Lodge portion of their housing scheme. Particulars from the Burgh Surveyor.

Eccles Electricity Committee invite tenders for the supply of three 500 k.v.a. three-phase transformers. Specifications from the Borough Electrical Engineer, and tenders to the Town Clerk by Aug. 25.

Stirling Council require tenders by Aug. 22 for electrician's work in connection with the erection of 40 houses comprised in their Shiphaugh housing scheme. Specifications from the Burgh Engineer.

Athy Urban Council invites tenders by Aug. 18 for public electric lighting for three years. About 50 lamps will be required, and permission will be given for the use of overhead wires and poles.

Edinburgh Corporation invite tenders for three 10,000 k.w. turbo-alternators and six water-tube boilers. Specifications from the engineer (Mr. F. Newington), Dewar-place, and specifications and drawings may be seen at the office of Sir Alex. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders to the Town Clerk by Sept. 11.

Aylesbury Council have placed an order with Johnson & Phillips for the supply of cable.

St. Pancras (London) Electricity Committee has placed an order with Strachan & Henshaw for an extension of the ash and coal-handling plant at King's-road station, at £1,900.

Blackburn Corporation have been authorised to accept the tender of the English Electric Company for the equipment of a new generating station at Whiebirk, at a cost of about £270,000.

Grimsby Corporation has accepted the tender of the Kennicott Water Softening Company for water-softening plant and a fire tank; and that of the British Electric Plant Company for an electric pump.

Heywood Corporation have placed orders with Bruce Peebles & Company for a 400 kw. motor converter, switchgear, &c., and with the Macintosh Cable Company for e.h.t. and l.t. cables.

Hull Electricity Committee has accepted the tender of the Stirling Boiler Company for a boiler, and that of the Erith Engineering Company for a stoker. The annual contract for oils has been secured by Messrs. Alan Thelwell & Son.

Accrington Corporation have accepted the tender of Messrs. W. T. Glover & Company for the supply of 5,400 yds. of cable, at £4,000 12s. 8d.; that of the British Thomson-Houston Company for a turbo-generator, at £24,000; and that of Hick, Hargreaves & Company for a condenser, at £7,800, and air filter at £586.

The following tenders were accepted by the British Government Departments during June: *Ministry of Munitions.*—Johnson & Phillips, switchgear. *Crown Agents for the Colonies.*—Siemens Bros. & Company, battery material; Connolly Bros., cable; Chloride Electrical Storage Company, Lux cells and electric lighting materials; Automatic Telephone Mfg. Company, telegraph apparatus; British L.M. Ericsson Mfg. Co., telephones. *India Office.*—W. T. Glover & Co., cable; General Electric Company, Carsak elements; Chloride Electrical Storage Company, cells; Lancashire Dynamo Company, generating plant; General Electric Company and Sherwood & Company, lamps; Peel-Conner Telephone Works and Automatic Telephone Mfg. Company, telephones. *Post Office.*—Siemens Bros. & Company, telegraph and telephone apparatus; Automatic Telephone Mfg. Company, British L. M. Ericsson Mfg. Company, North British Rubber Company, Peel-Conner Telephone Works, Phœnix Telephone & Electric Works and Western Electric Company, telephone apparatus, British Insulated & Helsby Cables, Fuller's United Electric Works, Johnson & Phillips, London Electric Wire Company & Smiths, New Gutta Percha Company, Siemens Bros. & Company, H. W. Smith & Company, Union Cable Company and Western Electric Company, telegraph and telephone cables; Siemens Bros. & Company, zinc rods; Western Electric Company, flameproof wires. *H.M. Office of Works.*—Johnson & Langley, electric crane, &c.

Business Items.

The Scientific, Glassware and Potash Production Branch of the Board of Trade has removed to 7, Seamore-place, London, W.1.

Messrs. C. F. Casella & Company have removed their factory to Walthamstow, and have opened offices at 49 & 50, Parliament-street, S.W.1, to which address correspondence should be sent.

Ex-Capt. W. Palmer and ex-Sergt. J. E. Ruley have commenced business as electricians, under the style of Palmer, Riley & Company, at Market-chambers, Blackburn-road, Accrington.

A number of electric generators and motors, a.c. and d.c., with starters and pulleys, are offered for sale by Mr. H. Ryan, 121, Middlesex-street, London, E. 1.

By order of the Ministry of Munitions an important sale of electrical plant and equipment and stores will take place on Aug. 25, 26, 27 and 28, at H.M. Factory, Oldbury, near Birmingham. Catalogues and further particulars from the Auctioneers (Messrs. A. R. Collins & Company), 1, Newhall-street, Birmingham.

The Optical Pyrometer Syndicate has issued a pamphlet which gives some particulars of the "Wedge" pyrometer. It is claimed that it is the only practical pyrometer which makes use of the principle of the absorption of light in reading temperature. The light emitted by the heated body is absorbed by a special prism and the temperature is read at the extinction point.

Messrs. C. A. Vandervell & Company, Ltd., of Acton, have issued a new edition of their booklet "Running Instructions for the C.A.V. Dynamo Car Lighting and Starting System." The booklet runs to 40 pages and apart from the clearly written instructions as to the lighting equipment, the location of faults, the treatment of the battery, care of the head lamps, starters, &c., it contains many sectional illustrations and a clear diagram of connections.

The Westminster Tool & Electric Company notify us that, owing to the difficulty of meeting the demand for their Westool portable electric drills and other tools with their present facilities, they are erecting new works at Putney where they are concentrating their head office. In future communications for the head office or works should be sent to Westool Works, 116, Putney Bridge-road, Putney, London, S.W. 15. Telephone: Putney 1179; telegraphic address: "Westolelco-Put, London."

The Sun Electrical Company, Ltd., has recently issued its revised conduit list, which gives particulars and prices of all standard electrical conduit in handy form. The company has also issued a pamphlet on the Xcel electric iron, a new electric iron which is entirely British made, and the company claims it is equal in appearance and capability of service to the best of the American irons. The former pamphlet is for the trade generally, but the latter has been prepared for the electrical contractor and retailer for re-distribution among the general public. Copies will be sent to any reader on applying to the company at 57-9, Neal-street, Long-acre, London, W.C. 2.

Mr. C. J. Elton and Mr. William Crawford (partners of Messrs. Kilburn, Brown & Company), together with Mr. J. Scrivener, commercial manager, and Capt. S. R. Mullard, M.B.E., A.M.I.E.E., works manager, have been appointed directors of the "Z" Electric Lamp Mfg. Company, Ltd. Messrs. Kilburn, Brown & Company continue to act as secretaries of the Company. The management has, for some time, been conducted with the co-operation of the gentlemen now forming the board, and we are informed that the result of the past year's trading of the Company has been particularly successful. Arrangements have been made for increased output to meet the expanding demand for the "Z" drawn wire lamps, and the general supplies section will be greatly augmented by new lines and increased stocks.

In order to deal more adequately with impending developments of high and low tension overhead transmission and distribution work, a consolidation of interests has been arranged between the Twiss Engineering & Electric Transmission, Ltd., and Messrs. J. B. Saunders & Company, Ltd. Mr. Sydney G. Leech joins the board of the Twiss Company and Mr. G. V. Twiss becomes a director of Messrs. Saunders. The facilities already possessed by the Twiss Company with regard to designing and manufacturing transmission line material and equipment, will thus be augmented by the extensive contracting—erecting and maintaining—experience and organisation of Messrs. Saunders, so that the companies can supply overhead transmission lines for extra high or low tension erected complete in every detail. Each Company will maintain its own individuality and inquiries for transmission line material and equipment should be sent as hitherto to Twiss Engineering & Electric Transmission, Ltd., at 62-63, Queen-street, E.C. 1, London, but inquiries for transmission lines erected complete may be sent either to the Twiss Company or to Messrs. J. B Saunders & Company, at Cromwell House, 6-9, Surrey-street, Strand, W.C., London, when in either case the same joint service will be rendered.

Bankruptcies.

Claims against Wm. Jas. McCombe, tramway manager, Berkeley House, Prince's-avenue, Hull, are to be sent by Aug. 30 to Mr. W. G. Hall, Union & Smith's Bank-chambers, Hull.

Claims against Fredk. Jas. Hornett, electrician, lately trading at Lemon Quay, Truro, are to be sent by Aug. 25 to Mr. Coulter Hancock, 12, Prince's-street, Truro.

The discharge of Lewis Alfred Thompson, electrical engineer and contractor, formerly trading as Saville & Walton, at Bream's-buildings, Chancery-lane, London, has been granted, subject to debtor's consent to a judgment for £40.

Companies' Reports, &c.

The directors of Babcock & Wilcox, Ltd., have decided to offer one new ordinary share at £2 per share for every four similar shares now held. The share capital will then be increased from £1,960,000 to £2,460,000.

The profit of the North Staffordshire Tramways Company for 1918, after providing for debenture interest, was £4,975. With £435 brought forward the available sum is £5,392, out of which the usual dividend of 5 per cent. has been paid, leaving £592 to be carried forward.

The directors of the County of London Electric Supply Company have declared interim dividends on the preference shares at the rate of 6 per cent. per annum for the half-year ended June 30, and on the ordinary shares at the rate of 5 per cent. per annum, both less tax.

The directors of W. T. Henley's Telegraph Works Company, Ltd., have declared a dividend on the preference shares at the rate of 4½ per cent. per annum, for the half-year ended June 30 last; also an interim dividend on the ordinary shares of 6d. per share, both less tax, and payable on 1st prox.

The net profit of the Kidderminster & District Electric Lighting & Traction Company, Ltd., for 1918 was £1,192 after providing for debenture interest, and adding £46 brought forward. The dividend has been paid on the preference shares, and it is proposed to carry forward the remaining £193.

At an extraordinary general meeting on the 8th inst. of Electro-Magneto Motors, Ltd., resolutions were adopted sanctioning the conversion of the company from a private into a public undertaking, and increasing the capital to £12,000 by the creation of 40,000 ordinary shares of 1s. each.

At the meeting of the Guildford Electric Supply Company, Ltd., on the 8th inst., it was reported that the total revenue for the past year was £10,776, compared with £11,419 for 1917. The decrease was due to the rationing of electricity. The balance on the revenue account was £1,856 (after crediting depreciation fund account with £500), compared with £2,273. After making provision for debenture interest and interest on loans, the balance was £217, which was carried forward. The total connections number 1,405, against 1,320.

The result of the operations of the Lisbon Electric Tramways, Ltd., for the year 1918, after deducting interest and amortisation due on the debentures of the "Companhia Carris de Ferro de Lisboa," interest on and redemption of the debentures of the company and London expenses, shows a net profit of £8,094, and with £3,135 brought forward, the balance (£11,229) has been carried forward. A sum of £10,000 has been transferred from the Exchange reserve depreciation. During the year 80,806,364 passengers were carried, and the receipts were Es. 3,523,069, compared with 79,434,362 passengers and Es. 2,754,964 in 1917. The growth of the working expenditure during the year has been without interruption and is again attributable to the higher cost of supplies as well as to the further increases in wages which have had to be made to meet the demands of the employees on account of prevailing conditions. Owing to the above causes the working expenditure during the period has been extremely high and shows an advance over the abnormally high figure of the preceding year of £97,933. An increase in the rates of the season tickets was put into force at the beginning of the year, and further advances in the tariff were arranged in May, 1918, but the much higher cost of operation has more than counteracted any benefit the company might have gained from the additional revenue. Local affairs in Lisbon have been very unsettled, and no satisfactory adjustment of the question of tariffs with the Government and the municipality has been possible. Lieut.-Col. Stephen Hungerford Pollen, C.M.G., succeeds Admiral Sir A. H. Markham on the board.

The profit of the Aabada Trust, Ltd., for the year ended March was £8,710, and a dividend of 5 per cent. was declared at the meeting on Friday. Mr. H. Robertson, who presided, said the later business which had been undertaken by the trust in connection with electrical and engineering propositions would not have been possible but for the experience of their managing director, Mr. C. S. Colton. What had been accomplished so far warranted the belief that the new department was now on a sound foundation. Lieut.-Col. Francis E. Drake, another of their directors, had also intimate associations in the electrical world, and was at the present moment negotiating some very important matters, whereby the trust should secure the European rights in some inventions which had already proved great successes in America. The trust was laying itself out specially for handling matters connected with the engineering and electrical world. The trust had a staff of competent experts and a testing department for making any necessary experiments.

Mr. Charles S. Colton said the policy of the Trust was to handle electrical and engineering propositions and inventions. That was an entirely new field, and the work already accomplished in a few months' time was good enough to give a definite indication of what might be expected in the future. One of the chief profits in the period under review had come from the sale of an American invention. In addition, the Board had been successful in disposing of certain concessions and interests in West Africa. The board had succeeded in placing an American electrical meter with a large concern in this country at a substantial profit. The trust had an important interest in a new dry battery, and arrangements had been completed whereby a large electrical concern was taking over the manufacture of that battery for sale throughout the British Empire, except in Canada. A further acquisition of the trust was a 50 per cent. interest in a new wireless system. Money and time had been spent on the apparatus, and it was believed that the principle had been clearly demonstrated.

MARCONI'S WIRELESS TELEGRAPH COMPANY, LTD.

Mr. Godfrey C. Isaacs, who presided over the annual meeting last week, made a long and interesting speech on the position of the Company and its subsidiaries, the negotiations with the Post Office, &c. After an analysis of the report and accounts, which were abstracted in our issue of the 1st inst., he said that the Belgian Company (the Société Anonyme International de Telegraphie sans Fil), whose head office was now in Brussels, had paid 12½ per cent. for each of the years 1916. 1917 and 1918, making a total of 50 per cent. for the past five years. In France the Compagnie Universelle de Telegraphie et de Telephonie sans Fil sold the whole of its tangible assets to the Compagnie Generale de Telegraphie sans Fil, which was formed at the beginning of last year with a capital of 12,500,000 francs, and might be said to control the wireless telegraph business of France and her colonies. The business of the Compagnie Generale had developed so quickly that it was found necessary to double its capital. The Compagnie paid for the period from Feb. 5 to Dec. 31. 1918, a dividend of 27.226 francs per 500-franc share and 1.302 francs for each founder's share. The Compagnie Francaise Maritime et Coloniale de Telegraphie sans Fil, which hitherto had conducted the business of the French Mercantile Marine, paid for the past year 10 francs per share of 100 francs and 93.75 per founder's share. A new company, the Compagnie Generale de Telegraphie sans Fil, had been created to take over the whole of the French Mercantile Marine. The Amalgamated Wireless (Australasia) and the Marconi Wireless Telegraph Company of America each paid 5 per cent. for 1918. He had no reliable information about the Russian Company, but he had been informed that business was being conducted under most difficult circumstances. In Norway, a Norwegian Wireless Telegraph Company had been formed, and in China a Company with a nominal capital of £700,000, had been established. In the latter the capital would be subscribed in equal moieties by the Chinese Government and the Marconi Company. For their patent rights they would get one-third of the profits in each year until such time as they might be paid a substantial sum of money which had been agreed in satisfaction of those patent rights. By reason of their shareholdings and patent rights they were now entitled to two-thirds of the profits of the Chinese National Company. The Marconi Wireless Telegraph Company of Canada had made good progress but it had not yet been able to pay a dividend. The capital would be reduced by halving the nominal value of the shares, making their shares $2½ each, instead of $5, and 500,000 new shares of $2½ each would be created. In Italy they had continued to do a substantial business under able management of the Marquis Solari, and the Compania Nacional de Telegrafia sin Hilos also continued to make good progress. The commercial service with Germany and Austria continued and it would soon be reopened with Italy. In the spring of this year permission was received to commence a service with this country, but neither the Spanish station nor the station in this country proved altogether satisfactory for an efficient telegraph service. The Argentine Company had been obliged to mark time, but preparations were being pressed forward to complete the erection of a high-power station near Buenos Aires and another in this country for a direct telegraph service at reduced rates. The Pan-American Company, which was formed for conducting telegraph services between North and South America, was also engaged in building a station in Buenos Aires to communicate with New York. They were awaiting the official declaration of Peace in the United States of America for the high-powered stations in the United States to be retransferred to private ownership, when direct telegraph services would be opened between Europe and New York. By an agreement with the Colombian Government they would erect a station in Bogota.

War Services.

He regretted that the Official Secrets Act and a sense of patriotism prevented him from reading a full record of the Company's services to the Empire during the war. Yet they had not been able to obtain anything approaching what they deemed a reasonable offer for such work. They had asked the Post Office to pay for the 80,000,000 words which they intercepted and reported day and night since the outbreak of war to as many sometimes as 40 different addresses directed by the Government. The work was done under the most difficult circumstances. either under direct instruction from the Government or at the Company's suggestions made as the result of its observations of altered enemy tactics. Enemy fixed and portable stations, naval stations, comprising service ships, submarines and aircraft, had to be dealt with. They designed entirely new receiving apparatus to meet the continually changing circumstances and counteract enemy activities. Upwards of eight million words were in foreign languages, including Russian, German, Italian, French and Rumanian. Since their stations were returned to them after the Armistice, they had been conducting work of a similar nature, but of a simpler and easier one, for another Government Department, which had fixed 3d. per word for the work. and they had accepted what the Department considered reasonable. For the more difficult work the Post Office had only offered 1·5d. per word, and that was to cover also compensation for having been deprived of the use of the whole of their stations, except Clifden, during the war. The Company had again been driven to commence new proceedings against the Post Office. Mr. Isaacs then dealt at some length with the recent award of Mr. Justice Lawrence in the Company's claim for damages for breach of the contract to erect the Imperial Wireless Chain; he criticised the decision of the Post Office to erect the stations and said the Department was experimenting with obsolete or useless patents. He demanded that before more money was squandered upon the Imperial stations an inquiry be held to investigate the extraordinary procedure of the Post Office. Mr. Isaacs then referred to recent changes in the directorate, &c.

New Companies.

COMMERCIAL ELECTRICAL ACCESSORIES, LTD. (157,476).—Private company. Reg. July 29, capital £20,000 in £1 shares (5,000 participating 7 per cent. cumulative preference), to acquire wholesale and export electrical supply business carried on by Tredegar, Ltd. First directors are H. A. Bartlett and A. W. J. Bedbrook.

T. B. S. ELECTRICAL CONSTRUCTION COMPANY, LTD. (157,594.)—Private company; reg. July, 31, capital £1,000 in £1 shares. Objects: To carry on the business of electrical engineers, constructors and contractors, dealers in electric plant, &c. The first directors are R. Brown, G. F. Stagg and A H. Tree. Reg. office, 68, Victoria-street, S.W.

NORTHERN ELECTRICAL MFG. COMPANY, LTD. (157,494).—Private company. Reg. July 29, capital £3,000 in £1 shares (1,000 7 per cent. cumulative preference). Manufacturers of and dealers in electrical switchgear, electrical accessories, switchboards, magnetos, signalling apparatus, batteries, dynamos, &c. Directors: S. Dobson, W. Dobson, J. Dobson and T. Barnes. Reg. office: Back Church-street, Bradford.

POLLOCK & MACNAB (1919), LTD. (157,587).—Reg. July 31, capital £150,000 in £1 shares (100,000 cumulative preference). Objects: To take over the business of Pollock & Macnab, Ltd., engineers and machine tool makers. First directors are J. Macnab and S. Macnab, and any others to be appointed by the subscribers. Reg. office: Britannia Machine Tool Works, Bredbury, near Stockport, Cheshire.

UNELMA LIMITED. (157,507).—Private company. Reg. July 29, capital £9,000 in £1 shares. Objects: To take over the business of a manufacturer of electric batteries, dry cells for bells and telephones, pocket lamp cases, electrical novelties, &c., carried on by B. Pordes as the United Electrical Manufacturers' Company. The Board of Trade has licenced the acquisition by the company of the above business, the books and documents of which have been liable to inspection under sect. 2 (2) of the Trading with the Enemy Act. First directors are B. Pordes (permanent) and M. Pordes. Reg. office: 18, 20 and 22, Christopher-street, E.C.

Prices of Metals, Chemicals, &c.

			Tuesday, Aug. 12.	
		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£107 0 0	—	£5 0 0
Electro wire bars ...	,,	£115 0 0	—	10 0 0
H.C. wire, basis ...	per lb.	1s. 3⅜d.	—	0 0 1
Sheet	,,	1s. 3¼d.	—	0 0 0⅝
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 7⅜d.	—	0 0 1
Brass 60/40—				
Rod, basis	,,	0s. 10½d.	—	0 0 0½
Sheet, basis	,,	1s. 2⅜d.	—	0 0 0⅜
Wire, basis	,,	1s. 2¼d.	—	0 0 0¼
Pig Iron—				
Cleveland warrants	per ton	—	—	—
Galvanised steel wire, basis	,,	£32 10 0	—	—
Lead Pig—				
English	,,	25 15 0	—	0 10 0
Foreign or colonial	,,	24 5 0	—	1 0 0
Tin—Ingot	,,	261 0 0	—	16 0 0
Wire, basis	per lb.	0 3 3	—	0 0 4

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £21.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d. to £8.

Copper Sulphate.—Per ton £45.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 7d.

Shellac.—450s. to 455s. October delivery at 463s. to 465s.

Rubber.—Para fine, 2s. 5¾d.; plantation grades, 1s. 11d. lb.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W.T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From The Electrician, Aug. 12, 1882.]

Alexandria.—News from this town received during the week states that arrangements have been completed for throwing the electric light over the enemy's lines from Ramleh.

The Telephone for the House of Commons.—In the House, recently, Mr. Gray asked the first Commissioner of Works whether he would consider the desirability of placing the House of Commons in telephonic communication with the Telephone Exchange, and also of placing one of the Exchange telegraph instruments in the House for the convenience of Members. In reply, Mr. Shaw-Lefevre was understood to say that he hoped during the recess to make arrangements in the direction suggested. The only difficulty was to find a suitable room.

Cable Laying off Egypt. In all probability before these lines are read a cable will have been laid between Alexandria and Port Said by the Eastern Telegraph Company's s.s. "John Pender," so that the fleet will have direct cable communication to England. The work was commenced on Thursday last, the "John Pender" having arrived off Alexandria on the previous Sunday.

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ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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Notes.

Mr. Lloyd George's Statement.

THE figures given by MR. LLOYD GEORGE in his statement to the House of Commons last Monday were sufficient to make every Member feel the extreme seriousness of our present industrial position. We only hope that the true meaning of these figures may be appreciated by the workers. In saying this we do not mean to suggest that employers also have not a very great responsibility in attempting to relieve the position, but nevertheless the fact remains that the immediate future of this country rests very largely in the hands of the workers. So long as the idea is cultivated that the Government has the magic power of extracting wealth beyond that which is being produced, the country must inevitably traverse the road to ruin. At present we fear that the position is very far from being realised by the rank-and-file of labour, and thus we see the unjustifiable strike of the Yorkshire miners and industrial troubles of a similar kind. It is no use demanding higher standards of living if the means of such higher standards are not made available. Indeed, before so very long, if the present policy is followed, there must inevitably come a terrible lowering, instead of raising, of the standard of living, and if this comes about there will certainly be a vast amount of misery. The announcement that the mining industry is not to be nationalised will have been received with relief by all those who are engaged in industry, but we regret to see the tendency on the part of Labour leaders to make this question a matter of politics. If our various industries are to become election cries, the well-being of this country from the financial point of view will become hopeless. It should surely be realised that the carrying on of industry is absolutely different from the carrying on of politics, and that industrial problems cannot be decided satisfactorily by persons who know nothing whatever about them. With regard to other points raised by MR. LLOYD GEORGE, various questions of trade were the most important. We welcome the promised protection against dumping. If, as is often alleged, no such thing as dumping occurs, then provisions against it can do no harm. On the other hand, if there is dumping (*i.e.*, unfair competition for the purpose of damaging our industries), such provisions will certainly do good through rendering our manufacturers more secure. The only serious objection we can see to such methods is that there may be considerable difficulty in deciding what is a fair price, for we certainly do not wish to eliminate competition. Where competition is removed there is stagnation, but ordinary competition is a very different thing from dumping. Another objection, and one which we fear to some extent, is that such methods may lead to an increase in bureaucratic control. This is an ever-increasing danger, and one against which we must guard ourselves as far as possible.

Adult Education of the Working Classes.

AT the Conference held by the Industrial League last week an interesting Paper was contributed by MR. J. M. MACTAVISH on "Education in its Relation to Labour and Industry." The author sought to determine why so few grown-up people take advantage of our educational facilities, and among the reasons given he mentions that students must adapt themselves to the regulations of the Education Authorities instead of managing classes for themselves; and further, that a good deal of latent, and even active, suspicion exists as to the bias of the universities. We can understand that the workers would naturally prefer to run their own classes on somewhat social lines, and indeed a great deal is already done in this direction. Such methods have greater elasticity than a fixed syllabus at a fixed centre. Nevertheless, education cannot be carried on so far in this way as on the more rigid lines. With regard to bias, it appears to us that this can only be felt in connection with certain subjects. In history, for example, there may be a feeling that certain aspects are not sufficiently treated, and in economics it may be felt that the view of the employer is emphasised too much. When, however, we come to art and science there cannot be any such feeling, and indeed the courses throughout should deal with knowledge and facts, and not with biased opinions; otherwise, for example in economics, it becomes easy to spread false education. We fear this has already been done with unfortunate results in certain districts. We doubt if there is any need for a new educational authority, but a good deal might be done to keep the Board of Education and the universities more actively in touch with adult education, such as was described in a comparatively recent Government report on this subject, and thus to assist the movement as far as possible.

Charges for Street Lighting.

THE charge to be made for street lighting has often been a subject for discussion, more particularly when it is a case of a municipal electricity department supplying electrical energy for municipal lighting. It is so easy to present a rosy appearance when one municipal department is made to appear prosperous at the expense of another, but from the point of view of the prosperity of the municipality as a whole such a course has nothing to commend it. The subject has recently been considered by Mr. T. Rowland and Mr. H. G. Rowledge, acting city electrical engineer and city accountant respectively at Peterborough. The general principle has been laid down that such services should be rendered at cost, the charges being made up of (1) loan charges in respect of lamps, &c.; (2) actual amounts expended in wages for attending to the street lamps; and (3) the amount per kilowatt-hour, depending upon the load-factor. In regard to the first item, there can be no question. The second item, it appears to us, omits any charge for supervision. Generally the greatest difficulty arises in the third item, but actually there should not be much difficulty here if the full data are available. There is just the one question as to what is meant by cost. Although in municipal services profit is not a serious object (and this is really provided to a certain extent by the capital charges), yet it is desirable to include in the cost a sufficient sum to build up a proper reserve fund to maintain the financial stability of the concern. This point is often forgotten.

The Fallacy of Profit-sharing.

A very interesting article, entitled "The Fallacy of Profit-sharing as a Reward of Labour," was recently contributed to "Industrial Management," by Mr. P. L. Burkhard, who discusses a number of profit-sharing schemes which have been adopted by various industrial concerns. The title seems more pessimistic than the contents of the article suggest, the author's contention really being that the principle of participation in profits by the employee is sound, but that the real reward for labour consists in the giving of adequate regular wages, the profit sharing being merely a supplementary source of revenue. The most common fallacy to be guarded against is the assumption by employees that very large accumulated sums of money rest in the hands of the management, which, if divided, would raise the standard of workers to a comfortable level. Setting aside a few exceptional cases, it has been shown by economists that in most industries a general 10 per cent. rise in wages would sweep away the profits—unless the price of the article manufactured were raised a corresponding amount, or the productivity increased. It is obvious, therefore, that profit-sharing cannot increase the workers' revenue seriously without enormously raising the cost of living. Mr. Burkhard is at pains to show that no general scheme of profit-sharing can be applied to all industries. The plans adopted range over a wide field. The distribution of stock (or certificates of low denomination) to employees is usually more advantageous than the distribution of money. The distribution of a bonus at Christmas is not strictly speaking profit-sharing. Combined profit-sharing and saving methods have much to recommend them. The great danger to avoid is the belief that profit-sharing schemes can make good inadequate wages. The author mentions 26 cases where profit-sharing failed, and in at least half of these the trouble apparently arose from the above cause. Profit-sharing, therefore, is a process not to be rashly embarked upon, but requiring very careful preliminary study. Perhaps one of its greatest merits is that it gives employees an insight into the extent and distribution of the profits, and is thus a safeguard against extravagant demands. Further, it gives the employee an interest in the well-being of the business, and is an incentive to provide efficient services.

Old Centralians.—Now that the war is over it is felt that every endeavour should be made to revive all the activities of this Association. Old students of the City and Guilds College who are out of touch with the Old Students' Association are requested to write to Mr. G. W. Tripp, Lyndhurst, Hayes Road, Bromley, Kent, the Honorary Secretary of the "Old Centralians."

Illuminating Engineering Society Convention in the United States.—We notice that the annual convention of the American Illuminating Engineering Society is to take place in Chicago from Oct. 20-23. During the war the convention has been somewhat curtailed, but it is expected that the proceedings this year will be of exceptional interest. A special effort will be made to enlist the co-operation of other associations and industries concerned with lighting.

Institute of Chemistry.—The "Proceedings" of the Institute of Chemistry for July refer to a number of matters of professional interest to chemists. We note that the Council have appointed a committee to consider, jointly with a committee of the Institute of Metals, the position of chemists and metallurgists in the Services and Reserve, and the action to be taken to secure for them due recognition and status. The General Purposes Committee is also dealing with the relation of professional chemists to the Whitley Councils.

Visit of a Czech-Slovak Technical Commission to the United States.—Most people, we imagine, have still somewhat hazy impressions regarding the Czech-Slovak republic, and its present state of industrial development. It is, therefore, interesting to notice that a commission from that country has recently been touring the United States in order to investigate water power and methods of irrigation. This commission was recently received by Mr. G. O. Smith, Director of the United States Geological Survey, and is visiting the Niagara Falls and other well known water power installations. It is proposed to apply the information gained to the development of water power and irrigation projects in the Czech-Slovak republic.

International Research Council.—We observe that the meeting of the International Research Council, opened by the King of the Belgians in Brussels last month, was completed on July 28. Some useful preliminary work seems to have been done relating to co-operation in various fields of science, and a resolution was passed inviting the assistance of the countries which have remained neutral during the war. We notice that while Brussels has been selected as the legal domicile of the Council, conferences of the associations dealing with specific subjects will probably be held in succession in various countries, and that the secretary of the Council will transact business from Burlington House, where a room has been set aside for the purpose by the Royal Society.

Journal of the British Science Guild.—The "Journal" of the British Science Guild for July, 1919, as usual records a considerable amount of useful work done by the various committees on education, the metric system and other matters, emphasis being attached to the relatively small number of full-time students of science and technology in the United Kingdom, as compared with Germany, and also the inadequacy of the existing State support. In the report of the 13th annual meeting held in June last a summary is given of the addresses delivered by Major-General J. E. B. Seely, Lord Sydenham and Sir Joseph Thomson; and an appreciation of the late Sir Boverton Edwood by Prof. Frank Clowes is also included.

Combined Wood and Steel Transmission Towers.—In view of the discussion that is constantly taking place regarding the relative merits of wood and steel towers for transmission lines, it is of interest to observe, in the "Electrical World," an account of a combined wood and steel structure which was used on a 27-mile run and occasioned an economy of 10 per cent.; the method was, no doubt, suggested by the high prices which have ruled for steel during the war. The structure utilised was two or four yellow pine poles supporting a galvanised steel superstructure. It is stated that with this arrangement the cost of excavation and erection was less, but this advantage was partially compensated by increased cost of haulage. The life of the structure is estimated at about 10 years, but the wood is easily replaced.

Federation of Technical and Scientific Associations.—A natural corollary to the growth of professional associations operating as registered Trade Unions is the formation of Federations of such associations. One such Federation is the Federation of Technical and Scientific Associations, in which are included the National Union of Scientific Workers, the National Association of Industrial Chemists, the Electricity Supply Commercial Association and the Electrical Power Engineers' Association. The immediate object of the Federation is to secure the recognition of the claims of the executive, administrative and supervisory grades of the various industries and to secure united action on matters of general interest affecting these grades. A meeting will be held on Sept. 6 in order to approve the constitution of the Federation, and eligible associations are invited to attend.

Coal Mining in Spitzbergen.—In view of the general coal shortage the possibilities of developing the coal of Spitzbergen have been attracting much attention recently. The "Journal" of the Royal Society of Arts, in a note on this subject, mentions that coal was first exported from this locality in 1900, and on the west coast of the island where the climate is tempered by the Gulf Stream, claims have been taken out by British, Swedish, Norwegian and Russian Companies. One Norwegian company in two years has exported 85,000 tons of coal, which is said to be of good quality for steam purposes, though hardly suitable as a gas coal. It is stated that it is frozen to a great depth and is thus perfectly dry—a condition which has advantages from the mining standpoint—and the upper layer of sandstone, below which the coal is located, makes an excellent roof.

Electrical Heaters for Petrol Distillation.—The "Electrical World" mentions a simple form of electric heater now being adopted in the United States for the distillation of petrol and other volatile liquids, the boiling points of which it is desired to determine. The spiral heating coil of "nichrome" wire is inserted in a conical groove turned in a solid block of refractory insulating material and so arranged that practically all the heat is focussed upon a small opening 1¼ in. in diameter in the top of the device. The flask placed above the heater is thus subjected to sufficient heat without the danger of igniting inflammable vapour. The heater can be clamped to any convenient support and is provided with an adjustable rheostat. While primarily intended for the use indicated, it is thought that the concentrated heat which the device affords would be suitable in many cases in which a small gas flame is commonly employed.

Faraday House War Service Record.—We have received a copy of the War Service Record of the past and present students of Faraday House. The Record, which is an excellent one, is limited to those who served with the British and Allied Forces. As a frontispiece there is a good portrait of Col. Hubert Sparks, C.M.G., D.S.O., M.C., Croix de Guerre (president of the Faraday House Old Students' Association). Then follows a list of the military distinctions gained and the record of those who served. We regret to notice that a number of promising engineers and students made the supreme sacrifice, among these being Lieut.-Col. R. W. Hammond, Captains E. T. Hayne and S. J. Snowden, Lieutenants C. S. Hipwell, W. P. Hinds, C. W. Short, N. S. Smith and T. K. Walker, Second-Lieutenants Corke, Davison, Hawkins, Hoggett, Orton, J. H. and W. Parr-Dudley, Ritson, J. B. Smith, Tonking, Trollope, Turton and T. P. Wilson.

Instruments Showing Presence of Combustible Gas in Air. The Bureau of Standards, Washington, has issued a Scientific Paper, No. 331, on "New Forms of Instruments for Showing the Presence of Combustible Gas in the Air." The Paper contains a description of experimental work upon the combustion of gases at the surface of an electrically-heated wire and the application of this phenomena to the design of instruments for detecting the presence or indicating the amount of combustible gas in the air. The devices described and illustrated are the "compensated bridge," the "glowing wire" indicators and the "bimetallic" detector. The operation of the compensated bridge indicator depends upon the change in electrical resistance of the wire, and it gives a continuous indication of the amount of combustible gas at the point at which the resistance element, called the "detector bridge," is placed. When the percentage of gas reaches a pre-determined limit, a circuit is closed operating an alarm or other protective device. By the "glowing wire indicator," which is a portable device, an observer may quickly determine the amount of combustible at any accessible spot by adjusting the current through an active wire to such a value that the wire just shows a visible glow. The current required decreases with increase in the amount of gas present. The bimetallic detector is an automatic device, in which the heat of combustion of the gas at the surface of the wire causes the bending of an adjacent bimetallic strip, which in turn closes an alarm circuit.

Dazzle-Painting of Ships.—A most interesting Paper on the above subject was read before the North-East Coast Institution of Shipbuilders at their "Victory Meeting" held last month. Lieut.-Commander Norman Wilkinson, R.N.V.R., who has made a speciality of this work during the war, explained very clearly why the ordinary conventional idea of camouflage, *i.e.*, the attempt to produce invisibility, failed in the case of ships at sea. On land, one is dealing with a stationary object and fixed surroundings, and the chances of rendering an object indistinguishable are much greater; but at sea where the colour of sky and sea are constantly changing, and we are dealing with a moving object, the device is much less successful. There are also other factors, such as the destruction of delicate colour patterns through the grime of coaling or even ordinary wear and tear, and the fact that a submarine commonly sees a ship first silhouetted against the sky, which also makes it difficult to apply devices intended to conceal ships. The best plan, therefore, was to accept the fact that ships cannot be rendered invisible, and instead to endeavour to confuse the submarine regarding their course. The illustrations shown by the author will be familiar in general principle to most of those who had occasion to be near ports or at sea during the war. The idea was to paint the ships with streaks and patterns of light and dark paint, in a bold manner so that its outline is broken up, and especially so that it becomes difficult to tell whether the ship is proceeding towards the observer or receding. Some of the illustrations are quite striking in this respect and experience showed that it was often most difficult to tell the bow from the stern of a dazzle-painted vessel, or to state with certainty whether she was proceeding on a port or starboard course. The result of this confusion was that a submarine often failed to take up the correct position for firing, and having once done so, frequently was unable to catch up a ship and regain this correct relative position. As a matter of fact, the proportion of dazzle-painted ships hit was much less than in the case of ships of uniform tone. A feature was the adoption of varied patterns, so as to prevent any particular type becoming familiar, and it was common practice to employ a different pattern on the two sides of a vessel.

Personal.

Presentations have been made to Mr. C. W. Salt, of Torquay, who is taking up the appointment of city electrical engineer at Carlisle. The officials of the Council presented him with an engraved cigarette box and the staff and workmen of the electricity works made a presentation of a handsome case of gold-mounted briar pipes.

We understand that Mr. Charles H. Merz has arrived in South Africa or the purpose of preparing a report upon the proposal to adopt electric traction for certain sections of the South African railways and of advising the Government regarding the generation and supply of electric power in the Union generally.

Electric Heat for Drying and Baking.*

By GEORGE J. KIRKGASSER.

The use of electric heat in place of gas or other fuel for such industrial processes as drying, baking, &c., has developed considerably during the past five years, because of its reliability, cleanliness, ease of control, safety and reduced fire hazard, and speed. Even where a good supply of natural gas has always been available, shortages have occurred forcing manufacturers to look to some other heating agent.

Ovens are employed for many purposes and vary in size and method of operation. Where only drying is to be done, and the temperature must be between 100°F. and 200°F., such ovens are used for drying clothes, macaroni, printing ink, herbs, varnish, ammunition shells, armatures, &c. Food warmers or cabinets are also in this class.

Japanning and enamelling require higher temperature, usually near 400°F. to 450°F., and grid or ribbon type heater units are used. Ovens of this kind are used for japanning or enamelling metal furniture, automobile parts, metal signs, motor frames, brass beds, telephones, metal conduit, stoves, metal boxes and a hundred and one other articles. Japanning was first accomplished by the use of liquid lacquer or varnish derived from vegetables grown in Japan and baked in the sun. To-day the word japan has a much wider meaning, and the protective or decorative coating is baked on by artificial heat. If not properly done imperfect work results, the rejections in many cases running over 50 per cent. Through the application of electric heat most of the uncontrollable variables entering into japanning work have been practically eliminated. Definite results can be secured, and if one batch of work is satisfactory, others following under similar condition will be equally good. Portable electric heating units can be located in any position needed to insure the best temperature distribution. Since the control of the current and, therefore, the temperature, is simple, the variables of the human element are reduced. In one large plant automatic control is used throughout, one individual located in front of an instrument board a distance from the ovens, having general supervision and being responsible for the process and results. The time for baking electrically is one-half or less than with gas heat, since a higher temperature can be maintained.

Comparison between Electric Heating and Fuel Combustion

In a direct-fired gas oven the heat is transferred to the work largely through convection. In an electrically-heated oven some heat is brought to the work in this way and the balance by radiation, which probably penetrates more and accounts for the more rapid setting of the coat of japan under the surface. If heat is obtained from fuel complete combustion is almost impossible, since the mixture of the fuel and air varies and cannot be controlled with great accuracy. More heat is required to do a given amount of work because so much heat is discharged into the atmosphere and so much of the fuel is not completely burned.

The application of electric heat to ovens depends upon local conditions. In some ovens it may be necessary or sufficient to install the heaters along the side walls, while in other cases it may be necessary to supplement the heaters on the side wall with one or more rows down the centre of the oven. The number of heaters for any given installation depends upon the weight of material baked, maximum temperature required, time required in which to each maximum temperature, ventilation or changes of air per hour, location of heaters and oven construction.

In most enamelling oven installations the maximum temperature will be from 400°F. to 450°F., which will be reached in from one-half to one hour's time. The ventilation or changes of air per hour will depend upon a number of variables, such as kind of enamel used, speed of baking, maximum temperatures and oven construction. This will vary through a range of from 10 to 20 complete changes of air per hour. In many cases, owing to interference of trucks, conveyors of work, the heaters may extend only a definite distance above the floor line, in which case it is necessary to place part of the heaters elsewhere to get sufficient heat in the oven.

The heating element of the Westinghouse oven heaters consists of a resistor ribbon wound on a number of fire clay bushings assembled on two steel tie rods, between two pressed steel end plates. The ends of the ribbon are secured to forged steel terminals which are clamped to the steel tie rods, the rods, therefore, becoming the terminals for the heaters. These rods are insulated from the end frames, where they pass through, and the ends are threaded for bolting on the connectors. The heaters are normally rated at 2·5 kw. 120 volts. Any number of these heaters may be installed in an oven and connected to any single phase, or polyphase, alternating current, or a direct current 110, 220 or 440 volt power circuit that may be available. On 220-volt service, two heaters are connected in series. Where three-phase power circuits are used, the heaters are connected in what is known as three-phase delta.

Japanners have heretofore accepted as inevitable a higher temperature near the back of the ordinary kiln or box-type oven than that prevailing near the door; they have also accepted as inevitable a higher temperature near the ceiling than near the floor. With electric heating units of the proper sort, it is just as easy to hang heaters on the doors as it is on the stationary walls, and it is equally easy to place them on the floor. This makes it possible to obtain a practically uniform temperature distribution throughout the entire oven, and this leads to high quality and high speed. In the long, continuous type of oven so arranged that the work is carried through on a conveyor, there is some combination of temperatures along the run of such an oven that will give the best work in the shortest time and the flexibility of the electric heating units adapts them ideally to the determination and the maintenance of such combinations.

The work carried on in an electrically-heated oven is heated largely by energy radiated from the hot metal of the heating units, and only to a slight extent by convection currents. Microscopic examination has shown that both quality and speed improve as the proportion of heat transferred by radiation increased, and an oven in which heat transfer by convection could be entirely eliminated should give maximum quality and speed.

In japanning and enamelling ovens heat must be supplied for the following chief purposes:—

1. Raising the temperature of the work.
2. Raising temperature of parts used for supporting or carrying the work.
3. Raising the temperature of the ventilating air.
4. Supplying the loss which occurs from the external surfaces of the oven, known as radiation losses.
5. In case of intermittent operation, such as a kiln-type oven or the semi-continuous conveyor type oven, raising the temperature of oven walls and heating equipment.

The material is usually at room temperature, which is approximately 70°F. This must be heated from room temperature to the maximum temperature desired. After the work has reached its maximum temperature, no additional heat is absorbed by it regardless of the length of time it may be held at that temperature, as a certain definite amount of heat is required for raising the temperature of a given substance through a given range in temperature, irrespective of the length of time consumed in heating. However, if the heating is accomplished in one hour a certain amount of current demand will be required, but if the heating is accomplished in one-half the time, double the amount of current expressed in kilowatts will be required with exactly the same kilowatt-hour consumption. The total weight in pounds of metal or work heated multiplied by the degrees rise in temperature or the difference between the initial and maximum temperature, multiplied by the specific heat of the metal gives the power required in B.Th.U's. For example:—

Weight of work baked per hour, 3,000 lb.
Initial temperature, 70°F.
Final temperature, 450°F.
Length of bake, 1 hour.

$$3{,}000 \times (450-70) \times 0{\cdot}125 = 142{,}600 \text{ B.Th.U.}$$

$$\frac{142{,}600}{3{,}412} = 41{\cdot}8 \text{ kw.-hours.}$$

The specific heat of iron is here assumed to be 0·125.

The item of raising the temperature of the parts used for supporting or carrying the material to be baked cannot be neglected as quite often the conveyor or supporting racks or trucks will weigh as much as the work itself. However, the conveyor or trucks may be at some higher temperature, if the conveyor or trucks re-enter the oven before they have time to cool off to room temperature. As in the case of the work entering the oven, it is important to know the initial and the final temperature of the conveyor or supporting racks or truck.

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* Abstract of an article in "Industrial Management."

For example :—

Weight of movable truck or conveyor entering the oven per hour, 1,500 lb.

Initial temperature, 150°F.

Final temperature, 450°F.

$$1{,}500 \times (450-150) \times 0{\cdot}125 = 56{,}250 \text{ B.Th.U}$$

$$\frac{56{,}250}{3{,}412} = 16{\cdot}5 \text{ kw.-hours.}$$

Heating Air Necessary for Ventilation.

Ventilation being necessary for certain kinds of baking, it is important to consider the power needed.

The amount of power required for heating the air used in the ventilation of the oven depends upon the initial and final temperature of the air, the pounds of air entering, and its specific heat. Since the ventilating air is obtained from the enamelling room, the initial temperature is assumed at 70 deg. The final temperature will be that of the air leaving the oven. In the case of the kiln-type oven or semi-continuous conveyor oven, the air is withdrawn at the maximum oven temperature, but with a continuous-conveyor type oven, where the incoming work is bathed by the outgoing air, the temperature of this ventilating air at the exhaust point may be considerably below the maximum oven temperature.

The total quantity in cubic feet of air supplied per hour, multiplied by the temperature rise in degrees Fahrenheit, multiplied by the specific heat of air, divided by the cubic feet of air per pound, will give the heat required in B.Th.U.'s for ventilating purposes. The specific heat of air at 450°F. is 0·245. At 450°F. there are 22·9 cubic feet of air per pound.

The following example serves to illustrate the working out of a concrete heating problem. Assume that 10,000 lb. of sheet metal are to be enamelled per hour, at a maximum temperature of 450°F., entering the oven at 70 deg. and leaving at 300 deg. The oven is of the continuous type, the work being hung on the conveyor, dipped automatically while travelling, drained and conveyed continuously through the oven. The oven is in the form of a room 27 ft. wide, 54 ft. long and 8 ft. 6 in. high, with insulated walls consisting of 4 in. of high-grade insulating material. The conveyor travels at a speed of 6 ft. per minute and weighs 12 lb. per foot, giving a total weight of 4,320 lb. per hour. It will enter the oven at about 150 deg. and leave at 450 deg. About 12,400 cubic feet of ventilating air are used per hour, with a temperature rise of 380°F. The radiation loss area of the walls is 4,293 sq. ft., having a surface temperature of 100°F. and a radiation constant of 0·6. The total heat requirements per hour are :—

	B.Th.U.	Kw.-hours.	Watts per unit.
Radiation	225,400	66·1	15·4 per sq. ft.
Conveyor racks	162,000	47·5	11·0 per lb.
Sheet metal load	287,500	84·4	8·44 per lb.
Ventilation	514,400	151·0	12·2 per cubic ft.
Total	1,189,300	349·0	—

Absorption by the walls is not considered in a continuous-type oven. In this special case, 156 heaters with a maximum demand of 360 kw.-hours were necessary. This resulted in 28·7 lb. of material being baked per kilowatt-hour.

In large plants electric current is purchased or generated at a cost of 2 cents a kilowatt-hour or less.

Types of Electrically-heated Ovens.

Ovens are divided into three main types :—

1. Kiln or box type. (*a*) Hand-loaded. (*b*) Truck-loaded.
2. Semi-continuous conveyor type.
3. Continuous conveyor type.

In the first, the work may be carried in and hung on hooks or other supports by hand, or the work may be first placed on trucks and the entire truck pushed into the oven and left there during the bake. The latter can be quickly removed and another loaded truck placed in the oven. The semi-continuous conveyor type oven consists of an oven having doors at both ends with an overhead conveyor running directly through it. This is usually a continuous chain passing through the oven and returning over the top. A batch of material is dipped in the enamel and hung on the conveyor to drip for 15 or 20 minutes and then carried into the oven by the conveyor. While the first batch is being baked, the second is being dipped and being hung on the conveyor. As soon as the first batch has baked the conveyor is started up, the first being carried out, and the second batch into the oven. A third batch is then dipped and hung on the conveyor, while the second batch is being baked, and the first batch removed from the conveyor. This operation is repeated indefinitely.

A continuous conveyor-type oven consists of an oven with a conveyor running through it which operates continuously and not intermittently as in the case of the semi-continuous oven. The work is hung on to a moving conveyor or chain and carried directly into the oven. The speed of the chain, the length of travel and the temperature of the oven must be such, that by the time the work reaches the exit, the enamel has been thoroughly baked. The doors must be open continuously. In order to prevent heat losses through these openings and the smoke and vapours from filling the enamelling room, the oven must be constructed so as to obtain an air seal around the opening, or an exhaust fan connected at the proper point of the oven to secure an air balance, and at the same time provide ample ventilation.

The hand-operated kiln-type oven is the most inefficient type of oven used. Since the work must be carried in by hand, the oven cannot be at a very high temperature during the loading period. Also, after the baking has been completed the oven doors must be opened and the oven allowed to cool down to about 150°F. before the workmen can enter the oven for removing the work. Before the oven can then be loaded, ready to be put into operation again, the temperature is down to that of the room. This means that in almost every case this type of oven must be heated from approximately room temperature up to maximum baking temperature for every bake that is obtained. With the truck operated kiln-type oven, the doors may be open a much shorter period than where ovens are hand-operated, from 5 to 10 minutes being ample time after the doors have been open for removing the trucks and running other trucks into the oven. The semi-continuous-conveyor oven is about as efficient as the truck-operated oven because, as the work progresses through the oven, both ends of the oven must be laid wide open when loading, with the consequent result of a large cooling effect. Ovens of this type will drop from 450 deg. to 250 deg. while this change is being made. The total weight of the conveyor in proportion to the amount of work entering the oven per bake is probably not so great with this type of oven as in the case of the truck-operated oven, hence the efficiency of operation is improved in this particular. The overall efficiency, however, is approximately the same as the truck-operated oven.

The continuous conveyor-type oven is the most efficient type of oven, it operates continuously at one temperature and requires a minimum of ventilation and a conveyor of minimum weight. The net result of this is that the latest designs of continuous conveyor-type ovens have an efficiency in excess of double the amount obtained by the best semi-continuous conveyor-type oven.

The efficiency of the above types of ovens, expressed in pounds of work or finished product, per kilowatt-hour consumption for ovens of the latest of each of the respective types, having the highest grade insulation, proper ventilation and intelligent operation of the oven is :

Kiln-type oven, hand-operated, 6 lb. to 8 lb. of work per kilowatt-hour.

Kiln-type oven, truck-operated, 10 lb. to 12 lb. of work per kilowatt-hour.

Semi-continuous, conveyor-type oven, 10 lb. to 12 lb. of work per kilowatt-hour.

Continuous conveyor-type oven, 25 lb. to 30 lb. of work per kilowatt-hour.

Standardising Japanning Operations.

Since the principles of scientific management have been adopted so generally and with much success, the standardising of japanning, enamelling or drying operations is receiving greater attention than before. Such scientific standardisation is well exemplified in the use of the continuous conveyor-type oven. In the hand-loaded kiln type oven the work after being dipped is hung up on racks or supports and then after the oven is loaded, current is turned on, and later the reverse of this operation takes place. A large amount of heat is wasted in heating up the oven after each batch and manual handling of material is costly and consumes much time. With the continuous process, which is the one dictated by scientific management, mechanical devices are used to the greatest extent—not only freeing labour for other work, but thereby eliminating a source of error and inefficiency. The work is dipped all at once, carried to and through the oven and then to a point where the next operation is to be performed. With this method all movements and processes may be definitely set and then duplicated in exactly the same manner over and over again. If desired the oven may be so planned and constructed that the work is passed through zones of properly graduated and properly maintained temperatures, so that it may be treated and cooled exactly in ways found to be best by experiment. The ventilation of the continuous conveyor-type oven can be controlled much better because the openings are sealed, and there is no intermittent throwing open of the oven with the resultant cooling-off.

At the National Screw and Tack Company's plant at Cleveland, the use of electricity for heating its drying ovens has resulted in increased production and lowered unit costs. The ovens are now heated to 400°F. in one-tenth the time required under old conditions Rods that used to be kept in ovens 75 to 90 minutes, are now finished in 20 minutes or less. The daily output was about 18 tons, and now it averages 55 tons.

In another factory an operation was carried on which included, first, the placing of pieces on a rod, which was then carried by two men into an oven where it was hung up. In each bake an average of 35 of these rods had to be loaded and carried into the oven. They were then pre-heated for one to one and one-half hours, carried out and dipped, and then hung up to permit the superfluous liquid to drip off, after which they were carried back into the oven and baked for 12 hours. This method had been practised for years in that industry and was commonly used. To electrify this process it was necessary to change the cycle of operation, and eliminate a great deal of the heat loss due to the opening and closing of the oven as well as the cooling-off of the material after each step. To accomplish this, a continuous conveyor-type oven was installed, the operation of which requires the labour of only a man or boy to place the material on a chain conveyor and another to take the finished product from the conveyor as it comes from the oven. All of the former operations are accomplished in the travel of the conveyor. The saving in labour through the installation of this oven was sufficient in itself to pay for its cost in approximately seven months. A uniform product is turned out; the saving in floor space is approximately 75 per cent.; there are no culls: the temperature is held constant automatically, preventing over or under baking, and shop conditions are improved.

Electrically-heated Core Ovens for Foundries.

Electric heat is eminently adapted for core drying because of the thoroughness of the drying action of the radiating heat. The cores are baked more rapidly and as a result of any efficiency plan depending on standardising, a process through accurate control of factors, the production is increased, the product bettered, and possibility of imperfectly baked cores eliminated. Enough installations have been made to show that the results are as satisfying as has been effected in the japanning and enemalling field. The ovens are similar and the sizes and arrangement of racks depend upon the size of cores to be baked.

Sherardizing Ovens.

In the process of sherardizing, which is a means of rust-proofing, the electrically-heated oven has now been found extremely superior. This process consists of treating the metal article in zinc dust in such a way that the entire exposed surface is impregnated. The dust used consists of metallic zinc with zinc oxide which can best be uniformly handled by keeping the temperature of the oven constant. About 10 years ago sherardized metal moulding was put on the market in competition with the usual enamel-covered conduit used in electrical construction work. Since then sherardizing has been extended to the coating of many iron and steel products, as well as being applied to brass to produce a finish resembling nickel plate.

In the report recently made by the engineering department of the Society for Electrical Development, they cite as an example of saving of sherardized products the case of an automobile manufacturer changing over from brass hub caps to sherardized steel caps. Brass caps running four to the pound at 34 cents a pound would cost 20 cents more per set of four than the steel sherardized caps. On a production of 25,000 caps there would be a saving of $5,000, which could be increased by substituting sherardized steel for other brass or nickel-plated parts.

The ovens used for the sherardizing process are of the rotary type, and the electric units used permit of controlling the temperature, so that the surfaces of the articles reach and maintain the condition most suitable for the best sherardizing. The oven is revolved by a motor and the zinc dust is thus brought in constant and intimate contact with the articles or material. The heating elements are imbedded in the sides of the drums and current led to them through collector rings mounted on the shaft. This is done because the oven is rotated during operation. The temperature of a sherardizing oven is considerably higher than that of an enamelling oven, the "high" heat at the start being over 700°F. This "high" heat is held until the metal is in a condition to absorb the zinc dust (in which it is packed). "Low" heat is then thrown on for two or three hours to give time for thorough depositing and then the current is thrown off. When the temperature of the oven drops to about 350°F. the door may be opened and the material removed.

Gun Shrinking Ovens.

In the gun-treating ovens as now used in ordnance plants, temperatures ranging from 700°F. to 1,000°F. are employed. These ovens are used for shrinking gun jackets in place, being from 15 ft. to 75 ft. long and cylindrical in shape. Heat other than electric heat could not be applied very easily, and by proper placing of the electric heater units the necessary uniform distribution of heat is secured.

Miscellaneous Application.

Shelf heaters form a means of applying electric heat to ovens already built or in use, such as are not intended for high temperature work, as the current consumption is not sufficient to give extremely high temperatures. They are suitable for a great variety of purposes, such as: Laboratory closets, lacquering ovens, evaporating and drying closets, plate warmers, &c. More than one shelf may be used when there is sufficient height and a single shelf does not give a sufficiently high temperature.

Perforated shelves may be made up with space heater units placed below, and this arrangement is used for many odd purposes, such as keeping oil and grease in quickly usable form in garages, factories, &c.

110,000-volt Transmission Line Over the St. Lawrence River.*

By S. SVENNINGSON.

The Shawinigan Water & Power Company transmits power from the generating plants at Shawinigan Falls, north of the St. Lawrence river about 20 miles, to the towns on the south side of the river, supplying various towns and industries, including asbestos mines. The current is transmitted at 50,000 volts from Shawinigan Falls to the St. Lawrence, where the voltage is stepped down to 25,000 for transmission across the river by the submarine cable, then stepped up to 50,000 volts and transmitted at this voltage to Thetford and Sherbrooke (the two branches). At the time the submarine cables were installed, the alternative of putting in an overhead crossing was considered, but the amount of power to be transmitted at that time was so small that the expense of an overhead crossing did not appear justified. However, the demand for power on the south shore steadily increased. By the beginning of 1916 five submarine cables were in operation, two three phase and three single phase, and the capacity of the transformer house had reached 10,000 kw. Submarine cables have always been a source of trouble and expense. The current in the river carries them down stream, and is sometimes strong enough to pull them apart In the winter the ice has often put them out of commission, and temporary pole lines were erected across the ice to maintain the service. When, therefore, in the autumn of 1916 the demand came for more power for the south shore, partly for war work, the company decided in favour of an overhead crossing.

The construction of an additional submarine crossing would have involved an expenditure of about $150,000 for the purchase and installation of cables, additional transformers, about 4,000 kw. capacity, and their switches, lightning arresters, &c., and the necessary extension of the transformer houses. Besides this, the weak point in the line would not have been improved. The overhead crossing was estimated to cost $200,000, the difference between the two being offset by the advantage of obtaining greater security from interruptions to the service, and a gain of from 2 to 3 per cent. in regulation by cutting out the transformers, together with the elimination of a considerable amount of operating and maintenance expense.

Preliminary Investigation.

The shores of the St. Lawrence river were carefully surveyed, and it was finally decided to investigate in detail two alternatives. (*a*) A three-span crossing at Point-du-Lac, each span approximately 2,200 ft. long. (*b*) A single-span crossing between the cable houses 4,800 ft. long.

From a construction point of view, the site at Point-du-Lac appeared at first to be very favourable for an overhead crossing. The St. Lawrence at this point is about 7,000 ft. wide, but as the water is very shallow, except for a distance of 2,000 ft. in the centre, a crossing could have been built using three spans of approximately 2,200 ft. each. This arrangement, though somewhat cheaper in itself, would have necessitated the building of about 15 miles of double-circuit high-tension pole lines in order to connect up with the main transmission lines. This additional cost would have brought the total cost approximately up to that of the single-span scheme, and the latter was finally decided on.

General Description.

The crossing as completed consists of a central span 4,801 ft. long and two anchor spans, the north shore span 571 ft. long and the south shore span 951 ft. long. There are two towers 350 ft. high and 60 ft. square at the base, the upstream and downstream faces tapering to a width of 14 ft. at the top. A cross-arm at the top, 14 ft. wide by 100 ft. long, carries three double-groove sheaves 8 ft. in diameter and 50 ft. apart, over which the anchor cables pass. The tower foundation is made up of four circular reinforced concrete piers 11 ft. in diameter placed on the corners of a 60 ft. square. These piers are connected by heavily reinforced concrete beams 4 ft. wide by 8 ft. deep. Three lines of cable 50 ft. apart span the river between the two towers. The cables are $1\frac{3}{8}$ in. in diameter, made of galvanised plough steel, and composed of six strands of 19 wires each, with a stranded core of 30 wires. To each end of the centre span cables is yoked two anchor span cables.

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* Abstract of Paper read before the American Institute of Electrical Engineers.

During February, 1917, borings to a depth of 100 ft. revealed very fine white sand with occasional strata in which a little clay was mixed. The piers were constructed in the form of hollow cylinders of reinforced concrete with an outside diameter of 11 ft. and an inside diameter of 7 ft. This work was begun early in the year, but owing to high water, high winds, rain and labour troubles it was not completed until about the middle of September.

Cables.

The cables are $1\frac{3}{8}$ in. in diameter, of galvanised plough steel, made up of six strands of 19 wires each, and a stranded steel core of 30 wires. Tests made at McGill University showed that the wires had an average yield point of 221,000 lb per square inch, and an average breaking load of 258,000 lb. per square inch. The completed cable was tested, the yield point being found to be 158,500 lb., and the ultimate strength 186,400 lb., or 193,000 lb. per square inch and 227,000 lb. per square inch respectively. The test of the completed cable indicated a modulus of elasticity of 7,250,000 lb., or 8,800,000 lb. per square inch. The usually accepted value for the modulus for stranded steel cables is about 21,000,000 lb. per square inch, but the behaviour of the cable during erection bore out the results of the test.

The bridge sockets used for connecting the cables were machined out of solid blocks of steel, so as to allow a grip of 9 in. on the cable. The cable was passed through a tapered hole in the centre of the bridge socket and broomed out on the end for a length of 15 in to 18 in. The wires were then cleaned with gasoline and held in place by means of a templet made of $\frac{1}{8}$ in. steel plate, which fitted over the back of the bridge socket. The bridge socket was suspended bottom up and heated by gasoline torches for about half an hour, when spelter was poured into the conical hole through a 1 in. diameter hole in the centre of the templet. After being allowed to cool, the ends of the wires projecting from the templet were cut off and the templet was removed. It was found that if the spelter was heated to just the right temperature (*i.e.*, just hot enough to ignite a sliver of wood thrust into it) the full breaking strength of the wire was usually developed in a length of 6 in.

Shortly after the bridge sockets were poured it was found necessary to shorten two of the cables, and the speltered end was cut off. We had one of these cones of spelter cut in the machine shop, and found that the spelter adhered so firmly to the wires that the section could be machined without lifting the wires out.

Insulators.

The insulators which were used eventually consist of a large ring girder and two spiders. The ring girder is 8 ft. in diameter, and made up of two 9 in. channels 12 in. apart, with $\frac{3}{8}$ in. cover plates. The upper spider is connected to the ring girder by means of three $2\frac{1}{2}$ in. bolts 10 ft. long, one at the end of each spider arm. The centre spider is supported on the ring girder by six porcelain insulators of eight skirts each, two insulators at the end of each spider arm. The clear distance between the spiders is about 36 in.

The special compression porcelain insulators have a tested breaking strength of 60 tons each; this is about four times the estimated maximum load. Electrical tests showed a dry flashover of 302,000 volts and a wet flashover of 262,000 volts. The completed insulator has a net weight of about 6 tons.

Erecting Cables.

The three lines were erected in succession. The ends of the anchor cables were hoisted over the towers, the south shore cables made fast to the centre span cable, drawn over the tower until the bridge sockets touched the main sheave, tied to the top of the tower and attached to the anchor pier. The north shore cables were next attached to the centre cable, the suspension insulators and copper line fastened to this and the cable hoisted into place. The hoisting was done by a steam hoist braced against the centre anchor pier.

The copper conductor in each line is supported by 17 suspension insulators spaced about 250 ft. apart, the end insulators being about 400 ft. from the towers. The copper lines drop from the end insulators to strain insulators on the tower at the 150 ft. level, pass through the tower to the back, where they are connected to another set of strain insulators. On the north side the lines pass direct from the main tower to a transmission line tower on the shore, a distance of about 600 ft. On the south side a light structural steel truss, 50 ft. long, hung from two sets of the anchor cables, provides an intermediate point of suspension, forming two spans of 500 ft. each. Access to the insulators attached to the truss is provided by a walkway running up from the anchor pier and suspended from the anchor cables.

After the cables were erected an almost constant vibration in them was observed, varying in intensity and somewhat similar to that in a violin string, with definite nodes 12 ft. to 15 ft. apart. About a month after the line was put into service this vibration seemed to shake loose the bolts connecting two of the suspension insulators to the cable, and they dropped and hung suspended on the copper line. Two of the riggers volunteered to go out on the steel cable, fish up the insulators and attach them again. A short time later an insulator on one of the other lines broke loose, and it was similarly re-connected. The cables as originally strung allowed the following clearances between the copper conductors and the average water level during the season of navigation: Down stream, 172·5 ft.; centre, 178·8 ft.; up stream, 180·6 ft.

The temperature at time of erection was about 20°F. As there is a change in sag of approximately 1 ft. for each 10 deg. change in temperature the above would correspond roughly to clearances at 110°F. of 163·5, 169·8 and 171·6 ft. respectively. At the time these cables were erected the sag was expected to increase as the cables stretched under the load until the strands were drawn tightly together. There was no data available by which to predict the extent of this increase. The hoist, therefore, was left in position, so that the cables could be pulled up when the sag became too great. In May of this year it was found that the sag in the cables had increased by from 24 ft. to $27\frac{1}{2}$ ft., and that in order to obtain the necessary clearance over the channel we would have to take up 24 ft. in the sag of the down-stream cable and 13 ft. and 14 ft. in that of the centre and up-stream cables respectively. The amount by which a cable is to be stretched in order to take up a given amount in the sag varies inversely as the modulus of elasticity of the cable, which, however, is itself affected by the gradual stretching to which the cable is subjected.

Ice Protection

Ice conditions in the St. Lawrence river at this point are at times very troublesome, and it was, therefore, advisable to construct some kind of guard piers outside the towers. During the winter about 3,000 tons of field stone were deposited on the river bed on each side about 75 ft. from the up stream and river faces of the towers, carrying the rock to an elevation about 3 ft. above the surface of the ice. The ice usually goes out about this level, but last year conditions were exceptionally severe. The guard piers are now being completed by means of reinforced concrete cribs filled with rock, and carried to about the level of the maximum recorded high water.

Sag Calculations.

In calculations for sags, tension, length of cable, &c., under various conditions, the parabolic formulæ were used in preference to the hyperbolic formulæ for the catenary, on account of greater simplicity. At working tensions the difference between results obtained by the respective formulæ was negligible. Thus the parabola formulæ gave about 6 in. more sag and about 1 ft. less length of cable than the catenary formulæ for the same conditions of tension and temperature.

The maximum load on the cable was assumed to be $\frac{3}{4}$ in. of ice all round, and 10 lb. of wind per square foot of projected area, for both the steel and copper lines at a temperature of zero °F. Under these conditions the calculated tension in the cable is about 106,000 lb. with a sag of 228 ft. The normal tension at summer temperatures is about 61,000 lb. with a sag of 185 ft.

Conclusion.

In our design the accessibility of various insulators and other working parts that are subject to breakdown has been kept in view. Automatic hoists have been provided in the towers, as well as ladders which run from top to bottom, and provide access to the suspension insulators at various levels. The crossing has been in uninterrupted service for about nine months. It has not yet weathered a winter, with its low temperatures, gales and sleet storms, so that we still have something to learn about its action under these conditions; but serious trouble from this source is hardly expected.

Electric Welding: Its Theory, Practice, Application and Economics.*

By H. S. MARQUAND.

(Continued from page 176.)

Summary.—In this article the author concludes his description of various methods of preparing welds and gives some further illustrations of various kinds of work that is now undertaken. He then passes on to the economics effected by machine welding, and to the testing and strength of electric welds.

Owing to the strong objection to placing a riveted seam in a position where it will be subjected to high temperature, it is now common practice to butt weld in new plates to the backs of combustion chambers, weld in new lower tube plates, &c. (Fig. 75). In fact, wherever serious wastage has taken place, the defective area of plating can be cut away and new portions of plating welded in (Figs. 76 and 78).

It is of considerable interest and importance that, although the author's company have effected many thousand pounds' worth of boiler repair work every year, they have never had to cast a rivet before or after welding.

The welding of a plate into an existing structure or plate rigidly supported on all sides is a most scientific operation, but can be done by the electric arc system with entire success by complete knowledge of the technical difficulties and expert workmanship.

With the electric metallic arc the temperature, though extremely high, is very localised, and the surrounding plating or metal is in no way detrimentally affected right from the line of the weld. However, the effects of expansion and contraction have to be very carefully studied, especially in commercial repair work, as the conditions of working are rarely those calculated to assist the operation. Varying atmosphere, temperature, cold draughts and generally unfavourable hindrances are the usual order of daily practice.

Any suggestions and advice of procedure which could be set out here might prove in practice dangerous rather than helpful, owing to the fact that what might apply in one case may be inadvisable in another case. Each individual case must be examined and treated on its own merits.

However, when butt welding two plates or portion of plates, or welding in insert patch plates, the edges to be joined should be chamfered at about 45 deg. each, and kept apart about $\frac{1}{8}$ in. Should the weld be a long one, say over 1 ft., the edges should not be paralleled and the spacing should be increased from $\frac{1}{8}$ in., increasing $\frac{1}{8}$ in. per foot of weld (Fig. 14). The expansion should be allowed to work all one way, and the welding

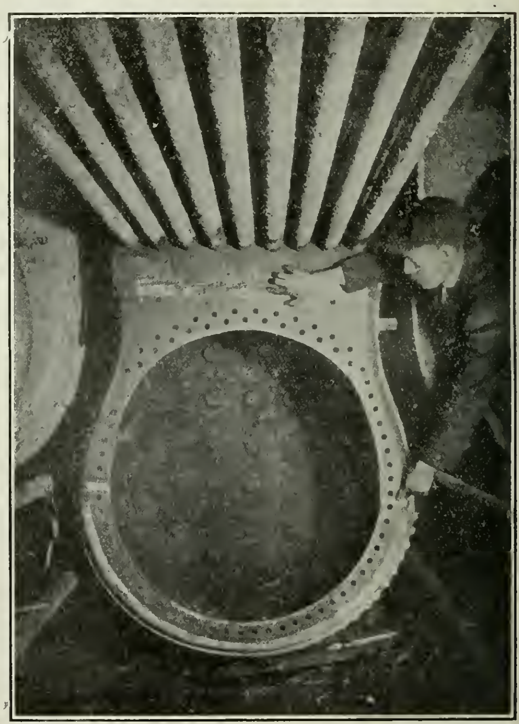

Fig. 75.—Repair recently Carried out in London. New lower half tube plate welded in, in two halves.

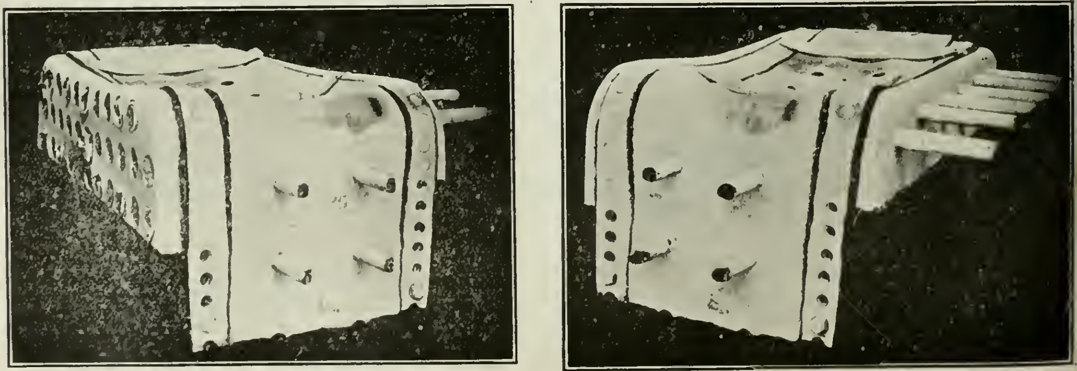

Fig. 76.—Repair recently Carried out on the Tyne. Fractured and collapsed main boiler combustion chamber top. Cut out, renewed, and electrically welded into position.

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is best commenced and carried through with as few breaks as possible.

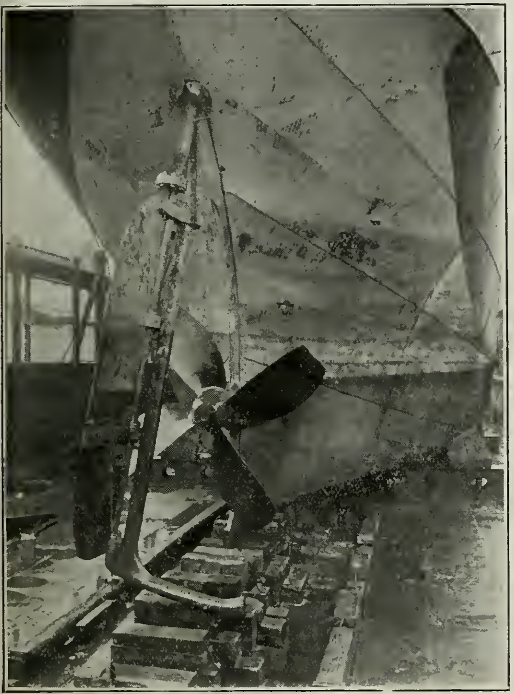


Fig. 77(1)

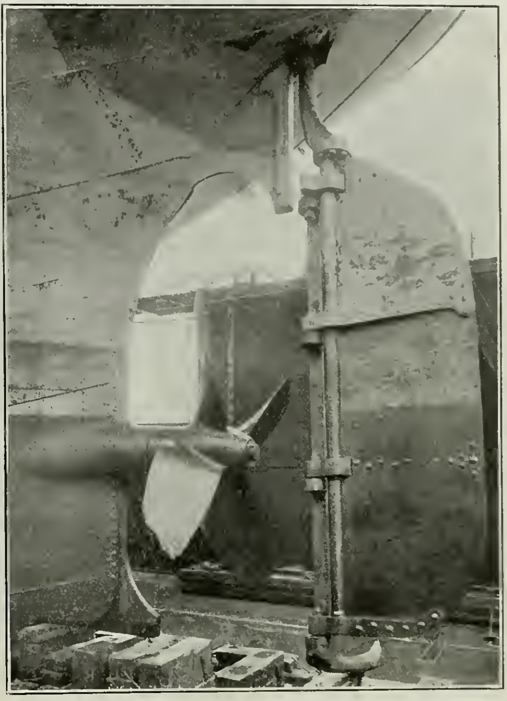


Fig. 77(2).

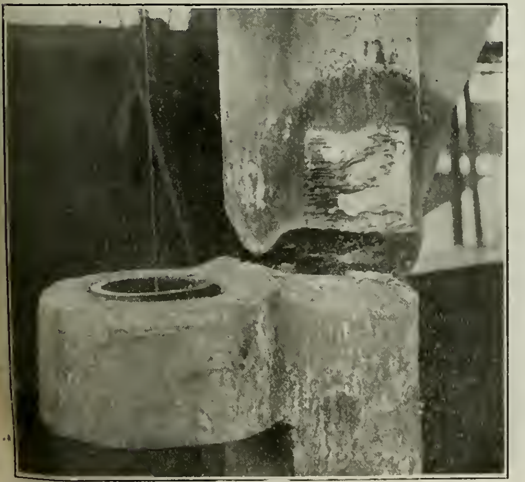


Fig. 77(3).

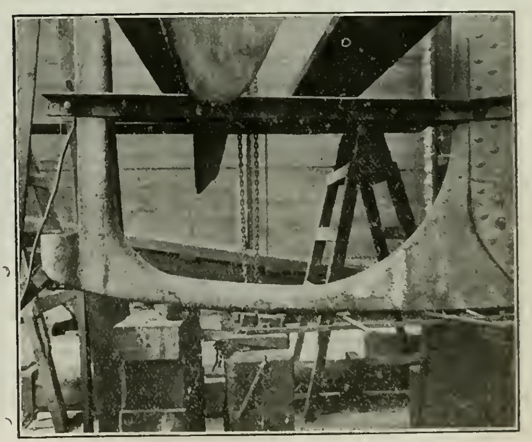


Fig. 77(4)

Illustrations of Repairs to Stern Frames.

Fractures in furnace or shell plating must be cut clean out to the full section of the plating, V-eed as already described and welded up by commencing at the bottom of the V and working the metal as it is deposited diagonally, each layer crossing the previous layer with its grain at an opposite angle. It is most important to train welders from the very commencement to get their metal right through the section of the plating. When the weld is completed, the metal added should be chipped, so that the section of the plating through the weld is only a very little in excess of that of the original plate.

Fractured or worn stern frames, rudder posts, stem posts, wastage on stern and other hull plating can be most successfully made good by the metallic arc process. Figs. 77 and 79 illustrates one of many stern frames repaired by the writer's company quite recently. The repair was carried out to the entire satisfaction of the Admiralty, Board of Trade and superintendents. The photographs are self-explanatory.

Many remarkable repairs to machinery have also been carried out in marine and land installations.

The repairs effected by arc welding on several interned German and Austrian vessels in New York in 1916 were of supreme interest, and are splendid examples of what can be done.

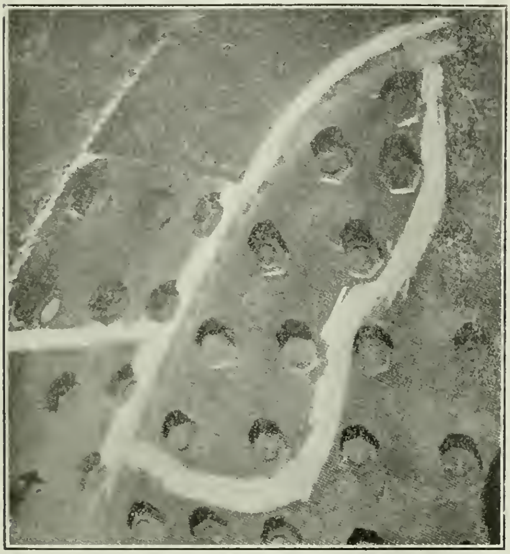


Fig. 78.- Repairs by Electric Arc Welding Effected in 1918, Bristol Channel Area.

Showing a portion of a combustion-chamber back plate cut out and a new plate welded in flush, also part of wrapper side renewed and welded.

Fig. 79.

A number of excellent articles have already appeared in the leading engineering magazines descriptive of these repairs, which will be referred to in the appendix to these articles.

In passing, however, the writer would point out that, wonderful as these repairs were thought to be at the time, and cleverly executed they certainly were, yet in this country, for several years prior to 1916, numerous repairs to cast-iron cylinders, bed plates, condensers, pumps, &c., had been most successfully effected in marine and land practice.

The writer has superintended the carrying out of electric welding repairs to cast-iron structures on ships in situ, saving tens of thousands of pounds in the cost of dismantling and renewals. The tube plate landings of condensers when wasted away to the extent that the condenser can only be condemned are now commonly built up completely by means of the metallic arc process. Fractures in cylinders, condensers and pump chambers can also be made good.

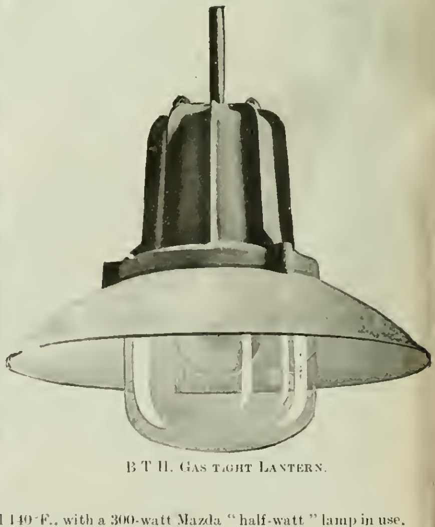
It goes without saying that this class of work, perhaps even more than hitherto described, can and should only be attempted by the most highly skilled labour with the assistance of expert supervision.

(*To be continued.*)

A Gas-tight "Half-watt" Lantern.

The truth of the proverb about necessity being the mother of invention was exemplified during the war as never before. Every military and naval exigency gave rise to a fresh problem, requiring for its solution the design of a new appliance or the modification of an old one. Execution in most cases followed hard on the heels of necessity. A case in point has reference to the lighting of munition works, shell-filling factories, airship factories and sheds. For absolute security it was considered necessary that lighting fittings should be perfectly gastight in order that, in the event of a lamp breaking, there would be no risk of explosion. This may not seem a very difficult problem, but, as a matter of fact, the design of a suitable gastight lantern for use with the "half-watt" type lamp was by no means simple, owing to the impossibility of providing ordinary means of ventilation to dissipate the heat from the lamp.

The British Thomson-Houston Company, of Rugby, succeeded in designing a lantern which completely satisfied the requirement that the maximum temperature of any part of the lantern should not exceed 140°F., no matter how long the lamp might be alight. This lantern (type 917, form A), shown in the accompanying illustration, consists of a c.i. body in one piece, provided with cooling fins to dissipate the heat generated by the lamp. These fins are arranged similarly to the radiating fins on the cylinder of a motor cycle engine. The reflector is a vitreous enamelled mild steel spinning. The globe is of clear blown glass, supported in a c.i. ring and hermetically sealed by means of a rubber gasket. The lantern is completely gas and watertight, and, although there are no ventilating apertures, the temperature of the metal parts is guaranteed never to exceed 140°F., with a 300-watt Mazda "half-watt" lamp in use. Several hundreds of this lantern have been supplied for shell-filling factories, &c.; but, in view of the fact that a gas-tight and water-tight lantern for "half-watt" lamps is required in many peace time industries, the B.T.-H. Company have decided to standardise the lantern, and to include it in future catalogues of industrial lanterns.



B T H. Gas tight Lantern.

On the Measurement of Small Susceptibilities by a Portable Instrument.*

By Prof. ERNEST WILSON.

In connection with some recent work on rock specimens the author developed an instrument for the measurement of susceptibilities of low order.† This instrument differs from that of MM. Curie and Chéneveau in that an electro-magnet is employed instead of a permanent magnet, and thus the magnetic field can be varied in intensity. It is simple in construction, portable and capable of easy and rapid adjustment.

For magnetic survey work the important range of susceptibilities is from about 0·000002, the upper limit being about 3 or 4 in the case of magnetite crystals. The instrument is capable of measuring from about 0·15 to 0·0003 with a strong suspension, and so low as 0·000015 with a weaker suspension can be observed.

The underlying principle of the instrument is given in the equation $F=\frac{1}{2}K\frac{dH^2}{dx}$, where F is the mechanical force per unit volume acting upon the substance, whose susceptibility is K, and dH^2/dx is the gradient of the square of the magnetic force varying with x the distance. The specimen is preferably in the form of a short cylinder. Powder or solution is contained in a small glass tube, fixed to one end of a horizontal beam, supported by a phosphor-bronze strip. Normally it hangs between two fixed poles of wrought iron, capable of being magnetised to varying degrees of strength by a permanent magnet. The torsion-head of the instrument which supports the suspended system is turned until the angle of twist between it and the beam is a maximum. Let this angle be θ, and let the volume of the specimen be V, then the susceptibility K is calculable from the equation $K=C\theta/H^2V$, where H is the intensity of the magnetic field and C is a constant of the instrument. Magnetic damping was not employed, as it was thought inadvisable to have any possibility of disturbance when small magnetic fields were used. The magnet consists of two rings of tungsten steel, capable of rotation in a horizontal plane about an axis coinciding with the axis of the specimen, when hanging symmetrically between the pole-pieces. Each ring is magnetised with north and south poles on opposite ends of a diameter, and the upper ring is provided with a scale in order that the relative position of the poles on the magnet rings can be determined. If the magnet rings are so placed that their like poles are together and coincide with the poles, one of these becomes a north and the other a south pole, and in this the intensity of the magnetic force between the poles is a maximum.

Two methods for variation of the force H are available, (*a*) keeping the like poles together by means of the locking device, the two rings can be turned through known angles and the force passes through zero value when the angular movement is 90 deg. from the maximum; (*b*) keeping the lower magnet ring fixed in the position of maximum force and turning the upper ring from its position of maximum force, the value of H can be reduced until the angle turned through is 180 deg., when the difference between the two magnets is obtained. It is difficult to obtain exact equality in the strength of the two rings, and, the difference between two large and nearly equal forces is liable to be seriously affected by a slight variation in one of them. During the ageing of the magnets this difference is liable to vary. It is, therefore, desirable to vary the magnetic force by turning the two rings simultaneously, thus sacrificing the more open scale available when one ring only is rotated.

The magnet rings are made of hardened tungsten steel, and experiments summarised in the original paper show that the steel was of the highest grade for the purpose of permanent magnets. The ageing of these rings is one of the vital points in the instrument. It was determined by measuring the force between the poles of the magnet. For this purpose a coil having the same dimensions as the poles was attached to a ballistic galvanometer, and deflections were obtained on quickly removing it from the gap. The first set of rings has aged 31·5 per cent. from March 14 to May 19, and the second set has aged 39 per cent. Experiments are being made with other arrangements of magnets and pole-pieces.

When it is desired to demagnetise the pole-piece or a specimen after the application of a large force the rings were locked relatively to one another at intervals gradually increasing the angular displacement between the poles, and thus diminishing the maximum field. At each interval the two rings, so locked together, were rotated a few times. A series of curves was obtained showing how the face varied during each operation. The curves show a gradually diminishing amplitude combined with variable phase displacement. Experiments with various types of poles show that the maximum magnetic force for a given pair of rings and given gap between the pole-pieces can be increased by using two poles which are in the plane of the rings and not elevated. The gain is considerable, and amounts to about 30 per cent., the difference being caused by leakage. For this reason the latter type of poles has been adopted. Two sizes of phosphor-bronze strip have been used. The strong one has a rectangular cross-section of 0·85 mm. by 0·09 mm., and its length is 10 cm. At a radius of 10·9 cm. the force in dynes per 1 deg. of twist was measured, and found to be 1·50. This strip does not take up an appreciable permanent set when one end is twisted through 180 deg. The smaller section of strip is 0·85 mm. by 0·04 mm., and experiment shows that the ratio of the restoring forces for equal lengths is 20·6 to 1 in the two cases. The length of strip employed in the instrument is 10 cm., and the radius of the beam is 10·2 cm.

From previous experiments with the more elaborate instruments several specimens of widely differing susceptibilities were available. They are not truly circular in section, as when dealing with rock specimens much time would be spent in making them so. The table below gives some of the figures obtained with the two suspensions with the magnet rings in the position of maximum force. The ratio of the instrumental constants is about the same as that of the restoring forces in the suspensions. The variation in the value of the constant is due in part to the specimens not being exactly alike as regards shape and size. Also in the case of rock specimens the susceptibility is liable to vary throughout the mass.

The variation of the magnetic force H with angular movement of the two magnet rings, locked together with their like poles coincident, was tested by the exploring coil and ballistic galvanometer, and also by the deflections obtained with two specimens in the gap. Values of H so obtained are compared with the values calculated on the assumption of the sine law. Given the maximum value of H, the force for other positions can be calculated. It is thus possible to apply known forces when making determinations, and this is important in some cases in which the susceptibility is not a constant and in some function of H. But even when the susceptibility is constant it is necessary for a given suspension and large range to vary the force; the phosphor-bronze strip must not be twisted

Description.	Instrumental readings.		Mean value θ°.	Previous determination of susceptibility.	Instrumental constant C.
	Left.	Right.			
Strong Suspension—					
Grey granite	91	98	94·5	0·0021	7·75
Ironstone	11	11	11·0	0·0003	9·80
Chalybite	40·5	41·5	41	0·0006	9·5
Red hæmatite	15	16	15·5	0·00022	9·5
Dolerite	156	164	160	0·0047	8·4
Weak Suspension—					
Kaolin and chalybite mixture unbaked	103	92	97·5	0·000153	0·50
Manganese sulphate, normal solution	13·5	6·5	10	0·000018	0·43

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* Abstract of a Paper read before the Physical Society.

† Proc, Phys, Soc. Lond., 1910., Vol. XXII., Pt. III., p. 343.

beyond the elastic limits, and, therefore, when the susceptibility is large a small value of H is imperative.

If rock specimens are ground in a non-magnetic mortar, and then tested for susceptibility, in a large number of cases the susceptibility of the original rock can be fairly closely inferred. In magnetic survey work it is important to test a large number of specimens of the same rock in order to obtain an average. It may therefore be an advantage to grind such specimens, as the work entailed by cutting to shape would be prohibitive. When powders are used they are contained in a small glass tube which has a diameter of about 1 cm. and a length of about 4 cm., correction being made if necessary for the glass in the tube.

An Improved Voltmeter for Synchronising Purposes.*

By Dr. G. KEINATH.

The alternate-current voltmeter has always been supposed to labour under an unavoidable drawback, inasmuch as the division of the scale is of a quadratic nature, especially over the lower portion. All sorts of attempts have been made to deal with this, and instruments have been constructed which give a linear sub-division over nine-tenths of the range. The first tenth of the range is, however, still small, and amounts to 2 or 3 per cent. of the whole scale. But for synchronising purposes the lower part of the scale is of importance. The plan has therefore been adopted of making the maximum deviation correspond to one-half or one-third of the whole voltage; and while this has the advantage of multiplying the deflections on the lower part of the scale by 2 or 3, it has certain disadvantages, which are specially marked when gas engines are the source of motive power. A very simple method of altering this consists in the employment of a resistance, in series with the voltmeter, which has a high temperature coefficient. The resistance, which is ordinarily used, is made of resistance-wire, which has a negligible temperature coefficient; on the other plan, the value of the resistance would change very decidedly with the temperature. Thus, on low voltages, the resistance would be very small, but as the voltage rises, the resistance would increase. Metal filament lamps are such resistances, and are in a shape ready for use. The resistance of such a lamp, when hot, is about 10 times the resistance when cold. But the gas-filled lamps are somewhat different from those with a vacuum. With gas-filled lamps the resistance when hot is about 12 times the resistance when cold; this compares with a ratio of 10 to 1 for vacuum lamps. Moreover, the resistance at the start increases slightly differently in the two cases. The author gives some curves, constructed on a logarithmic system of co-ordinates, which compare the increase of the resistances in the two cases. The resistances of the two types of lamp at full pressure are assumed to be the same; and it is seen that for values of the voltage less than 10 per cent. of the full voltage the gas-filled lamps have a notably lower resistance than those of the vacuum type. With vacuum lamps, the resistance increases almost uniformly with the 0·55th power of the voltage; there is no very noticeable deviation from the straight-line law (as shown on logarithmic co-ordinates) for values above 0·5 per cent. of the full working voltage.

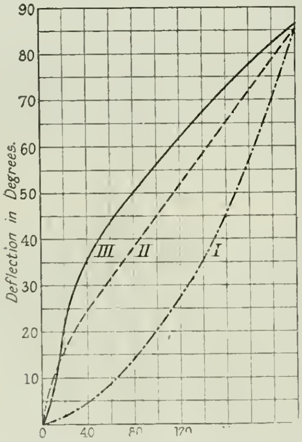

Fig. 1.—Curves showing the Effects of Various Resistances in Series with the Voltmeter.

I. Hot wire instrument, the resistance of the hot wire being 6 ohms, a constant resistance in series with it. II. The same instrument, the resistance in series with it being a 60-watt 220-volt tungsten lamp. III. An instrument with a rotary iron core, the resistance of the coil is 30 ohms, the voltmeter is in series with a 60-watt, 220-volt tungsten lamp.

If such a lamp is put in series with the voltmeter, it becomes evident that the division of the scale will be much improved over the first part of the range; this improvement will depend on the ratio of the resistance of the voltmeter to that of the lamp. The smaller this ratio is the greater will be the improvement. On the other hand, instruments which have rotary iron cores can have their scales much improved by properly shaping the cores. In the diagram curve *I.* gives the calibration curve of a normal hot-wire voltmeter with a constant series resistance; curve *II.* gives the calibration of the same instrument if a 60-watt 220-volt tungsten lamp is joined in series with it, instead of the constant resistance. The first portion of the scale is about 10 times as great as before; the scale is almost linear from the start; the start remains quadratic as before, but it is so small in extent that it is scarcely noticed. Curve *III.* shows an instrument with a rotary iron core, in series with which a tungsten lamp is placed. Curves are also given showing the effects produced under similar conditions by a gas-filled lamp, placed in series with the voltmeter; the law by which the resistance increases in this case is slightly different from that which holds for the vacuum lamp. It is seen that the gas-filled lamp is not so suitable for the purpose, and that the deflections on the voltmeter over the lowest part of the scale are only one-third of those which are given when a vacuum lamp is put in series with the instrument.

A photograph of an instrument is given on which there are 10 divisions, corresponding to equal differences of voltage. With an instrument of this kind, the synchronising process can be carried out with great certainty. If the diameter of the face of the instrument is 225 mm., then at the beginning of the scale a deviation of 2·5 mm. is given by 1 per cent. of the maximum voltage of the instrument; this is a deflection of 1·2 deg. in the case in question. An instrument of this kind has been used for a long time in a colliery installation in the south-west of Germany; it is provided with a minimum-current relay, and effects the automatic synchronising of some gas-driven and turbine-driven generators. Lamps, containing iron wires, like Nernst lamp-resistances, are not suitable for the present purpose. They certainly extend the first part of the scale, but with a further increase of voltage they keep the current constant, so that no further alteration of voltage is shown. In an instrument of this kind the damping of the pointer is important. If this damping is insufficient, the pointer may overswing itself towards zero in such a way as to mislead the attendant. The damping is best of the aperiodic type; it may also be of the dashpot type, to which the main objection is that the process of switching the machines in parallel takes rather more time. The objection may be raised that the use of lamps detracts from accuracy, and that the lamps may require to be renewed, whereby inconvenience may be caused. On the other hand, it is fair to say that for synchronising purposes, accurate readings are not necessary; if a lamp requires renewal, it can be replaced by another of the same kind without the risk of any very serious consequences. A fresh calibration is hardly necessary, seeing that the resistances of lamps of the same type are not likely to differ by more than 2 per cent. An accidental breakage of the lamp may occur very occasionally, but the lamp is hardly likely to burn out, considering that it only burns at full pressure for a few seconds at a time. If required for continuous use the lamp should be suitable for a voltage 10 per cent. above the normal. The method herein described has been protected by patents belonging to the firm of Siemens & Halske.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 46 1918.

Extensions at Poplar.

Under the able management of the borough electrical engineer and general manager, Mr. J. Horace Bowden, M.I.E.E., the demand for power from the mains of the Poplar Borough Council has increased so much since the large extensions, made in 1913, that recently further important extensions were carried out, including a 4,750k.v.a. turbo-alternator and two 1,000 k.w. rotary converters. A general view of the engine room is shown in Fig. 1 and a near view from the exciter end, of the most recent turbo-alternator to be installed is given in Fig. 2. The general neatness of the design will be noted. The two turbo-alternators seen to the right in Fig. 1 were put into commission in 1913. Each is rated at 3,000 k.w., 0·8 power factor, and runs at a speed of 1,500 revs. per min. The alternators are mounted on an extended bed-plate and supply energy at 6,600 volts, three-phase 50 cycles. The set just recently erected comprises a three-phase 6,600-volt, 50 cycle turbo-alternator, rated at 4,750 k.v.a. driven at 3,000 revs. per min. by a Zoelly turbine of the multicellular impulse pattern, in which there are a number of impulse wheels, each rotating in a separate chamber formed by means of the diaphragm plates.

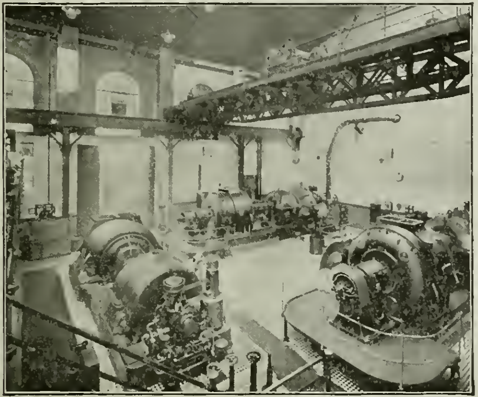

Fig. 1.—General View of the Power House, Showing New 4,750-k.v.a. Turbo-Alternator on the Left.

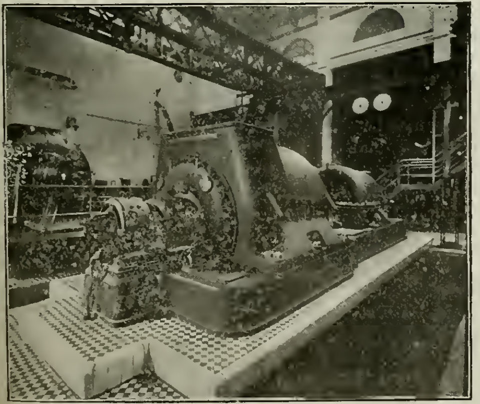

Fig. 2.—View of 4,750-k.v.a. Set from Exciter End.

Reference to Fig. 3 will show what is one of the main features of the turbo-alternators (which were supplied by the General Electric Company), *i.e.*, the great strength of the bracing of the windings. Each coil is securely wedged and supported by bronze clamps, thus rendering the machine capable of withstanding severe short circuits. Another special feature of the turbo-alternators is the system of ventilation. Fans are fitted to either end of the rotor shaft, one for producing a flow of air through the stator and the second for producing the requisite flow of air through the rotor. Air is drawn by the fan on the coupling end of the rotor into the space enclosed by the end guards, and, after cooling the stator coils at the coupling end, passes through a number of axial channels in the core to the other end, thus cooling the whole of the stator. The fan at the other end of the rotor draws a separate current of air through the rotor, thus thoroughly cooling it. The two air currents never intermix, the air which is used to cool the rotor not being used to cool any part of the stator, and in consequence a very low and even temperature rise is obtained. The rotor is constructed from a solid steel forging, the slots being milled out. The conductors are insulated by means of mica troughs placed in the slots, the tops of which are finally closed by steel wedges.

In the power house is also installed a 1,000 k.w. rotary converter by the General Electric Company, for supplying continuous current to the 460-volt three-wire network. This machine is of the self-synchronising type and starts up from the alternating-current side only. It is designed for reactance control and runs at 500 revs. per min. Due to shortness of plant, this machine had to carry 20 per cent. overload for several months, and the fact that it stood up to its work sparklessly speaks highly of the design of the set. A similar 1,000 kw. rotary converter with its self-synchronising panel has been installed at the High-street sub-station. This machine supplies current to the three-wire 460-volt network. It is designed for reactance control and for starting up only from the alternating-current side by means of a three-phase induction motor. The High-street sub-station is designed to accommodate 12 1,000-kw. converter sets, one bank of motor converters and one of rotary converters. A separate annex is provided outside the main building for the transformers for the rotaries. Every effort has been made in laying out this sub-station to provide for simplicity and ease in running cables and making connections to both machines and switchgear. The extra-high-tension cables enter from the outside into a roomy, well-lighted culvert and are taken straight up to a gallery upon which the extra-high-tension truck cubicle type switchgear is situated. The low-tension switchgear is below this gallery on a platform slightly above the maching floor level. A 20-ton traveller crane, together with a good entrance, facilitates the rapid and safe handling or removal of plant when necessary. We understand that Mr. Bowden anticipates that his load in this district will grow to such an extent that he will soon have several units installed.

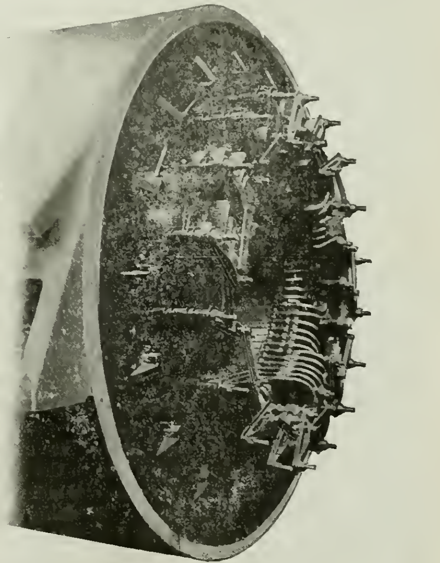

Fig. 3.—Clamping Arrangements for Winding End-Bends on the Turbo-Alternator Stator.

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Women in the Engineering Industry.

It has long been foreseen that the future of the vast numbers of women drawn into engineering and munition work would prove a difficult after-war problem. We have now the actual problem before us, and in one way or another it is being settled—one can scarcely say permanently solved. In many cases the matter has been settled by women voluntarily returning to their homes or domestic duties; but there are other women, especially those who have lost husbands or male relatives in the war, who would like to continue earning their livelihood in the engineering industry, and to these Lady Parsons recently referred in her Paper before the North-East Coast Institution of Engineers and Shipbuilders.

Many people seem to share the impression that the entry of women into the so-called engineering trades dates only from the war. It would be more true to say that the influx of 1915 was on an unprecedented scale. Lady Parsons shows that female labour was already causing complications in the metal trades in 1840; and again in 1870 the brass workers and others protested loudly against the invasion of their trades by women. About the year 1900 women began to pour into the electrical and other new and progressive trades, such as the cycle and motor industries. Their entry on this and other occasions synchronised with the introduction of automatic machinery.

Broadly speaking, therefore, the influx of women into engineering trades during the war cannot be considered new. It has attracted attention chiefly on account of the very large numbers of women employed and the remarkable speed with which many of them attained proficiency in unfamiliar processes. It is doubtless true that much of the work was repetition, lending itself well to the application of "dilution" methods; but there were also many instances in which women learned to perform really skilful operations in a very short space of time. Lady Parsons remarks that quite a number of girls were able to set and grind their own tools, and that a small proportion could set up their jobs from drawings. In some special cases the aptitude shown was remarkable. In one firm, repairing guns up to the largest sizes, there were girls who could design repairs to guns and mechanism, make the working drawings and carry out the work. Lady Parsons does not ascribe these results to outstanding abilities, though doubtless such cases as those quoted above indicated exceptional gifts. The results, she considers, were mainly due to the sensible training given. Such experience should lead us to question very seriously the utility of the pre-war training of apprentices, with its waste of time on profitless jobs and limited opportunities for acquiring knowledge.

It should not be necessary to recall now what has been said so often regarding the valuable services rendered by these women during the war. We must confess that their hopes that they would also be allowed to participate in the making of the implements of peace seem to us natural and, in the main, justified. After the praise given to their war efforts, it seems poor gratitude to deny them the chance of continuing engineering work. Yet it appears that the engineering industry is now to be again barred to women by an agreement made between the Treasury and the Trade Unions. Lady Parsons remarks that no women sat on the conferences that preceded this agreement, and consequently their point of view was never raised, although 90 per cent. of the workers on munitions were women.

After one and a half million women have received a certain amount of training in schools that have cost the country over £30,000,000, it seems poor economy to scrap all these potential wealth producers. In any case, it is only a proportion of these women who desire to remain in engineering. Many will gladly return to their homes, their husbands and their domestic duties, leaving their jobs to demobilised men; but there are other women whose claims to employment are as urgent as those of men returning from the Army. Male workers in industry are constantly asserting that they will not return to pre-war conditions, and are demanding a higher standard of living; but many women, with their war experience, have changed their ideas just as completely, and are now desirous of economic independence and freedom of opportunity in industry.

For our part we think that, for good or ill, the conditions prevailing in this respect before the war can never return. In course of time women will enter many industries and professions denied to them before the war. Artificial restrictions can be of only temporary effect, especially in view of the changed political status of women. In these various fields women must, however, find their level. During the war they have done many varieties of work formerly assigned exclusively to men. In those industries which they enter in the future they must conform again to a common standard of work and remuneration for men and women. Ill-paid, inefficient human female labour is a curse to any industry, and will be shunned alike by masters and men. A desire for the exclusion of women from industry is sometimes based on the fear of widespread unemployment; but, considering the circumstances, the absorption of men demobilised from the Army has so far been rapid. The only serious objection is based on the possibility that the retention of women might prevent demobilised men from getting back into their work. A period may come, of course, when unemployment will prove a serious problem; but this period, even if it occurs, should only be temporary. Ultimately there should be work for every able man and woman. The wastage to be made good is so tremendous, and the facts of the situation are too strong to be disputed. In this reconstruction work, we are convinced, women will ultimately have their fair share.

Review.

I Fenomini Elettro-Atomici sotto l'Azione del Magnetismo. (Electro-atomic Phenomena under the Action of Magnetism.) By Augusto Righi. (Bologna: Nicola Zanichelli). Pp. xvi.+434. 17.50 lire.

At a time when streams of free electrons have become of practical importance in amplifiers, and other modern devices, the publication of a connected series of researches on certain phenomena of vacuum discharges is a welcome event. Prof. Righi, the veteran physicist of Bologna, can look back upon half a century of uninterrupted research, in the course of which he has published some 300 Papers on electrical and optical subjects, including his famous contributions to the study of Hertzian waves. The present work gives a general introduction to electrical science in the light of the ionic and electronic theories, followed by three chapters on those researches with which Righi's name has been lately identified.

The first, and perhaps the most important, of these chapters, deals with "magneto-ionisation," a conception formed to account for the influence exercised by a magnetic field on the intensity of a vacuum discharge. This influence is covered by the author's simple hypothesis that the energy required for ionising molecules is diminished by a magnetic field, the molecules being oriented in such a manner that the "satellite electrons" experience a centrifugal acceleration which enables them to break away more easily. Another chapter is devoted to the author's "magnetic rays," which appear to follow the lines of force of a strong magnetic field, instead of being simply deflected by it. Whatever may be the ultimate value of the author's method of visualising these phenomena, it is certain that his hypothesis of close spirals strung on the magnetic lines, links together a great array of somewhat unconnected happenings, and this is always of value. The "ionomagnetic rotations" described in the next chapter form a fascinating series of experiments on what may roughly be stiled "electromagnetic radiometers," in which Righi's experimental skill shows at its best. The final chapters deal with applications of these conceptions to magneto-electric displacements in gases and solids. Mathematical appendices put into more precise language some matters which the very lucid text makes generally intelligible. E. E. F.

Oscillations During the Discharge of an Induction Coil.

By E. TAYLOR JONES, D.Sc.

(*Concluded from p.* 169)

Curves of the potential at the terminals of X-ray tubes have been obtained by A. Wehnelt,[*] who used for the purpose a Braun tube oscillograph with an arrangement for reducing the potential to a value suitable for this instrument. Although in his experiments the induction coil was supplied with alternating currents, the curves obtained by him are similar in general character to those described here ; the hard tube gave a curve showing one or two deep indentations, the soft tubes showed a more gradual fall, followed by a nearly horizontal or slightly rising portion. It is, however, impossible to judge from his photographs whether the discharge through a soft tube shows any tendency to prolong the period of the positive wave, as is very markedly the case in Fig. 9 above (*see also* Fig. 17).

When the primary current was only slightly greater than the minimum, tube *A* gave potential curves similar in form to those given by the coil with the tube disconnected. This was also the case with tube *B* when it behaved normally ; but this tube showed at times certain peculiarities which were found to be associated with a very variable initial potential of the discharge. The discharge frequently began at a potential considerably higher than the normal value. An example is shown in the two curves of Fig. 11, taken on the same plate and at the same current ($i_0=2$ amperes), the initial discharge potential being considerably higher in the upper than in the lower curve. When this happened at the same current the tube glowed much more brightly—and presumably the cathode ray current was greater—at the discharge which began at the lower potential. Another example of this delayed discharge is shown in Fig. 12, taken at a stronger current ($i_0=5{\cdot}2$ amperes), the potential in this case rising nearly to the maximum attainable without the tube before falling rapidly to the value at which the later portions of the discharge took place.

INVERSE CURRENT AT BREAK.

It was observed by Duddell,[†] when determining the wave-form of the current through an X-ray tube by means of an oscillograph connected in series with the tube, that a large negative, or inverse, pulse of current was sometimes indicated at break, there being at the time no such inverse discharge at make. When this happened the tube failed to glow the right way. Duddell regarded the effect as being due to the tube acting as a rectifier in the wrong direction, allowing the first oscillation after the break to send a negative, but not a positive, current through the tube.

A similar effect was frequently observed in tube *B*, in which it appears to be an extreme case of delayed discharge. The effect is illustrated by the next three photographs, of which the first (Fig. 13) shows the form of the electrometer curve when the tube was disconnected (frequency ratio$=3$), the second (Fig. 14) the tube curve at inverse discharge, the third (Fig. 15) the tube curve at direct discharge. The second and third photographs were taken on the same occasion and at the same current ($i_0=2{\cdot}35$ amperes). The maximum potential in Fig. 14 is practically the same as that given by the coil (for the same current) without the tube. The discharge evidently occurred in the second, or negative, half-wave, the tube glowed incorrectly, and the ballistic galvanometer gave a deflection in the negative direction. In Fig. 15 the discharge occurred at the normal potential, the tube glowed correctly, and the galvanometer deflection was positive. The discharge could always be made to pass the right way by sufficiently increasing the primary current i_0 at break. The value of i_0 at which the change from inverse to direct discharge took place was different on different occasions ; it was sometimes over 3 amperes. When the tube was in a given state the greatest attainable secondary potential (*i.e.*, with the tube removed) appeared to be the chief factor determining the direction of the discharge. The higher this maximum potential the less likelihood was there of the discharge being delayed beyond it and becoming inverse.[*] Thus, the inverse discharge occurred more readily when the primary capacity was increased from the optimum value, or when the interrupter failed to work properly.

FIG. 13.

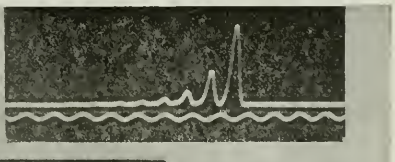


FIG. 14.

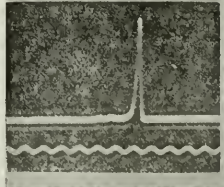


FIG. 15.

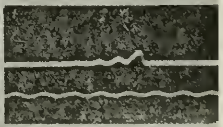


FIG. 16.

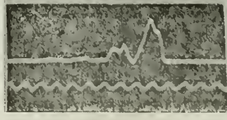
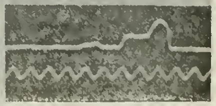


FIG. 17.



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[*] "Ann. de Phys.," 47, p. 1112 (1915).

[†] "Journal" of the Röntgen Society, No 17, Vol. IV., Pt. XVIII., Fig. 16 (1908).

[*] The inverse discharge at break occurs sometimes, as before remarked, in the spark discharge between two similar electrodes in air at atmospheric pressure.

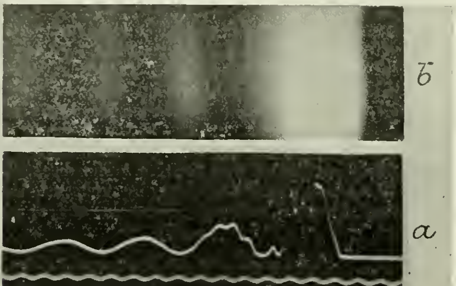
Another example of inverse discharge at break is shown in Fig. 16, taken with tube B, the primary current at break being in this case 3·2 amperes. The first half-wave has the same form, and its amplitude is within 1 or 2 per cent. the same as when the tube is disconnected. The discharge takes place in the negative portion of the first oscillation. When the current was slightly increased the discharge became direct, the curve then taking the form indicating a soft tube. Fig. 17 is the curve (taken on the same plate) obtained at the current $i_0=7{\cdot}36$ amperes.

It is frequently stated that the inverse current through an X-ray tube is due to the negative secondary E.M.F. at make, and this is undoubtedly the cause sometimes; but it is clear that this view of the matter does not cover all cases in which the effect is observed, and, in particular, it does not account for the fact that the inverse discharge sometimes occurs much more readily at break than at make.

ON X-RAY PULSES.

In some experiments made with tube A a spectrum tube was connected in series with the X-ray tube, with a view to observing whether there was any evidence of a variation of current (indicated by the luminosity of the spectrum tube) corresponding with the fluctuations of potential during the discharge. An example of the results obtained is given in Fig. 18 ($C_1=10$ mfd., $i_0=9{\cdot}2$ amperes), showing the electrometer curve (a), and above it the narrow part of the spectrum tube photographed simultaneously (b). The tube was in the hard state at the time, and the curve shows the sharp indentations characteristic of this state. The spectrum tube, on the other hand, shows a single, broad and intense discharge band,[*] without any trace of fluctuations corresponding with those of the potential, though it shows plainly the two oscillations of the very small capacity current following the discharge. There can scarcely be any doubt that if the current through the X-ray tube had consisted solely, or mainly, of the pulses that must accompany the sharp variations of potential (represented by the indentations in the curve) this would have been shown by the appearance of dark bands in the bright discharge band of Fig. 18 (b). It appears, therefore, that these pulses do not constitute the main discharge current through the tube, but only small fluctuations superposed upon it.[*]

Fig. 18.



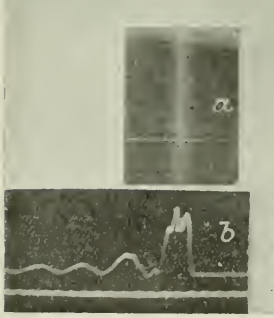


Fig. 19.

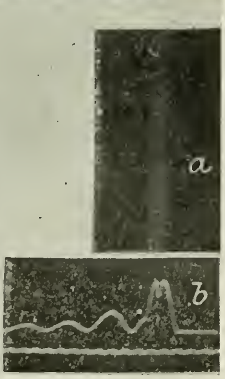


Fig. 20.

The X-rays given off by the tube, however, show evidence of a variation corresponding with that of the potential at the terminals. This was examined by mounting the photographic plate, with its plane vertical, at the end of an arm attached to the rotating table. On its way round, the plate passed in front of the X-ray tube (tube A), between them being placed two sheets of lead in each of which was a very fine vertical slit, so that only a very narrow beam of X-rays could fall upon the plate. The upper part of the plate, upon which the X-rays fell, was covered with black paper, the lower part was left uncovered to receive the rays reflected upon the electrometer and fork mirrors. These rays passed close by the edge of the lead sheets, and did not fall quite normally on the plate, this causing some distortion of the curves. The result of one of these experiments is shown in Fig. 19, (a) being the X-ray band (produced, of course, at a single discharge of the induction coil), (b) the simultaneous electrometer curve ($C_1=10$ mfd., $i_0=11{\cdot}4$ amperes). The arrangement was not found to be very suitable for giving the high speed of rotation required in the experiment, but the amount of separation produced on the plate is sufficient to show that the X-rays fall on the plate in three pulses corresponding to the serrations of the potential curve; or perhaps we should say that the beam of X-rays to which the plate is most sensitive is interrupted at some part of each of the indentations of the potential curve.

When the pressure in the tube had been somewhat increased by working the vacuum regulator the result was as shown in Fig. 20. In this case the black paper screen was not placed on the plate, but between the tube and the lead sheets. This was done in the hope of obtaining a rather clearer image: but the plate now became rather fogged, owing to stray light from the neighbourhood of the electrometer. The tube was still in a rather hard condition, the curve showing one indentation, and the X-ray band one interruption. The first portion of the X-ray band is wider than the second and than the interval between them.

When the tube had been further softened, so that the sharp indentations disappeared from the curve, being replaced by the gradual fall, the X-rays gave one uninterrupted band.[†]

Besides the X-rays concerned in the production of these bands there may have been others (of less photographic action) incapable of affecting the plate in the very short time occupied by a single discharge. The conclusions to which the present experiments point are that the rays which produce most effect on the plate are given off by the tube when the P.D. of the terminals is near its maximum value, that they are given off intermittently in accordance with the variations of the potential, and that they arise from cathode rays which form only a small fraction of the whole discharge through the tube. The remainder of the discharge current may be conveyed by cathode ray particles which do not give rise to X-rays, or which produce X-rays having less photographic effect; but there is difference of opinion as to whether a great part of the current is not carried by positive particles.

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[*] The electrometer was connected in parallel with both tubes in this experiment. The capacity current charging the electrodes would be much too feeble to produce the intense band of Fig. 18 (b), though it doubtless accounts for the early and fainter portion (on the right).

[*] The well-known oscillograms given by Duddell for the wave-form of the current through an X-ray tube (*l.c.*, Plate XVII., Figs. 5, 6, 7, 8) show, in the case of a soft tube and in one of medium hardness, a rapid rise and fall of the discharge current, also without superposed fluctuations.

[†] Deesauer has given ("Phys. Zeitschr.," p. 1104, 1912) an X-ray photograph, taken on a moving film, showing a number of X-ray pulses at a single discharge of an induction coil. Their frequency is of the same order as in the case of Fig. 19 (a) (1/2000 sec.). Dessauer suggests that the frequency of the pulses is related to the oscillation frequency of the secondary coil. In the case of Fig. 19 the two frequencies of the coil (secondary open) are about 100 and 1,000. If the secondary be regarded as closed, the (single) frequency is 285. Thus, the frequency of the pulses does not agree with any of the frequencies—at any rate, the fundamental frequencies—of the system. Also the pulse frequency probably increases with the primary current (*see* Fig. 10).

Correspondence.

ZIG-ZAG LEAKAGE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In one of your latest numbers, Dr. Miles Walker points out that in the Zig-Zag leakage formula, as first presented by Prof. E. Arnold, and given in a very similar form in the Paper on "Induction Motor Design," forming part of "Papers on the Design of Alternating Current Machinery," the fact that the formula is taken twice over, *i.e.*, once for the stator and once for the rotor, presents a very serious error. To show that this method is wrong, as an example the case was considered where the number of slots in stator and rotor are both the same. Figure 1 showed the corresponding zig-zag leakage flux.

Without intending to question the correctness of Prof. Miles Walker's treatment of the subject, I do not think that there exists any serious error in Prof. Arnold's formula. The Zig-Zag leakage-flux is interlinked both with the stator and rotor conductors and part of the lines shown in Fig. 1 would close behind the rotor slots and part behind those of the stator. If the number of rotor slots is the same as the stator slots, approximately half of the lines link the stator coils and the other half the rotor coils, thus forming a peculiar magnetic circuit.

The zig-zag leakage flux, like the slot leakage flux, has no separate existence, but forms part of the total flux of the machine.

For convenience sake they are, however, usually treated like separate fluxes and therefore we may as well go still further and treat the parts due to the effect of rotor and stator as separate components. In calculating thus the zig-zag leakage lines both for stator and rotor separately and adding these two values, the total lines zig-zagging the air-gap are obtained.

To use the formula once only, say for the stator, would naturally give entirely wrong results, unless a correction to take account of the differences in stator and rotor slot pitch and slot opening is employed. The very handy formula given by Dr. Miles Walker in his work "Specification and Design of Dynamo-Electric Machinery" is constructed on these lines. The influence of the number of stator and rotor slots is taken care of by the coefficient K_2 and thus of the slot opening by the gap contraction coefficient.

Although this rule gives good and quick results for semi-enclosed slots of standard shape and dimensions, the values become unreliable for open slots in both stator and rotor, whereas Arnold's method still gives good values.

Extensive tests have been made by T. Rezelman, W. Rogowski and others, which showed that values obtained by Prof. E. Arnold's method agree very closely indeed with actual test results, which also is my own personal experience.—I am, &c. F. A. Lauper.

Huddersfield, Aug. 12.

The "Wedge" Optical Pyrometer.

The "Wedge" optical pyrometer was introduced by Messrs. Cochrane & Company, Ltd., some years ago, and involves the principle of making use of the absorption of light by a special prism of red glass, the temperature being read at the extraction point. In a descriptive pamphlet issued by the makers some experience with this pyrometer is summarised. It is stated that observers at a large engineering works habitually agree in their readings within 5°C., while in a test by one of the large London gas companies four observers got within 10°C. of each other; and of the true temperature as ascertained by all the means available in a well-equipped physical laboratory the underlying principles of pyrometry are discussed, and some common causes of misunderstanding mentioned. Thus, it is sometimes overlooked that in a mass of material studied there may not be thermal equilibrium—*i.e.*, marked differences in temperature at different parts may exist. It will be observed that of two alternative methods of observing temperature through radiation the wedge pyrometer is based on the examination of rays of a certain range of wave-length, the red rays being selected as most convenient, being those which a heated body first emits as the temperature rises. It is to be noted that data are based on radiation from a "black body," and therefore in dealing with other surfaces (such as porcelain) a correction must be made.

Industrial League Convention.

A convention of the Industrial League, which has been established to bring employers and employed together for amicable discussion of industrial problems, was opened at Birmingham on Tuesday, the 12th inst.

PRESINDETIAL ADDRESS.

Mr. G. H. Roberts, M.P., Minister of Food, presided, and, in the course of his presidential address, said it was evident that if industrial warfare followed the other war all the sacrifice and expenditure would prove worthless. The great industrial struggles of this and previous ages had been largely attributable to misunderstanding and suspicion, and he was sure that more satisfactory results ensued from friendly negotiation, from open deliberation, than could ever follow from wild upheaval and protracted strife. He believed there was a better spirit developing, and that the great mass of employers now recognised that when they took a man or woman into their service they incurred a moral responsibility, and he believed that every employer would come to recognise that his duty did not end in paying out wages at the week-end, He was convinced that output could be stimulated without adding to the burdens of the worker. The world, after the work of destruction of the last four or five years, must necessarily be poorer and the lot of everybody harder. We lived in an atmosphere of false prosperity during the war, and too many of our people failed to realise that; we were living on our capital, on our credit; we were piling up debt which must be liquidated some time or other. Till we had achieved that liquidation, the old era of prosperity could never be restored. Our competitors in trade were getting off the mark more speedily than we were. The British workmen was not less efficient than the American if he would co-operate with his employers and insist that they should organise their work on scientific lines. Some people said "if we do little work the work will go further"; but one already saw the folly of that. If the erection of a factory cost three to five times as much, there would be no factories put up. He concluded with an appeal for goodwill and co-operation among employers and employed.

At the morning session on the second day the Bishop of Birmingham presided, and Mr. H. G. Williams read a Paper, of which the following is an abstract.

The Distribution of National Income.

For many years a stock argument on Socialist platforms was the statement that "labour is robbed of two-thirds of what it produces." This statement originated from statistical investigations made about 30 years ago by the Fabian Society, and its errors were twofold. It assumed that the whole of the wealth produced was the result solely of manual labour, and asserted that the share of manual labour amounted to one-third of the national income. Official inquiries showed the share of manual labour was substantially different from that commonly attributed to it, and he thought it was commonly agreed to-day that the production of wealth was the result of the application of labour, brains and capital to the raw materials. In 1907 the Census of Production, applying to 7,087,000 workers, showed the selling value of their production amounted to £1,765,000,000. The materials used cost £1,028,000,000. The net output was £712,000,000, giving a net output per person employed of £102 in the year, if they excluded out-workers. It represented a very low rate of production. Of the output, £65,000,000 at least was required to make good wear and tear, while Customs and Excise duties and new capital for development purposes reduced the balance of spendable income to about £567,000,000, from which again must be deducted the amount paid in direct taxation by the recepients, estimated at £30,000,000. If there had been no profits, and that income had been shared out equally amongst the whole 7,500,000 engaged in the industries concerned, it would have yielded an average weekly wage of 27s. 6d. Therefore, no conceivable changes which might have been made in 1907 could have provided that standard of living which all desired for the mass of the people, unless those changes had been accompanied by a very much greater production per head than existed in that year. The war had imposed upon us through increased taxation an extra burden of probably £700,000,000 a year, equivalent to an increase of 350,000,000 of the old sovereign. Unless we produced more we were going to be worse off to that extent. The level of individual prosperity was undoubtedly higher, but it was a false standard, owing to the many subsidies the Government had given, and more formidable still the excess of 50,000,000 of goods we were paying for monthly by extended credits. That was the real problem we had to face.

In a discussion which followed, Mr. Wilfrid Hill said before they could get on to increased production manufacturers must be accorded a larger measure of accommodation from the banks. As a consequence of the restriction of credit, there was an artificial restriction of production.

Mr. Whyper thought the Bank Holidays should be given up, and in their place workpeople should be granted one week's holiday in the year, with pay.

Mr. Isaacs believed the average workman was producing more than before the war, and the reason less goods were being turned out was that the best men were still in the army wasting their time. If the Government would get a move on, announce their trade policy, and close up all their twopenny-halfpenny little wars all over the world, we should soon regain our old position of supremacy.

Mr. Clarke said the Americans and Japanese were persistently winning the business by prices which could not be touched by his firm. By massed production in modern factories the Americans and Japanese were able to undersell us in many lines, and he was filled with alarm for the future of British trade if present conditions were to continue.

Replying on the discussion, Mr. **Williams** said he was opposed to nationalisation because we did not possess an organisation to run a nationalised industry. It must be run by civil servants. If we were to avoid corruption, we must give our civil servants absolute security of tenure, in which case we could not have a high standard of efficiency.

At the afternoon session, presided over by Mr. H. E. **Blain**, a Paper was read by the Right Hon. J. R. **Clynes**, M.P., on

Labour in Its Relation to Industry.

In the course of his Paper Mr Clynes said many capitalists work hard and long, but the reward to some of them is out of proportion to the service they give when that reward is compared with the reward of the worker, and to this fact many industrial troubles can be traced. The urgent human need is for something to be done now. The contact now maintained between the organised workers and the organised employers in many trades will probably relieve the State from the need of interference which either side previously called for when either side was afraid of the other, and when both sides would not come together, and it will tend to relieve the trade unions of most of the lesser workshop troubles. A great deal of the labour unrest springs from a desire on the part of the wage earner to find a more effective place in our industrial system than he has had before. There is a joint interest in industry which can only be jointly shared when the two parties act upon lines which will give mutual advantages to both, and enable them to exact from our trades or businesses the utmost which effort can obtain for the common benefit. Workmen will no longer submit to having their wages fixed at the lowest amount on which they can manage to live. Capitalists must no longer pursue their claims for private wealth, without regard to the human needs of the masses of workers. Employers must not think that workmen will agree to produce more unless they can enjoy a greater share of what they produce. Workers can make no graver mistake than to encourage under-production. Scarcity can cause real and continued privation to the masses of people whose purchasing power is limited. Lessened production means the greater prospect of unemployment. It keeps up prices, and lowers the workman's standard of existence. I should prefer that the employers should agree to restore pre-war workshop practices which, during the war the trade unions voluntarily agreed to set aside, but it seems now that there is no escape from legislative treatment. No apology is needed for the existence of trade union rules and regulations. I think the only considerable class which set aside its privileges and regulations during the war was the manual working class. Skilled workmen cannot continue to leave out of account the claim of the workman who is sometimes described as a less skilled or unskilled workman. Also opportunities of earning their living under conditions of dignity and with wages equal to their needs must be given, as rights, to women who have to maintain their homes. The speculator in raw materials for food and other commodities or even in finished articles should have no place in an age when employers appeal to the workers to increase production and appeal to Parliament not to let them alone. Some capitalists are as yet no more enlightened than to say there is no case for workmen sharing more of their profits, because workmen cannot share their commercial losses. No loss which employers could suffer exposes them to the privations commonly endured by workmen in times of depression and unemployment, and in the forfeiture of life and limb during the performance of daily toil workmen make a sacrifice and endure a loss which capitalists never know. The strike weapon must be retained by workmen, but its reckless or indiscriminate use can never be to the permanent advantage of the labouring classes.

At the final meeting on Thursday the **Bishop of Birmingham** again presided, and Mr J. **Mactavish** read a Paper on education in its relation to labour and industry of which the following is an abstract.

Mr. J. M. **Mactavish**, in commencing his Paper, urged that the industrial problem is primarily psychological, and not economic. It has its roots in human emotions and biases, and is not amenable to mere appeals to reason. There is great need for re-stating the problem in psychological terms, and the following are suggested as educational steps towards its solution :—

(*a*) The cultivation of a common human culture, based on a recognition of the native basis of the human mind, a basis common to all races and nations.

(*b*) That this culture can be best imbued by qualified teachers idealising humanity for our children in our elementary schools and rationalising the ideal in our higher schools and universities.

(*c*) Developing human energy by careful attention to the physical needs of our children.

(*d*) Awakening interest in work, by a more careful selection of work suited to the bents of young persons by liberalising technical education, and encouraging working-class control in the industry.

(*e*) Developing a system of adult education, controlled by a working-class educational organisation, recognised by existing educational authorities, including the Board of Education.

We may idealise the individual, in which case we produce the bumptious and pugnacious employer and workman, we may idealise the nation, in which case we cultivate the habits of mind which will inevitably lead to another European conflagration, or we may idealise a class, in which case we shall reap what we sow—a class war. There is only one safe ideal and that is humanity. We must escape from the idea that we have been divinely gifted with any inborn intellectual or other mental powers denied to other races or nations. While the primary innate tendercies of the human mind have different relative strengths in the native constitutions of individuals of different races, they are probably common to men of every race and of every age, and the native basis of the human mind is stable and unchanging. The world's greatest need is a common culture that will enable us to see in every member of the human family a living history of the struggle of our forbears to control and adapt themselves to their environment, struggling to become masters of their own destiny.

To attain that freedom which is essential to human growth and development it is necessary that our work should be such as interests us—such as enables us to express our pleasure in it. When men and women are not interested in their work they cannot be efficient. They become careless, and carelessness affects both the quality and quantity of the work. Since interest in work is essential to increased output, means will require to be devised for giving to workpeople a larger measure of freedom for expressing themselves in their work and a larger measure of control over their working conditions. The danger to the community that arises from the conflict of class interests is not merely due to an uneducated working class. It is equally due to an uneducated employing class. The successful employer knows how to utilise the forces that make for financial success, but he is too often ignorant of the sources of these forces, or of the results that will accrue from a too reckless use or exploitation of them.

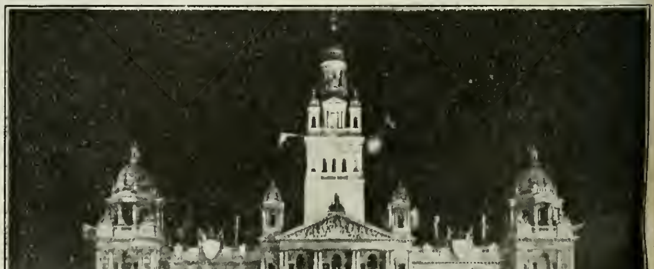
The importance of making provision for the education of adults is now generally recognised, but the best principles and methods of teaching, and the best form of authority for awakening interest, stimulating the demand and establishing the best principles and methods have not yet been clearly thought out. There is no organic link between the universities, L.E.A., and working-class organisations. Hence, while these bodies may provide lecture rooms and tutors, they have no means of awakening and stimulating interest and thus organising the demand. The authority responsible for awakening interest, stimulating and organising the demand, establishing and maintaining right principles and methods, and exercising general control should be a working-class organisation. This organisation must stand for education in the truest sense of the term. It must oppose any attempt to impose opinions. While it ought to have close relations with existing working-class associations, it must have its own distinct organisations and confine itself to its own functions.

The functions of the Board of Education, universities and L.E.A.'s should be to provide an adequate supply of good tutors, satisfy themselves that the standard of work done justifies the payment of grants, and accept full financial responsibility for the cost of tuition.

Provided that working-class organisations could be induced to accept the full measure of responsibility such a system would impose on them, and the Board of Education and universities were prepared to regard it as the representative authority, a system of adult working-class education probably unique in the world's history could be built up in a comparatively short time.

Peace Day Celebration in Glasgow.

The accompanying illustration is a reproduction of a photo, taken at midnight on Monday, Aug. 4, and shows the municipal buildings of Glasgow as they were illuminated for the Peace Day celebrations. The buildings were suitably decorated by a well-known firm, and the illu-



Flood-lighting of Municipal Buildings.

minations were carried out by the electricity department. The buildings were "flood" lighted by means of sixty-six 1,000-watt searchlight "flood" light projectors, erected on the roofs of two adjacent buildings, and the main tower of the municipal buildings was illuminated by means of 10 similar projectors. The whole effect was most brilliant.

It is believed that this is the first occasion in Great Britain when "flood" light has been used for the special illumination of public buildings, and although the installation was not so large as that at the Panama Exhibition of 1915 at San Francisco, it was more concentrated. George-square, in front of the municipal buildings, with its fine series of monumental statues, readily lends itself to decoration for a festive occasion. Floral and flag festoons, together with 4,000 electric lamps, were led from the Scott monument in the centre of the square to the tramway poles at the four corners, and the outside edge of the square was outlined with festoons of electric lamps. Owing to the Peace Celebration takeng place at a time when the hours of darkness were at the minimum, the illuminations were not seen with the maximum effect till after 10 p.m., but for the three nights when all lights were on in the square many thousands of Glasgow citizens watched the illuminations with interest and appreciation.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1917 Specifications.

129,304 B. T.-H. Co. (G. E. Co.) Electric transforming and converting apparatus. (4/10/17.)
129,309 Remy Electric Co. Circuit breakers for ignition apparatus. (10/11/16.)
129,310 B. T.-H. Co. (G. E. Co.) Means for detecting sub-aqueous sounds. (9/10/17.)
129,313 B. T.-H. Co. (G. E. Co.) Methods and apparatus for the amplification of small currents by electron discharge relays. (10/10/17.)
129,336 Watts. Aerial circuits for wireless telegraphy and other purposes. (24/10/17.) Consists in combining two or more directional aerials, and more particularly, closed or nearly closed circuit aerials in such a manner that the aerials shall act separately as directional aerials and simultaneously jointly as a compound non-directional aerial.
129,339 Potts. Electrical make-and-break contact. (25/10/17.)
129,346 Rogers & Lyon. Wireless signalling systems. (10/11/16.)
129,349 Davies, Judd & Eastern Telegraph Co. Electrical regulating apparatus. (27/10/17.)
129 355 Railing & Angold. Electric arc lamps. (30/10/17.)
129,360 Languepin. Electrodes for electric arc welding. (31/10/17.)
129,364 Western Electric Co., Nash, Penney, Grace & Mack. Sound detectors. (2/11/17.)
129,366 Nobbs & Falkirk Iron Co. Electrical heater. (3/11/17.)
129,373 Wilson, Dalby & Sir W. G. Armstrong, Whitworth & Co. Electric regulating switches for use with ordnance and for other purposes. (7/11/17.)

1918 Specifications.

129,394 Brownlow. Machines for cutting the globes or bulbs of electric incandescent lamps and the like. (13/4/18.)
129,397 Western Electric Co. (Western Electric Co.) Telephone systems. (8/5/18.)
129,400 Bennett, Lyon & Wrench. Conversion of electric currents. (19/12/18.)
129,406 Watson. Electric heating apparatus for liquids. (8/6/18.)
129,407 Morgan Crucible Co. & Spiers. Electrically-heated crucibles, melting pots, and the like. (8/6/18.)
129,414 Dearle. Liquid electrical resistances. (2/7/18.)
129,423 Rabinovitch & Mond. Electric batteries. (8/7/18.)
129,425 Williams. Electric accumulators. (8/7/18.)
129,438 Forrester. (Burgess, H.) Electric heating apparatus. (10/7/18.)
129,440 Leachman. Electric lamp switches. (10/7/18.)
129,449 B. T.-H. Co. (G. E. Co.) Electric locomotives or cars. (12/7/18.)
129,487 B. T.-H. Co. (G. E. Co.) Measuring and controlling electric power. (8/8/18.)
129,489 Marino. Electrolytic method of cleaning iron or steel. (9/8/18.)
120,198 Svenska Aktiebolaget Gasaccumulator. Hammer interrupters for radio-telegraphy. (14/9/17.)
129,500 British L. M. Ericsson Mfg. Co. & Brookes. Magneto-electric machines for ignition in internal combustion engines. (21/8/18.)
129,511 Colson. Terminal fittings of incandescent electric lamp holders. (11/9/18.)
129,512 Wheeler. Means for securing shades to the holders of electric lamps. (11/9/18.) (Patent of addition not granted.)
129,515 B. T.-H. Co. (G. E. Co.) Temperature indicators for transformers and the like. (13/9/18.)
129,524 B. T.-H. Co. (G. E. Co.) Electric incandescent lamps. (30/9/18.)
129,547 Flory. Means for supporting the shade of an electric incandescent lamp. (26/11/18.)
129,559 Camelinat. Electric lamps for use on motor vehicles and for other purposes. (20/12/18.) . .
124,188 Murray & Murray. Apparatus for electric welding. (9/3/18.)
129,563 Automatic Telephone Mfg. Co. (Automatic Electric Co.) Call indicator for telephone systems employing automatic switching apparatus. (30/12/18.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions*

July 4, 1919.

16,788 Siemens Bros. & Co. & Wood. Connection boxes for electric cranes, &c.
16,781 Smith. Terminal connections for telegraph and telephone wires.
16,809 Keating. Electric fuses.
16,822 Cook & Fletcher. Locking device for incandescent lamps.
16,828 Telephone Mfg., Co. & Erskine-Murray. Intercommunication telephones.
16,836 Manners-Smith. Fittings for incandescent lamps.

July 5, 1919.

16,843 Mond & Rabinovitch. Electric batteries.
16,876 Jagger. Couplings for electrical conduits.
16,883 Russon. Electrical level indicator for aircraft.
16,900 Bastian. Obtaining continuous supply of electrically-heated water. (France.)
16,905 Regnauld de Bellescize. Stations for duplex wireless telegraphy. (7/12/18,
16,916 Garwood. Electrical measuring instrument of moving-coil type.

July 7, 1919.

16,943 Benjamin. Operating synchronous telegraph systems.
16,962 Pettigrew. Brush for dynamos, &c.
16,982 Foster. Devices for measuring electrical resistance.

July 8, 1919.

17,048 Wilson. Apparatus producing or utilising electrical oscillations.
17,066 B. T.-H. Co. (G. E. Co.) Motor control systems.
17,073 Amberton. Electric circuit controllers.
17,088 Koch. Couplings or holders for electric wires, &c. (27/11/18, Switzerland.)

A Suggested British Empire Patent Law.

The Committee of the Institution of Electrical Engineers on Patent Law Amendment has issued its Report, which appears in Vol. 57 of the "Journal" of the I.E.E. The scheme outlined in the Report aims at carrying out what should be the main objects of any Empire Patent Law, namely, (1) low cost, (2) ease of application throughout the Empire, (3) reciprocity, (4) no change involved in the existing laws of the Empire, (5) adherence to the scheme optional by any Dominion.

Under the scheme any person may obtain an Empire patent covering as many of the British Dominions, Colonies, Dependencies and Protectorates, collectively referred to in the Report (for convenience, as Territories) as he may select, by making application to the British Patent Office. The fees payable will be the sum of the existing local Government fees in the selected Territories, plus such small fee as may be charged by the British Patent Office. The application will be examined and the patent granted in the same way as is an application for a British patent, and the specification when printed will bear the names of the selected Territories in which it is effective. Thereafter the patent will be assimilated with the domestic patents in each of the selected Territories and will be subject to the local Laws in such Territories for the determination of validity, &c. An Appendix to the Report gives a list of 48 Dominions, Colonies, Dependencies and Protectorates of the Empire which have their own separate enactments for granting patents.

It is clearly desirable that the cost and trouble of securing patent protection throughout the Empire should be materially reduced. Careful consideration has been given to the suggestion that a patent should be obtainable covering the whole of the British Empire in the same way that a patent in the United States covers all the States in the Union, but there are so many difficulties connected with such a scheme that it is not felt any practical result can be expected of any attempt to elaborate a proposal along such lines. It is believed that the present scheme is practical and has the merit that it can easily and immediately be put into operation without disturbing the existing laws in the various territories in the Empire.

It is assumed that usually an inventor will apply for a patent first in that part of the Empire in which he is domiciled or has his business or manufacturing establishment, and it is not proposed that the existing Patents Acts or Ordinances in the various parts of the Empire should in any way be disturbed. The scheme proposes that in each Territory a short Act or Ordinance should be passed to the effect that any Empire patent which has been made applicable to such Territory shall be received and treated by it in all respects as though such patent were a patent which had been granted under the territorial Patent Law. The fact that the form of the specification and claims of the Empire patent might differ somewhat from that of the domestic patent should not give rise to any practical difficulties.

It is obvious that such an Empire patent, in order to secure uniformity, must be issued from one centre, and it is therefore recommended that the Empire patent should be applied for and issued in the same way as a British patent. Where a British patent has been applied for or obtained, the Empire patent will be a duplicate of it. An applicant residing in any part of the British Empire may apply for a patent either in his own Dominion or in any other part of the Empire granting a patent and shall have a sufficient period—18 months is suggested—from the date of his first application in any part of the Empire in which to apply for an Empire patent. An Empire patent if applied for within such period shall have a priority date as of the date of application for the corresponding patent first filed in any part of the Empire.

To carry out the scheme it would be desirable to establish an Empire Patent Department of the Patent Office in London, in which all applications for Empire patents would be filed and the appropriate fees paid in respect of the selected parts of the Empire. To this Department would also be paid at the appropriate times such renewal fees as may be necessary. The Empire Patent Department would transmit through the appropriate channels the fees received and due to each of the Dominions, &c., in respect of the Empire patents issued and also the renewal fees. It is urged that whilst it would be highly desirable for all parts of the Empire to adhere to this scheme for an Empire patent from the outset, it is not necessary that the adoption of the scheme should be delayed until this has been achieved. It is strongly recommended that the Empire patent should rest on its own foundation in each part of the Empire. As to the fees payable in respect of the Empire patent, it would be very desirable for the various Dominions to agree on a scale of reasonable fees to be payable on application for a patent and at uniform times for the renewal of the same during its term. In order that objections to the early commencement of the scheme may not be raised by the various parts of the Empire on the ground of loss of revenue, it is suggested that the fees payable in any of the Empire Territories should remain as they are at present. It is believed, however, that the reduction in fees which is recommended would be more than made up in the total amount received by the greatly increased number of patents applied for in the various Dominions under the present scheme.

Commercial Topics.

Electrical Supplies for Poland.

It is announced that import permits from the Polish Government are not now required for the import of various classes of goods into Poland, including electrical plant and supplies for electrical installations, scientific and drawing instruments, &c.

* * *

Collection of Enemy Debts.

Apparently it is proposed to adopt the scheme set out in Article 296 of the Peace Treaty with Germany in regard to pre-war debts owing by persons in that country, and therefore no steps should be taken by British citizens to collect debts due to them by German nationals. It is not, however, proposed to adopt a similar scheme in regard to the other enemy countries, and British creditors may collect debts due to them by persons in those countries.

* * *

Belgian Industrial Recovery.

We are glad to see from recent reports that Belgian industries are making a rapid recovery and very many factories have been restarted. According to recent statistics 60 per cent. of the copper foundries which were in existence in 1913 are in operation. 51 per cent. of the manufacturing electrical works, 27 per cent. of the iron and steel foundries, 50 per cent. of the machinery and girder construction works, 35 per cent. of the chemical undertakings and 27 per cent. of the rolling stock and motor-car factories. For the purpose of helping in the reconstruction, transformation and development of Belgian industrial and commercial undertakings, the National Society for Credit Industry was recently established at Brussels with a capital of 25 million francs.

* * * *

Miners' Lamps.

The Home Office Committee on Miners' Lamps notify that they are prepared to consider new suggestions for improving the safety or illuminating power of miners' safety lamps, and to examine and (if necessary) to test any new devices or new types of lamps. Communications should be addressed to the Secretary of the Committee, Mr. Edward Fudge, Home Office, Whitehall, S.W. 1.

The lighting and ventilating arrangements in coal mines have an important bearing on the health of the workers, and every effort should be made to improve the existing lighting and operating conditions. In a Paper read at the recent congress of the Royal Sanitary Institute, Dr. Shufflebotham attributed to the low candle-power of safety lamps the disease known as miners' anystagmus; and he was of opinion that the poor light in all mines was a contributing cause to the large number of accidents there. It was confidently believed that by the compulsory introduction of suitable lamps of a candle-power of between 1 and 1·5 nystagmus could be checked, and in from seven to ten years entirely wiped out. In some Yorkshire mines electric lamps of a still higher candle-power were being used with good results. He recommended the introduction of increased candle-power lamps, increased and improved inspection, and monthly or weekly notification of accidents.

* * * *

Imperial Preference Regulations.

In pursuance of sec. 8 of the Finance Act, 1919, the Board of Trade have made regulations, which lay down that "goods shall not be deemed, for the purposes of the Act, to have been manufactured in the British Empire unless at least 25 per cent. of their total value is the result of labour within the Empire." In those classes of goods in respect of which an order has been made by the Board under sec. 8, sub-section (2) of the Finance Act, 1919, no part of the goods shall be deemed to have been manufactured in the British Empire unless at least 5 per cent. of the total value of the goods is the result of labour within the British Empire. When a number of separate articles are included in one parcel or shipment, each article shall be considered separately for calculating the proportion of value due to labour within the Empire. "The total value of an article" shall be its cost to the manufacturer at the factory or works, and shall include the value of containers and other forms of interior packing ordinarily sold with the article when it is sold retail, but shall not include the manufacturer's or exporter's profit, or the cost of exterior packing, carriage to port, and other charges incidental to the export of the goods subsequent to their manufacture. In calculating the proportion of value which is the result of labour within the Empire there may be included under the head of labour the cost to the manufacturer of any materials purely of empire origin entering into the composition of the article (including the interior packing), the cost of manufacture including wages, proportion of fuel, supervision, and other factory expenses and the cost of the labour of packing for retail sale.

The following may not be included in the proportion of value which is the result of empire labour: Any material or interior packings not entirely of empire origin, manufacturer's profit, or the profit or remuneration of any trader, agent, broker, or person dealing in the finished article, the expense of placing the goods in outside packages for export, and the cost of such packages, transportation charges, insurance and any other charges for services after the goods leave the place of production or manufacture.

Any question arising on the interpretation of the regulations shall be referred to the Board of Trade, whose decision shall be final. We are afraid that there will be a good many questions to be elucidated, and we can see that at least one result will be a large addition to the staff of the Board

Electricity Supply.

As from Sept. 29, the Great Yarmouth Council has decided to charge 10d. per unit for lighting and 2½d. for power.

A public enquiry was held at Worcester last week into the application of the Corporation for sanction to borrow £16,525 for extensions of mains.

Torquay Council has decided, in view of the increased cost of coal, to increase the price of electricity for light, power (except trams) and heating by ½d. per unit.

In order to meet the increasing local demand for current for industrial purposes, the Lancashire Electric Power Company intend to erect a sub-station in Walkden.

At present Aberdeen Parish Council is generating its own electricity, but the Poorhouse Committee has now been asked to report upon the economy likely to be effected by purchasing electricity from the Corporation.

Owing to the increased price of coal, &c., Norwich Electricity Committee has made a further advance of 20 per cent. in the charges for electricity, making a total increase over the pre-war standard of 60 per cent. for lighting and 70 per cent. for power.

The Board of Trade have extended for six months from July 31 the periods mentioned in the Abercarn, the Cowbridge and Penybont, and the Rickmansworth and Chorley Wood Electric Lighting Orders of 1914 for laying down mains, &c.

The accounts of the Blackpool electricity department for the year ended March 31, 1919, show income £58,171 (compared with £57,941 in previous year), gross profit £17,264 (£26,509), and the net result was a deficit of £2,727 (compared with a profit of £8,083). Units generated were 6,193,982 (6,375,398) and sold 5,108,415.

The Board of Trade has sanctioned the application of Ealing Corporation to increase the maximum charge for the supply of electric current from 8d. to 10d. per unit, but the extra amount to be charged shall not be more than sufficient to enable the undertaking to be carried on without loss.

Tunbridge Wells Corporation has decided to increase the charges for electricity from Sept. 29 as follows: Lighting 2d. and heating and power 1¼d. per unit, and public lighting 10 per cent. Application has been made to the Board of Trade to authorise an increase in the maximum charge for current in Spelhurst from 7d. to 9d. per unit.

The accounts of the Chester electricity department for the year ended March 25, 1919, show revenue £27,511 (compared with £26,649 in previous year) and working expenses £16,675 (£13,774). Interest, sinking fund, &c., required £9,694, and the net profit was £1,068. Cost per unit was 1·262d. (1·02d.), exclusive of capital charges. Maximum load was equal to 47,000 (57,530) 8 c.p. lamps. Units generated were 3,687,155 and sold 2,718,891.

The accounts of the Kingston-on-Thames electricity department for the year ended March 31, 1919, show revenue £31,181 (compared with (£26,349 in previous year), and working expenses were £27,457 (£19,356), interest required £3,448 (£3,115), leaving surplus £275 (£3,877), but after providing £5,702 (£5,663) for repayment of capital, the net result was a deficit of £5,426 (£1,786). Mr. Kingham, borough electrical engineer, says the extra expenditure due to breakdowns and increased cost of labour and materials was £5,940. Units sold were 1,608,450 (1,686,035).

The accounts of the Brighton electricity department for the year ended March 31, 1919, show revenue £130,557 (against £116,683 in previous year), gross profit £44,081 (£42,978) and net profit £3,112 (£2,887). Costs per unit were 2·05d. (1·78d.) exclusive and 3·02d. (2·66d.) inclusive of loan charges. Maximum load was 4,560 (4,613) kw., and load factor 25·4 (25·3) per cent. Units generated were 11,862,963 (12,278,205) and sold 10,144,392 (10,242,007).

The accounts of the Kirkcaldy electric lighting dept. for the year ended May 15, 1919, show revenue £23,007 (compared with £17,637 in previous year), working and general expenses £18,146 (£12,450), gross profit £4,861 (£5,186), interest charges £3,131 (£2,790), instalments for redemption of debt £2,595 (£2,414), and net profit £864 (£8). Units sold were 2,462,262 (2,379,600). The maximum load on feeders were 1,012kw. (1,003 kw.) and the load factor 27·7 (27·1) per cent.

Sheffield Corporation have decided to fix the maximum salaries of heads of municipal departments as follows: General manager and engineer of the electric supply department, £1,500 (by increments of £100); deputy manager, £850 (£50); general manager of the tramways and motor department, £1,500 (£100).

The increase of 6s. per ton of coal will involve the following advances in the charge for current: Units charged at over 2d. to be subject to an increase of 40 per cent. in lieu of the present increase of 25 per cent., and units charged at 2d. and under, 75 per cent. in lieu of 60 per cent.

The accounts of Burnley electricity department for the year ended March 31, 1919, show revenue £43,274 (compared with £38,043 in previous year), gross profit £16,006 (£17,691) and net profit £1,490 (£3,946). Total costs were 1·142d. (0·856d.) per unit, or 1·75d. (1·436d.) including capital charges. Maximum load was 2,555 kw. (2,449 kw.), and load factor 25·59 (26·51) per cent. Motors connected amount to 2,771 (2,260) h.p. Units generated were 6,636,372 and sold 5,728,371 (5,698,532). Mr. J. E. Starkie, borough electrical engineer, says in his report the increased works cost is mainly accounted for by £2,975 increase in wages and 4s. per ton increase in price of coal, and the quality of the coal is still much below pre-war standard.

Electric Traction.

Surbiton Urban Council has received sanction to borrow £1,114 for the purchase of an electric dust collecting van.

Llanelly Corporation has applied for sanction to borrow money for the purchase of four electric refuse collecting wagons.

Sunderland Electricity Committee proposes to increase the cost of current supplied to the tramways from 1½d. to 1¾d. per unit.

In return for permission to run its cars on Sunday, the Rothesay Tramway Company has offered to provide a complete electric lighting installation for the town.

Newport (Mon.) Town Council is recommended to purchase 17 electrical vehicles for the collection of refuse at a cost of £22,219, with £5,000 housing and repair shops.

The Bombay Electric Supply & Tramways Company has recently ordered 130 new trucks from America in order to cope with increased traffic. It appears that three years ago the company ordered 70 trucks in England, and only recently secured shipment of the first 64 of them. Meanwhile, 50 trucks were secured from America, and as the company urgently wanted additional rolling stock, the new order has gone to the United States instead of to England.

The accounts of West Ham tramways department for the year ended March 31, 1919, show revenue (after deducting £3,852 in respect of amount due to other authorities in connection with through running) of £237,487 (against £188,851 last year), and exclusive of allowance to men on active service, the gross profit was £22,468 (£3,263), and the net result a surplus of £7,739, excluding £15,442 allowance to men on active service. Working expenses were 14·27d. (11·279d.) per car-mile.

Though we have the greatest sympathy for Maimed and Disabled Soldiers and with the desire to see them placed in a position to earn their livelihood, still their employment as tramcar conductors requires careful consideration. In the case of an inquest on a person who was killed by a tramcar accident at Manchester last week the coroner said that, whilst no blame was attached to the guard, he felt that in view of the fact that he had lost one eye through service abroad, he ought to be found other work.

The Colchester tramway accounts for the year ended March 31, 1918, show revenue £19,092 (compared with £17,869 in previous year), and working expenses £13,908 (£12,935). Interest required £1,692 (£1,788), provision for repayment of loan £2,893 (£2,788), and the net surplus was £113 (£35). Revenue per car-mile was 16·421d. (13·046d.) and working expenses including power were 11·982d. (9·457d.). Tickets issued were 3,659,770 (3,248,958), and car-miles run 278,540 (328,274).

The receipts of the Burnley tramways department in the year ended March 31, 1919, were £124,213 (compared with £97,480 in the previous year), and working expenses were £95,209 (£68,203), leaving gross profit £28,273, which was disposed of as follows: Interest £6,247 (£6,590), sinking fund £9,171 (£8,941), rent of leased lines £1,456, reserve £6,020, and other purposes (including income tax) £5,379. Revenue per car-mile was 18·68d. (15·20d.) and working expenses, excluding power, were 10·98d. (7·61d.). Passengers carried were 20,111,603 (17,796,016) and car-miles run 1,595,898 (1,538,471).

The revenue of the Walsall tramways undertaking was £66,924 in 1917-18, and working expenses were £45,921. Interest required £4,764 and sinking fund £4,478, the net balance being £8,450, of which £5,000 is to be devoted to relief of rates. Revenue per car-mile was 19·046d. (compared with 16·666d. in previous year) and working expenses, including power, 13·069d. (9·859d.). Passengers carried were 12,539,676 and car-miles run 843,325. The motor services showed a revenue of £28,026, or 18·981d. (17·979d.) per 'bus-mile, and the amount carried to net revenue account £6,278.

On Saturday last a tramcar on the Hampstead–Holborn route of the London County Council left the metals when coming round the bend of the road from Great College-street to Pancras-road and overturned. As a result of the accident, one person was killed, another succumbed to his injuries, and 17 others were injured. In overturning, the front of the car struck and knocked over two section feeders containing the electric cables. The wires fused and set the front part of the car on fire. Underneath the burning wreckage three pedestrians were pinned, while the inside of the car was filled with a crowd of women and children trying to release themselves, and the outside passengers were lying in the roadway. The controls have been sealed up, and will remain sealed until the official Board of Trade inquiry.

The following particulars are abstracted from the report of Mr W. Greig, superintendent of the cleansing department of Glasgow Corporation, for the year ended May 31 last. The mechanical vehicles in use by the department for the collection and removal of refuse are two 3 ton petrol-driven motor wagons, acquired in 1913, and six 2-ton Edison electric wagons, acquired during the past four years. The petrol vehicles have not proved entirely suitable for the work of refuse collection, the cost being considerably higher than that of either horse or electric traction. Electric vehicles have given very satisfactory results, having been found efficient, reliable, economical and easily driven. It is proposed to place a further order for 10 of these electric vehicles. The comparative costs for electric, horse and petrol traction are: Electric 4s 2¾d. per ton, horse 5s., petrol 6s. 5d. Extensive repairs have again been required by the petrol vehicles, and, on several occasions, they have been out of commission owing to the difficulty of obtaining materials for carrying out the necessary repairs. This explains, to some extent, the high cost and better results may reasonably be looked for in normal times.

Imperial and Foreign Notes.

The Electrical Employers' Association of New South Wales has issued conditions of contract for wiring work.

The New South Wales Cabinet has agreed upon a general hydro-electric scheme for the State. The Premier (Mr. Holman) recently stated that works at Burrinjuck and the Gorge, Upper Clarence, would be the first to be put in hand.

It is stated that the adoption of electric traction on the Sandringham-Essendon section of the Melbourne Suburban Railways has demonstrated the advantages of the form of traction, notably in regard to quick acceleration. It is expected that the greater part of the metropolitan service will be electrified by June next.

A deputation of manufacturers recently waited upon the Lord Mayor of Sydney to urge the City Council to take steps to increase the supply of Electric Power in Sydney. The Lord Mayor agreed that there must not be any stagnation of trade by reason of any failure on the Council's part, and he promised to call a special meeting to deal with the matter.

The Board of Commissioners for the control of electric supply and distribution in the State of Victoria has appointed Mr. H. R. Harper (city electrical engineer of Melbourne) as its chief electrical engineer at a salary of £1,500, rising to £2,000 per annum. Mr. A. G. M. Michell will act as consulting hydraulic engineer to the Board.

The Victorian Minister of Works, Mr A Robinson, has promised that the Government would lose no time in putting into operation the Act recently passed to authorise the Victorian Government's Electric Power Scheme. A Board of Commissioners had been created and engineers appointed, and everything possible would be done to push on with work connected with the bulk supply proposals.

We recently announced that it had been decided to adopt electric traction on the Jamaica Railway. It is now reported that an engineer of the Westinghouse Company has taken the plans to the United States in order to prepare a report on the matter for the Government. The change will involve an expenditure of nearly £1,000,000, and it is to be hoped that at least some of this money will go to British manufacturers.

In a recent issue of the "Industrial Australian and Mining Standard" a section is devoted to "Tariff Reform: Industries that Need Protection." One of the industries is the manufacture of electric heating appliances, electric light fittings, &c., which was established in Melbourne during the war. It is stated that, with a tariff of 50 or 60 per cent., these goods will be produced in quantities to meet all the Australian requirements. At present the duty on such goods varies from 10 to 20 per cent. Our contemporary states that the development of electrical manufacturing industries is a *sine qua non* to national safety and progress, and a list is given of some local works which have been manufacturing electrical apparatus, dynamos and motors, and are capable of great further development under adequate protection.

The Government of Argentina has issued a decree authorising the Board of Hydraulic Works to make the necessary preliminary studies and surveys in connection with the proposed utilisation of the water of the Iguazú Falls in the generation of electric power.

According to Reuter, the Polish Government is considering a scheme for erecting a central wireless station in the neighbourhood of Warsaw. Some American financiers have already evinced interest in the project, and delegates from the Polish Government have left for America in order to consult electrical engineering firms. Offers have, it is stated, been received from the German Government for the construction of the station; but, although the price quoted is only one-eighth of the figure given by other European countries, these proposals are being held in reserve, as it is considered that the work should, if possible, be carried out by an Allied country.

In the report of the Japanese Railways for 1916-17 it is stated that a line of 8 miles in Tokyo was electrified in 1905, and in 1910 electric working was introduced on over 19 miles more. The electrification of the line between Tokyo and Yokohama was started in 1912, a double track line being laid alongside the existing steam line, and a regular service was inaugurated in 1915. With a maximum speed of about 54 miles an hour, the whole distance (19·2 miles) is covered in about 47 minutes, the schedule speed being 24·3 miles an hour. Direct current at 1,200 volts is employed, except for the city portion, where a pressure of 600 volts is used. High tension was adopted owing to the intention to extend the electric service to Yokosuka, 38·8 miles from Tokyo, to Kozu, 48·2 miles, and to Numazu, about 79 miles. At the power station, half-way between Tokyo and Yokohama, there are four gas engine alternator sets, three sets of Mond producers with ammonia recovery, two 400 kw. d.c. generators driven by a non-condensing steam engine, and two batteries of Babcock & Wilcox boilers. The gas engines are of the Nuremburg twin-tandem double-acting type, and each engine drives a 1,500 k.v.a. 11,000-volt alternator. The report states that in adopting gas engines, which entail many difficulties in driving, especially for the parallel running of the alternators at fluctuating load, the main consideration was economy, because, apart from the relatively low cost of the initial installation, gas engines of this type were judged especially adaptable for the use of cheap coal. As a result of tests, it was ascertained that at full load no more than 2 lb. of coal was required per kilowatt of output, while the ammonia recovery makes up for one-third of the cost of fuel. The heat of the exhaust gases is utilised in an exhaust boiler for raising steam.

Miscellaneous.

The Post Office has withdrawn the prohibition against transmission of telephone messages or communications except in the English language.

The members of the Electrical Trades Union in the Birmingham area, which includes the branches from Coventry to Wolverhampton, are demanding a minimum wage of £6 per week.

As the result of an inquiry into the wages claims by various trade unions connected with the Engineering and Foundry Trades, the Court of Arbitration has issued its award, and increases of 1s. or 2s. a week are made for a number of towns.

Capt. W. P. Durtnall has a scheme on hand for running Electric Passenger Boats on the Thames. They are to be equipped with his system of electric propulsion, and the Paragon Beater propeller, which permits of very easy manœuvring.

The Stockport automatic telephone exchange will be opened to-morrow (Saturday) with over 800 connected subscribers. The work on the exchange was commenced in 1907, but was stopped owing to the war.

The Patents and Designs and the Trade Marks Bills were read a second time in the House of Lords before the adjournment, but we are glad that the Committee stage will not be taken till after the recess. The Bills are of considerable importance and they require adequate consideration in committee. In the Commons only one sitting was devoted to each measure, a time which, in our opinion, was inadequate.

In reply to a question in the House of Commons, the Assistant Postmaster-General has refused to lay upon the Table of the House the full specification, blue-print and estimate for the new wireless telegraph stations at Oxford and Cairo, as some of the details are of a confidential character. His Majesty's Government was represented on the Inter-Allied Wireless Commission, the recommendations of which were under consideration by the several Governments concerned, and due care would be taken that all relevant international requirements to which the Government was a party were duly carried out by the stations at Oxford and Cairo. The arcs to be employed were of recent design.

Mr. Pike Pease also stated that the system decided upon had only been adopted after full inquiry. The leading Government experts had been consulted and the best independent advice had been obtained. Stations in France and Italy which employed a similar system had been extremely successful in communicating with the United States. The United States had one station equipped with the Alexanderson alternator and the French were installing the Latour alternator at certain stations; but it was not proposed to dispense with the arc system in either case.

Being no longer necessary in connection with the war, the Lights (Vehicles) Order of December, 1918, and the Lights (Driving of Animals) Order of October, 1916, have been revoked. It is stated that reports show that the Orders have been of value in preventing accidents and securing the safety of the public, and the Home Secretary appeals to motorists "to refrain from using brilliant headlights, and to remember, when driving in the dark, that cyclists are no longer required to carry rear lights nor persons in charge of cattle to carry lights.

The Commissioner of Police of the Metropolis has issued a useful memorandum giving a summary of the provisions of the existing law on the subbject of lights on vehicles. The subject is dealt with by various Acts and regulations depending partly on the nature of the vehicle and partly on rules of the local authority.

The Automobile Association is agitating for the issue of an Order making it compulsory for all vehicles, cattle, &c., driven on the road at night to be adequately lighted, and also permit the use by motorists of lamps of sufficient power to secure their own safety and avoid danger or inconvenience to other users of the road.

Whitley Council Progress.

On Tuesday a conference of representatives of electricity undertakings in the north-western counties of England was held at Manchester. Representatives of trade unions were also present, and each set of representatives decided to form a district council on the basis of the Whitley Report, under the National Council for Electricity Supply. There are 80 electricity undertakings in the area. These undertakings are to be divided into groups according to size, and each group will nominate its representatives on the council, which will consist of 24 members, 12 representatives of the employers and 12 of the workers.

The importance of completing the scheme recommended by the Whitley Committee, by the establishment of district councils and works committees, is urged by Sir Robert Horne, the Minister of Labour, in a recent letter to the Joint Industrial Councils. Sir Robert Horne points out that the formation of a national council is only one stage in the organisation and expresses doubt whether the spirit of co-operation between employers and workpeople can be sufficiently developed by the representatives of the employers' organisations and trade unions sitting together in councils unless the principle of joint consultation and action is carried further by their association together in each district and in every works. The underlying idea of the Whitley Report is that the worker should have a real voice in determining the conditions of his everyday work, and this cannot be secured unless he can speak, not only on matters affecting his industry as a whole, but also on those concerning the particular establishment in which he works.

At present there are national councils in no fewer than 40 industries of the country, and steps to set up district councils and works committees must be taken with the full approval of the national councils.

Business Items.

The address of the "Iron and Steel Trades Machinery and Iron Trade Circular" is now Bessemer House, Adelphi, Strand, London, W.C.2.

The Sterling Telephone & Electric Company, Ltd., have opened a branch office at No. 8, Park-place, Cardiff, under the management of Mr. W. Blogg.

Mr. Matthew Marshall will sell by auction at the "Mons" Factory, Glasgow, on Aug. 26, 27, 28 and 29, quantities of engineering plant and machine tools, hydraulic and electric machinery, electric motors, electric and acetylene welding plant, &c. Catalogues from the auctioneer, 72, Waterloo-street, Glasgow.

In order to concentrate the whole of their attention to wholesale business, Messrs. Napier Kimber, Ltd., have disposed of their electrical contracting interests to Messrs. Troughton & Young, of Knightsbridge, and in future communications should be sent to the firm at 109, Great Portland-street, W. 1, unless on matters relating to Yorkshire and Lancashire, which should be sent to their branch at St. George's Hall, Bridge-street, Bradford.

The Vaughan Crane Company, of Openshaw, Manchester, have issued a nicely printed and well-illustrated booklet relating to their Rope Lift and Electric Blocks. These blocks can be slung up anywhere ready for instant use on the connection of a flexible supply cable; they can be used at a fixed point or suspended from a trolley on an overhead travelling crane, or on an overhead runway track. They effect an important economy of labour and of time, and several hundreds are in use for a variety of purposes. The booklet gives full particulars and prices, specification of electric block, &c.

The first section of the new list of resistances, which is being issued by Messrs. Isenthal & Company, Denzil Works, Willesden, N.W.10, is devoted to the firm's improved models of Tubular Rheostats of the sliding contact type. The details supplied include the method of construction, dimensions and weights, prices, diagrams, &c. The manufacture of this class of resistance was largely in the hands of German firms before the war, and as the result of specialisation they produced an article which was extensively used in this country. In view of this fact, and in consequence of the immense demand for those resistances during the war, Messrs. Isenthal were induced in the autumn of 1914 to devote their energies to the development of this manufacture. They now state that they are now in a position to offer an article which, they claim, is equal, and in many respects (especially as regards mechanical design) superior, to the foreign originals. Further sections of the list, which will deal with other forms of resistances, are now in preparation.

Appointments Vacant and Filled.

An assistant lecturer and demonstrator in physics is wanted for the University of Liverpool. Applications to the Registrar by Sept. 1

A lecturer in engineering is required at the University College, University of London. Salary £250. Applications to Prof. Coker, Gower-street, W.C.1.

A pupils' demonstrator is required by Messrs. W. H. Allen, Son & Company, Ltd., Queen's Engineering Works, Bedford. Applications to the Secretary.

Applications are invited for the University Professorship of Physics in the Benares Hindu University. Salary Rs. 500-50-750 Applications to the Pro-Vice-Chancellor, Benares, India, by Oct. 15.

Lecturers in electrical and mechanical engineering and mathematics are required at the Technical College, Loughborough. Salary £300–£25–£350. Applications to the Principal by Aug. 27.

A demonstrator is required for the electrical engineering laboratories of the City and Guilds Technical College, Leonard-street, Finsbury, E.C. Applications to Prof. Eccles by Aug. 31.

The Council of Armstrong College, Newcastle-on-Tyne, invites applications for the post of professor of experimental physics. Salary £600, rising by biennial increments of £50 to £800 per annum. Applications to the Secretary by Aug. 30.

The delegacy of the City and Guilds (Engineering) College require three demonstrators in electrical engineering. Salaries £150–£200, with special bonuses of £120–£135. Applications to Prof. T. Mather, Exhibition-road, S.W.7., by Sept. 6.

A demonstrator in physics is required at the Municipal Technical Institute, West Ham. Salary £150, rising by annual increments of £10 to £180 per annum. Applications to the Principal, Romford-road, Stratford, E. 15, by August 24.

The Shanghai Mutual Telephone Company, Ltd., require four junior assistant engineers and four foremen. Salary in each case 150 rising to 250 taels (average 3s. per tael) per month. Applications to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W.1.

Dr. W. Wilson has been appointed senior lecturer in the Department of Physics at King's College, London.

Capt. Frederick Downie, head of the electrical engineering department of the South Wales School of Mines, has been appointed head of the new electrical engineering department of Rutherford Technical College, Newcastle-on-Tyne.

The council of University College of Wales, Aberystwyth, have made the following appointments: Prof. G. Owen, of the University of New Zealand, to be professor of physics, and Prof. W. H. Young, of Liverpool, to be professor of mathematics.

Tenders Invited and Accepted.

INVERCARGILL (N.Z.) Council require tenders by Oct. 9 for supply and erection of a steam turbo-alternator

The District Fund, Gas and Electricity Committees of STOCKTON-ON-TEES Corporation invite tenders for six months' electrical stores. Tenders to Town Clerk by Aug. 30.

STOKE-ON-TRENT Council require tenders for the erection of cooling towers for the electricity department. Specification, &c., from the Borough Electrical Engineer.

MANCHESTER Tramways Committee require tenders by 10 a.m. Sept. 2 for supply of points, tongues and hardened steel centres and paving blocks. Specifications, &c., from the General Manager.

SYDNEY (N.S.W.) Council require tenders by 3 p.m. Nov. 10, for the supply of electric motors for use in connection with their motor-hiring branch. Specification from the City Electrical Engineer.

LONDON COUNTY COUNCIL invite tenders by 4 p.m. Sept. 2, for four electrically drawn wagons with towers. Forms of tender, &c., from the Clerk of the Council, County Hall, Spring Gardens, S.W.1.

ECCLES Electricity Committee invite tenders for the supply of three 500 k.v.a. three-phase transformers. Specifications from the Borough Electrical Engineer, and tenders to the Town Clerk by Aug. 25.

Tenders are required by first post Sept. 15 for six months' supply of electrical goods, ironmongery, &c., to the CHESHIRE COUNTY ASYLUM, Parkside, Macclesfield. Forms of tender from the Clerk of the Asylum.

PORTSMOUTH Tramways Committee invite tenders for 12 months' stores, including insulating materials, lamps and motor windings, overhead line material, oils, &c. Tenders to the Town Clerk by Sept 2. Specifications from the Engineer.

LINCOLN Corporation require tenders by 11 a.m. Sept 2, for the supply and erection of a 25-ton overhead electric crane for St. Swithin's power station. Specifications from Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W.1.

ILFORD Urban District Council invite tenders for the supply and erection of one 500 kw. rotary converter, transformer and switchgear. Specifications and forms of tender from the engineer, Mr. A. H. Shaw, and tenders to clerk of the Council, Mr. Adam Partington, Town Hall, Ilford, by Sept. 8.

GRIMSBY Corporation invite tenders for the supply and erection of two 1,000 kw. converters and c.c. and a.c. l.t. switchgear, e.h.t. switchgear and cables; coal and ash-handling plant and a 30-ton electrically-driven travelling crane. Specifications from the borough electrical engineer, Lieut.-Col. W. A. Vignoles, and tenders by Sept. 25.

EDINBURGH Corporation invite tenders for three 10,000 k.w. turbo-alternators and six water-tube boilers. Specifications from the engineer (Mr. F. Newington), Dewar-place, and specifications and drawings may be seen at the office of Sir Alex. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders to the Town Clerk by Sept. 11.

MANCHESTER Tramways Committee invite tenders for various stores, including permanent-way points, tongues, and hardened steel centres, wood paving blocks, ampere-hour meters, motor and controller parts, resistances, commutator segments, trolley poles, bases, wheel brushes and spindles, lamps, insulating material, carbon brushes, overhead equipment, cable, copper and steel wire, lubricants, oils, copper strip, &c. Schedules from the general manager, Mr. J. M. McElroy, 55, Piccadilly, Manchester, and tenders, addressed to the Chairman of the Tramways Committee, by Sept. 2.

SUNDERLAND Corporation have accepted the tender of Ferguson, Pailin & Company for supplying e.h.t. switchgear.

BRADFORD Corporation have placed the following orders: Hadfields, Ltd., manganese steel crossings, perforated steel cylinders and special point tongues; Collier Bros., 10 tons of copper trolley wire; Royce, Ltd., three electric capstans for Valley-road coal siding.

TORQUAY Council has accepted the tender of Babcock & Wilcox for the supply of apparatus to increase the burning capacity of boilers with oil fuel, and that of the Tudor Accumulator Company for a storage battery at the destructor works.

DARLINGTON Corporation has accepted the following tenders: Babcock & Wilcox, boiler; E. Green & Sons, economiser; Musgrave & Company, induced draught fan; Callenders Cable & Construction Company, cables.

GLASGOW Corporation have accepted the following tenders: Doulton & Company, single-way stoneware ducts; General Electric Company, 3/20 V.I.R. cable; Edison Accumulators, Ltd., six 2-ton electric vehicles, £1,304 each; Electric Vehicles, Ltd., two electric vehicles, £1,120 each; John Bennie, Ltd., lift for Dalmarnock power station, £1,056.

An important contract was recently awarded to the English Electric Company by LEICESTER Corporation, and includes the supply of a 5,000 kw. 3,000 revs. per min. turbo-alternator set, with condensing plant and circulating water piping, &c. The contract also includes rotary converters, transformers and e.h.t. switchgear, and a complete boiler-house equipment, including in the initial stages two marine-type Babcock water-tube boilers, each to supply 50,000 lb. of steam per hour at 200 lb. pressure superheated 250 deg. The plant will be installed at the Aylestone power station, an old boiler house being dismantled to accommodate the new boilers. A feature of the scheme of extensions is that the plant is so designed as to enable it to be easily transferred to the proposed super-power station when necessary.

Companies' Reports, &c.

An interim dividend at the rate of 7 per cent. per annum has been declared for the half-year ended June on the ordinary shares of the BROMPTON & KENSINGTON ELECTRIC SUPPLY COMPANY.

The shareholders of the BRITISH WESTINGHOUSE ELECTRIC MFG. COMPANY, LTD., have been informed that it is now proposed to change the name of the company to the Metropolitan Vickers Electrical Company, Ltd.

The directors of SIMPLEX CONDUITS, LTD., announce an interim dividend of £25 2s. per cent., tax free, on the ordinary shares for the year ended July 31, and a bonus of £2 8s. per cent. (less tax) on the preference shares. It is not anticipated that any further distribution will be made for the above period.

An interim dividend of 2½ per cent. has been declared on the capital of the WASTE HEAT & GAS ELECTRICAL GENERATING STATIONS COMPANY, LTD., in respect of the half-year ended July 31, and will be paid, less tax, on the 31st inst.

For the half-year ended June the directors of the TOTTENHAM DISTRICT LIGHT, HEAT & POWER COMPANY have declared a dividend at rate of 5 per cent. per annum on the preference stock and the full statutory dividends at the rate of 4½ per cent. on the "A" consolidated stock and 3 per cent. on the "B" consolidated stock.

The transfer register of the SOUTH METROPOLITAN ELECTRIC LIGHT & POWER COMPANY, LTD., will be closed from the 19th inst. to Sept. 1 inclusive, preparatory to payment of dividends on the 31st inst. in respect of the 7 per cent. cumulative first and 6 per cent. cumulative second preference shares, for the half-year ended June 30.

The report of CHADBURN'S (SHIP) TELEGRAPH COMPANY, LTD., states that, owing to the exceptional circumstances prevailing, it is impossible to submit at present a balance-sheet and profit and loss account for the year ended March 31, 1919. The directors recommend payment of a dividend of 6 per cent. on the ordinary shares and the usual dividends on the preference shares.

The net profit of ROYCE LIMITED for the past year was £8,037, and with interest (£192) and £1,786 brought forward the total available is £9,823. An ordinary dividend for the year of 5 per cent., tax free, is proposed, and £4,731 will be carried forward. In view of the increase of business, the board have decided to raise further capital and to strengthen the management. They have elected Mr. H. Ramsbottom a director and appointed him general manager, and they recommend that Mr. R. D. Hulley occupy the position of managing director and Mr. Ernest Claremont that of consulting managing director.

Mr. L. Breitmeyer presided over the meeting of the LISBON ELECTRIC TRAMWAYS COMPANY, and said the working costs for 1918 were £98,000 over those of the preceding year owing to the increased cost of fuel and wages. The company had had to pass the dividend on its ordinary shares for the past three years, and the preference dividend was over two years in arrear. The only means of increasing revenue was by an adjustment of tariffs corresponding to existing conditions, and they were in negotiation with the Municipal Council and the Government on the question.

Sir James Pender, Bart., presided over the annual meeting of the DIRECT UNITED STATES CABLE COMPANY, LTD., last week, and after giving an analysis of the report and accounts, referred to the litigation with the Western Union Telegraph Company. The control of cable-repairing ships, as indeed of all other vessels, had been in the hands of the Admiralty, and they were unable to secure the services of any ship until the Admiralty allocated the "Faraday" to them after she had completed certain work for the Western Union Company. They did not get the use of the ship until the summer of 1918 was well advanced, when enemy submarines had appeared in her vicinity, and in consequence of the extended period of bad weather, which prevented her working, and to her being ordered back to port by the Admiralty on several occasions, she was unable, before her machinery broke down, to make any effective attempt to repair the main cable in the deep water where the interruption had occurred. The expenses of that expedition amounted to over £77,000. Even before the ship sailed the directors were apprehensive that she might be prevented from completing the work in the time available, and warned the shareholders of the heavy expense to be faced. It was because the company had done everything possible to effect the repair, and was only prevented because the first use of the only vessel available was given to the Western Union Company, notwithstanding that the directors had first appled for her use, that they were so surprised at the action of that company in putting into force the penal clause of the lease. The matter was now before the Courts, and they had done, and should continue to do, everything possible to expedite the hearing of the action. The main cable was successfully repaired by the "Faraday" on June 28 last; it was now in good working condition, and was being operated by the Western Company. In connection with the last successful expedition of the "Faraday," it was found necessary during the repair to insert a length of 230 knots of new cable, which cost £31,243, but had it not been in stock its manufacture would have cost £83,275. The heavy expense of the abortive expedition of the "Faraday" had encroached very heavily upon the reserve fund. They had investments which could be realised on the prices now ruling for approximately £306,000, and a stock of cable worth at least £125,000, making a total of £431,000, which constituted their reserve fund.

The motion for the adoption of the report and accounts was adopted after some discussion. The retiring directors, Mr. C. E. Gunther and Mr. H. C. B. Underdown, and the auditors, Messrs. Deloitte, Plender, Griffiths & Company, were re-elected.

New Companies.

BRITANNIC WELDING & ENGINEERING COMPANY, LTD. (157,560.)—Private company: reg. July 31, capital £2,000 in £1 shares. To carry on the business of welding in all its branches, and that of metal workers, founders, &c. First directors are G. H. Jennings, A. J. Danaker and J. de Felice (Italian). Reg. office, 35 and 36, Imperial-buildings, Ludgate-circus, E.C. 4.

COLLEYS, LTD. (157,801).—Private company, reg. Aug. 8, capital £35,000 in £1 shares, to carry on the business of manufacturers of tramway and other printed tickets, telegraph coils, &c., and to enter into an agreement with Colley's Patents, Ltd., and its liquidator. First directors are W. W. Colley, C. V. Fisber-Rowe, J. Holland, H. Becker and F. E. R. Becker. Reg. office: 3-12, Marine-street, Bermondsey, S.E.

DIRECT ELECTRICAL COMPANY, LTD. (157,609.)—Private company; reg. Aug. 1, capital £1,000 in 900 ordinary shares of £1 each, and 2,000 deferred shares of 1s. each. Electrical and mechanical engineers, gasfitters, buyers and sellers of all kinds of electrical and mechanical apparatus. Agreement with D. H. C. Higgins and J. Dunkley. First directors are D. H. C. Higgins and J. Dunkley. Reg. office, Staple Inn-buildings, 325, Holborn, E.C.

E. P. I., LTD. (157,526).—Private company. Reg. July 30, capital £10,000 in £1 shares, to carry on the business of electricians, mechanical engineers, suppliers of electricity, electrical engineers and contractors, carriers of passengers and goods, &c. Secretary: H. Dewhurst. Solicitor: R. B. Stephenson, 34, Castle-street, Liverpool.

ELECTRIC TOOLS & MOTORS, LTD. (157,867).—Private company. Reg. Aug. 12, capital £16,000 in 10,000 preference shares of 2s. each and 15,000 ordinary shares of £1 each. Objects: To carry on the business indicated by the title, and that of civil, mechanical and electrical engineers, and to enter into an agreement with Lord Clifford. Lord Clifford is the first managing director. Reg. office: 31-33, High Holborn, W.C.3.

ELECTRICAL & MAGNETOS, LTD. (157,690.)—Private company; reg Aug 5, capital £2,000 in £1 shares. To carry on the business indicated by the title. Reg. office, 11, York-street, Swansea.

GRASSMOOR WELDING & ENGINEERING COMPANY, LTD. (157,451).—Private company. Reg. July 28, capital £10,000 in £1 shares, to carry on the business indicated by the title. Directors: A. T. N. Barnes, E. E. Barnes, E. C. Barnes and Marjory R. Barnes. Secretary: I. N. Saxton, Brookside, Chesterfield.

J. HADDEN & COMPANY, LTD. (157,335.)—Private company; reg. July 24, capital £10,000 in £1 shares. To carry on the business of manufacturers and repairers of and dealers in electric light fittings, and electric, magnetic, galvanic and other apparatus, &c. Permanent directors are J. Hadden and H. Barker. Reg. office, Haydn Park Works, Askew-road, Shepherd's Bush, W. 12.

HALL & STINSON, LTD. (157,901).—Private company. Reg. Aug. 13, capital £3,000 in £1 shares, to take over the business of electrical engineers and contractors, dealers in apparatus, &c., carried on by H. G. Hall and B. Stinson at Sheffield. First directors are H. G. Hall, and B. Stinson. Reg. office: 237a, Glossop-road, Sheffield.

LYELL, LIMITED (157,911).—Private company. Reg. Aug. 13, capital £5,000 in £1 shares, to acquire any of the assets of J. C. Lyell & Company, Ltd., and to carry on the business of acetylene and general engineers and electricians, manufacturers of and dealers in apparatus and machinery, tool makers, &c. First directors are J. C. Lyell (113, Great Portland-street, W.) and P. W. Wall.

MANSELL & OGAN, LTD. (157,912).—Private company. Reg. Aug. 13, capital £5,000 in £1 shares (3,500 preference, 1,250 ordinary and 250 founders). Objects: To carry on the business of factors of, agents for and wholesale and retail dealers in electrical apparatus and accessories, &c. First directors are M. Mansell and F. B. Ogan. Reg. office: Gloucester Mansions, Cambridge-circus, W.C.2.

MERSEY ELECTRICAL ENGINEERING COMPANY, LTD. (157,620.)—Private company; reg. Aug. 1, capital £1,000 in £1 shares (100 founders'). First directors are N. Trant (managing) and J. Sumner (permanent governing directors, subject to holding 25 founders' shares). Sec., A. J. Cookson. Reg. office, 15, Old Post Office-place, Liverpool.

NORMAN JOHNSON & COMPANY, LTD. (157,877).—Private company. Reg. Aug. 12, capital £5,000 in £1 shares (3,500 6 per cent. preference). Objects: To take over the business carried on by N. Johnson & Company as engineers, and to carry on the business of electrical and general engineers, manufacturers of motors, motor parts, &c. First directors are N. Johnson and E. J. Hawkins. Reg. office: "Hop Poles" Engineering Works, Baker-street, Enfield.

PEERLESS FLASH LAMP COMPANY, LTD. (157,854).—Private company. Reg. Aug. 11, capital £24,000 in £1 shares, to enter into an agreement between the British Thomson-Houston Company and James Y. Fletcher (General Electric Company), Sydney H. Callow (Siemens Bros. & Company) and Francis W. Willcox (B.T.-H. Company), and to carry on the business of electric flash lamp manufacturers, manufacturers of electric lamps, aeronautical and general engineers, &c. The shares are to be issued in equal proportions to the British Thomson-Houston Company, the General Electric Company and Siemens Bros. & Company. First directors are F. W. Willcox, J. Y. Fletcher and S. H. Callow. Reg. office: 16 and 16a, Stonehouse-street, Clapham, S.W.

RALPH TOURNE, LTD. (157,971).—Private company. Reg. Aug. 15, capital £3,000 in 2,800 preference shares of £1 each and 4,000 ordinary shares of 1s. each, to carry on the business of electricians, electrical and general engineers, &c., and to adopt an agreement with R. Tourne and H. Green.

A. B. ROBERTSON & SON, LTD. (10,569).—Private company. Reg. in Edinburgh Aug. 11, capital £10,000 in £1 shares. Objects: To carry on the business of electrical and sanitary engineers, &c. First directors are A. B. Robertson, senr., and A. B. Robertson, junr. Reg. office: 260, Union-street, Aberdeen.

SIMPLEX IGNITION SYNDICATE, LTD. (157,837).—Private company. Reg. Aug. 9, capital £1,000 in £1 shares, to acquire an invention for obtaining ignition by compression of air, &c. First directors are Lieut. R. Y. Dickinson and A. Youngman. Reg. office: 27, Fetter-lane, E.C.

SPLITHORF ELECTRICAL COMPANY (OF LONDON), LTD. (157,628.)—Private company; reg. Aug. 1, capital £10,000 in £1 shares. To enter into an agreement with the American Supplies Company, Ltd., and to manufacture and deal in ignition apparatus and machinery for the ignition of internal combustion engines and appliances. Directors, C. E. Horaback and H. J. Hinley.

H. D. SYMONS & COMPANY, LTD. (157,614.)—Private company, reg. Aug. 1, capital £15,000 in £1 shares. To carry on the business of manufacturers of and dealers in insulating materials, merchants, importers and exporters, manufacturers of and dealers in metals, alloys and metallic compounds of all kinds, electrical, engineering and scientific accessories, &c. Reg. office, Park Works, Park-road, Norbiton, Surrey.

WILLIS & MONCRIEFF, LTD. (157,797).—Private company, reg. Aug. 8, capital £5,000 in £1 shares, to carry on the business of manufacturing opticians, mechanical engineers, tool makers, metal and glass workers, electricians, manufacturers of lenses, telephones, telegraphs, &c. First directors are T. S. Willis, J. Moncrieff and T. F. Miller. Reg. office: 32a, St. Mary's road, Plaistow, E. 13.

Prices of Metals, Chemicals, &c.

Tuesday, Aug. 19.

		Price.	Inc.	Dec.
Copper—				
Best selected	per ton	£110 0 0	£3 0 0	—
Electrolytic bars ...	,,	£118 0 0	3 0 0	—
H.C. wire, basis ...	per lb.	1s. 3⅜d.	—	—
Sheet	per ton	£142 0 0	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	per lb.	1s. 7⅜d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 10½d.	—	—
Sheet, basis	,,	1s. 2⅜d.	—	—
Wire, basis	,,	1s. 2¼d.	—	—
Pig Iron—				
Cleveland warrants	per ton	—	—	—
Galvanised steel wire, basis	,,	£32 10 0	—	—
Lead Pig—				
English	,,	26 0 0	0 5 0	—
Foreign or colonial	,,	25 12 6	1 7 6	—
Tin—Ingot	,,	272 0 0	11 0 0	—
Wire, basis	per lb.	0 3 3	—	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £21.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £44.

Boric Acid (Crystals)—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6½d.

Shellac.—450s. October delivery at 475s. to 476s.

Rubber.—Para fine, 2s. 5¾d.; plantation grades, 1s. 11½d lb

Thirty-Seven Years Ago.

[From The Electrician, Aug. 19, 1882.]

The Edison Electric Light System.—We have received a nicely got-up price list from the Edison Company, which contains, besides the mere list of prices, an illustrated description of the various parts of Mr. Edison's system, and testimonials which have been received from users of the lamps, &c.

The Opera House at Paris.—A fire caused by the electric light apparatus has created some consternation at Paris. No great damage was done, but faith in the freedom from fire by using the electric light is not so strong as it was. We still maintain that fire can be effectually guarded against, and when it happens it is the result of bad engineering.

Electric Light in Newry.—A. R. Walker, Esq., J.P., has decided to light up his extensive flour mills by the electric light, and has given his orders to Mr. J. H. Greenhill, of Belfast, for Crompton's Burgin machines and Swan's incandescent lamps. This order is the result of the highly satisfactory instalment of this combined system in the mills of Messrs. Furlong & Sons and Messrs. Hall & Company, at Cork, in December and January last, these firms having expressed their great satisfaction with the light.

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Notes.

Patents in 1918.

IN another column we publish a brief account of the annual report by the Comptroller of the Patent Office. This document is not as interesting as it used to be in pre-war days, and it may, perhaps, be said that the chief point of importance emphasised in the present report is the fact that the surplus of receipts over expenditure was £135,890, as compared with £124,427 in 1917. This revenue was obtained on a smaller number of applications than is usual under normal conditions, and serves to emphasise the point which was criticised very adversely in a report issued by the Institution of Electrical Engineers some little time ago. In this it was pointed out that a profit would still be shown if the renewal fees were halved. The work done by the Institution in this connection has now been completed by a report on the question of an Empire patent. A short abstract of this report appeared in our last issue, but it may be worth while to point out that the scheme recommended by the I.E.E. Committee consists in dealing with all applications for an Empire patent by a central office in London, and that any patent so issued would have effect in the various territories desired by the patentee, and for which fees had been paid. In other words, there would be no saving in the fees payable, which would be the same as those exacted locally; but there would be a very great simplification in procedure. We need scarcely remark that, although this is a step in the right direction, patentees would undoubtedly like to see a large reduction in the local fees. There is something ridiculous in having to pay innumerable fees to cover various parts of the British Empire, when the United States can be covered by a single fee, which is smaller than that exacted for protection in the United Kingdom alone. It is pointed out by the committee that there would be great difficulty in working on these lines, so we must hope that the suggestion of simplified procedure will be adopted, and that a reduction in local fees may possibly result in due course.

An Inventions Board.

THE appearance of these reports reminds us that SIR ROBERT HADFIELD has suggested the establishment of a Permanent Inventions Board. It is well known that the Munitions Inventions Department and the Board of Inventions and Research did invaluable work during the war in sifting out the ideas of inventors and developing those which were likely to be of advantage to the country. The same sort of thing is desirable in times of peace, though on a different basis. It is one thing to have an idea which in itself may be valuable, but it is quite another to get any such idea carried out if the cost involved is considerable, as is often the case. For this reason many useful inventions have probably been entirely lost, and the community at large has suffered correspondingly. The history of invention is full of cases where inventors have experienced the greatest difficulties in obtaining recognition. For example, SIR RICHARD ARKWRIGHT would not have succeeded in perfecting his spinning machine if he had not been assisted by a friend of means. Similarly, JAMES WATT was unable to make progress until he met an engineer of means and of a speculative turn of mind. A permanent Inventions Board would eliminate difficulties of this kind, and, although the placing of an invention on the market would be beyond its scope, preliminary work and investigation might well be undertaken and assisted.

Research Associations.

LAST month a conference of research associations was called by the Department of Scientific and Industrial Research, and various points of considerable interest were discussed. We give some account of the proceedings in another column. The subject which was first considered was the desirability of creating a central records bureau. It is not suggested that this bureau should take the place of similar offices for each association, but that it should be a central body which would have records of the work done by all the associations, presumably in less detail than would be required by any individual association. The difficulty of setting up a body of this kind is in discriminating between what is useful and what is comparatively useless. Otherwise, the scheme will become so cumbersome as to be inefficient. In this connection it must be remembered that work is usually published only when it is successful. On the other hand, those who are engaged in research are continually working at subjects where successful results have so far not been obtained, and it is generally of very great utility to such workers if they can have access to the unsuccessful work of their predecessors. It appears to us that there would be some risk of a considerable amount of duplication in the establishment of a central bureau. Detailed records must in any case be kept by the individual associations, and probably the most useful purpose that could be served by a central bureau would be to act as a sort of clearing house for the passing on of information from one association to another. Kindred problems occur in different industries, but it is very difficult for an individual working in one industry to know what is being done in some other industry. The establishment of a central bureau would enable the worker in any one industry to take advantage of similar work which had been carried out for a different, though analogous, industrial purpose.

The Reward of the Research Worker.

Another subject, and one of considerable difficulty, which was discussed at the Conference was the remuneration of those engaged in research work. We gather that a draft agreement had been prepared according to which any research worker might be rewarded for successful work in research. Great exception was taken to this method, and there is no doubt that it presents many difficulties. If individual rewards are given the natural effect on each worker is to lead to secrecy in the hope that individual results may be obtained, whereas the greatest progress is made by means of team work. One method of getting over the difficulty of patents is that mentioned by Mr. W. Dixon, according to which any employee has the right to patent his own ideas, but the employing company has the free use of such inventions. Whether this method works well in practice we do not know, but, generally speaking, the best method is probably the payment of adequate salaries which should be increased, in the discretion of the director, according to the utility of the worker. The real difficulty is that an invention raises a speculative hope which always fascinates the inventor, in the form of a possibility, if not probability, of an ample reward in the shape of royalties. On the other hand, the average employer may feel that research is not an investment which brings in profit at all quickly, and for that reason he may feel inclined to keep salaries at a lower standard that that which affords a suitable inducement. The director of a research association is in a happier position, being less dependent upon commercial results, and it therefore behoves him to give a lead in providing suitable and enlightened terms of employment.

The Co-operative Strike.

The strike of employees of many of the co-operative societies, which has now been settled, is of more than ordinary interest because in such societies the usual capitalist feature is lacking. As is well known, the capital in such cases is provided by labour, and the management also is in the hands of labour. This, however, has not prevented a strike, nor the incidents which generally accompany such troubles. Demands were made for improved conditions of employment and for uniform rates of wages; certain concessions were granted, but they were considered inadequate. Finally the employers issued lock-out notices, which was an unusually drastic step, and the employees decided to strike before such notices could take effect. The moral of the strike, which we hope will be noted by those who think that limitless demands can be met, is that, even when labour is in control, the standard of wages cannot be raised indefinitely, and that they must inevitably depend on production.

Municipal Tramways Association.—The annual conference of the Municipal Tramways Association will be held on September 17, 18 and 19, in Dundee.

Trees as Antennæ.—According to a leading article in "The Times," of the 27th inst., Major-General G. O. Squier has found it possible to utilise living trees as receiving antennæ in wireless telegraphy, and considerable use was made of this method in the U.S.A. during the war.

"Telephony at the Theatre."—In our issue of the 15th inst. we described a telephone installation by the Western Electric Company in the theatre at Crayford. We have received a letter from Dictograph Telephones, Limited, stating that they have for many years installed instruments for a similar purpose at several London theatres and also in churches.

Self-synchronising Machines.—We have received a letter from Mr. C. A. Lohr stating that the methods of starting up synchronous converters by an induction motor connected in series with the converter windings, or by means of choke coils inserted between the line and the converter during the starting period, are broadly anticipated by U.S.A. patents granted to him (No. 871,513 of 1907 and No. 1,204,169 of 1916). The first of these was explained in our correspondence columns of April 24, 1914.

"The Marconi Direction Finder."—In regard to the article on this subject which was published on the 8th inst. we have received a letter from Mr. E. Bellini stating that the apparatus would be more correctly styled the Bellini-Tosi direction finder, or at least the Marconi-Bellini-Tosi direction finder. As far as we are aware this contention is correct. We have also received a communication from Prof. A. Artom stating that the device is covered by his Italian patents 88,765 and 88,766 of 1907. This is a matter of controversy which has occupied our correspondence columns on more than one occasion.

Long-distance Wireless Telegraphy.—According to the "Wireless Press" (of Sydney, Australia), the wireless operator in s.s. "Karoola" has reported that when his ship was off the north-west coast of Australia he received clear messages from an English low-power station in the North Sea. The messages were transmitted on the ordinary short range wave-length of 600 metres. This feat was achieved with the new "Expanse" type magnifying valve receiver designed and manufactured in Sydney by Amalgamated Wireless (Australasia), Ltd. These receivers were originally designed by the company's managing director, Mr. E. T. Fisk, for demonstrating the possibility of receiving messages in Australia direct from the Marconi Station at Carnarvon, in Wales.

Wireless Society of London.—We learn with pleasure that this society is resuming its activities. At a meeting of the committee on the 24th ult., under the presidency of Mr. Campbell Swinton, F.R.S., it was announced that the hon. secretary, Mr. R. H. Klein, had resigned, and he was elected an acting vice-president. Mr. Leslie McMichael, 30, West End-lane, West Hampstead, N.W. 6, replaces Mr. Klein as hon. secretary. Intending new members and those who were members at the outbreak of war who have changed their address are requested to communicate with the hon. secretary. The society, which is open to all those interested in the study and furtherance of wireless telegraphy (amateur or professional), is at present in communication with the Post Office on the subject of licences. The finding of new club rooms is engaging the attention of the committee, and it is hoped to secure premises where the wireless equipment of the society can be installed and used. A general meeting will be held in a few weeks' time.

East Greenwich Fuel Research Station.—It is announced that good progress is now being made with the erection of the building for this scheme. Considerable delay was caused by alterations in the original plans, but it is expected that the plant will be so far complete by the middle of September as to enable operations to be begun. The offices and laboratories are complete, and the gas-holders are all ready. To supplement the electric power plant, the Admiralty have supplied a Diesel engine set, and have lent the services as chief engineer for three years of Engineer-Commander Shaw, who was chief engineer in H.M.S. "Invincible." The services of Prof. Thomas Gray have been lent by the Royal Technical College, Glasgow, as chief of the laboratory and chemical staff. Exact tests are to be carried out with special boilers on the comparative efficiency of coal, gas and oil in the furnaces. Experiments will be particularly directed to ascertain the maximum capacity of coal to yield motor spirit. Experiment will be confined at first to standard coal.

U.S.A. Government demand for Electrical Engineers.—The United States Civil Service Commission announces competitive examinations for a number of vacancies for electrical men in the Ordnance Department, Signal Service and the Bureau of Standards. Among the positions to be filled are those of plant superintendent, research physicist, mathematics and dynamics experts, radio engineers, engineers for electrical safety work, &c. The salaries (with the exception of laboratory assistants) range from $2,000 to $5,000 a year, the highest figure, somewhat curiously, being mentioned for the mathematics and dynamics experts. Even allowing for the presumably higher cost of living in the States, the salaries seem to compare favourably with those that would probably be offered in a similar contingency in this country.

Protection Against Dumping.—A brief statement on the Prime Minister's recent speech has been issued by Sir Vincent Caillard, President of the Federation of British Industries, who remarks, in regard to the removal of import restrictions that everything must depend upon the measures taken by the Government with regard to anti-dumping and protection to be afforded to important industries. It is thought regrettable that the Government have not taken definite action in these matters before removing the import restrictions, as manufacturers and producers are left in a state of doubt as to what the future will be, and there is considerable risk in spite of the automatic protection which the Premier stated was given by exchanges and freights, that production will be disorganised to a great extent and unemployment consequently increased, till such time as Parliament can pass definite measures to meet the situation.

Electric Furnace Regulator.—In the "Physical Review," Messrs. W. P. White and L. H. Adams describe a form of regulator for electric resistance furnaces which seems to have given good results. The heating coil is made one arm of a Wheatstone bridge, and combined with a galvanometer regulator, by which the resistance of the coil is maintained constant independent of variations in the electric supply. This is a satisfactory criterion provided that the furnace temperature is not appreciably affected by the temperature of the room and surroundings. In the latter case the furnace temperature might vary somewhat, even though the coil temperature is maintained constant. The method has, however, the considerable advantages that it is unnecessary to introduce any measuring device into the furnace chamber, and that all lag between heater and regulator is completely avoided. The regulation is stated to be extremely exact, one small furnace being maintained constant to 0·1 deg. for hours at a temperature of 500 deg. to 1,400 deg.

Hydro-electric Development and Natural Beauty.—It is interesting to observe that even in the present circumstances claims for the preservation of natural beauty, which is apt to be jeopardised in this industrial age, are finding expression in France. "L'Electricien," in commenting on this matter, claims that industrial developments must come first, but is not averse from any steps likely to prevent desecration of scenery without crippling industrial enterprise. A newly formed body, La Société pour la protection des paysanages de la France, has hit upon the practical scheme of holding an exhibition to illustrate cases in which industrial works have been, or about to be, erected without any unsightly effect. The society is receiving assistance not only from bodies concerned with natural beauty, such as the Touring Club of France, but also from those engaged in hydro-electric developments and in mining and metallurgical operations. In view of the growing development of water-power, the matter is of importance, and it is satisfactory to see that an attempt is being made to forestall criticism by co-operation between the two main interests affected

Lightning and Trees.—Some comprehensive enquiries into the effect of lightning on trees, undertaken by Mons. Vanderlinden during the years 1884 to 1896 have been assembled in the Annuaire de l'Observatoire royal de Belgique. The results, as presented in a recent issue of "L'Electricien," confirm general experience, and do not suggest any novel conclusions. It appears that topographical position is almost invariably the deciding element in causing a tree to be struck by lightning, and that individual peculiarities of trees have in themselves little effect. This, it is remarked, confirms Lodge's classic experiments on high-tension oscillatory discharges, from which the conclusion was drawn that the resistance of the conducting body was in general of small import. While there are some species of trees that seem to be more frequently struck than others—for example, poplars, oaks and conifers—it would appear that no variety of tree escapes immunity. In general it is not the most prevalent type of tree in a district that suffers but those which attain the greatest height, or are most situated in exposed positions. There is no apparent connection between liability to being struck and the form, properties, chemical composition and conductivity of the wood, nor even the nature of the soil in the vicinity. It is interesting to note that the passage of a discharge is only exceptionally responsible for the conflagration, and that, although the tree is in general scarred, there may be no visible sign of the injury.

The Yorkshire Electric Power Co. and the E.P.E.A.—The following statement has been issued by the E.P.E.A. :—

> Considerable unrest is prevalent amongst the engineering staff of the above company, and a serious position is created by the many resignations amongst the executive and supervisory officials of the company that have taken place during the past few weeks.
>
> The main cause of the discontent is the attitude of the management towards the staff. The effect of this attitude has been to create a state of affairs making it impossible for the staff to carry out their duties efficiently. An acute position was reached early in May last, when all the members of the staff resigned their positions as a protest against the state of affairs then existing. An agreement was arrived at between the directors of the company and the Electrical Power Engineers' Association acting on behalf of the members concerned, the spirit of which, however, has not been observed by the management.
>
> Since the date of this agreement there has been two dismissals and 10 resignations, nearly all of whom are heads of departments or their assistants.
>
> Nearly all the men concerned are members of long service with the company, and it is obvious that the state of affairs that causes these resignations must be an intolerable one. The Yorkshire Electric Power Company supply with electricity a very large industrial area, and it is hoped that in the interests of the community concerned, also in the interests of the shareholders whose business is at stake, some means may be found to remedy the present state of affairs.

In reply to this statement, the "Yorkshire Post" publishes comments by Mr. A. G. Lupton, chairman of the Company, from which it appears that two dismissals have taken place. These are due to suspension of new works until the Company know the effect of the new legislation now being embodied in the Electricity Supply Bill. As to resignations, an agreement has been made with the E.P.E.A. to refer the question in dispute (increased payments) to arbitration. Any unrest and discontent is attributed to unreasonable claims and mistaken anticipations of members of the staff.

Obituary.

The death has occurred of Mr. John Schabert, of Dukinfield, who was for 24 years with the Tudor Accumulator Company, and latterly, works manager. He was 51 years of age and a native of Luxemburg. At the inquest the Coroner found that death was due to lead poisoning.

The death is announced of Prof. A. G. Vernon Harcourt, D.Sc., F.R.S., vice-president of the Chemical Society and metropolitan gas referee. For some years he was Lee's Reader in Chemistry, and, from 1864 to 1902, tutor at Christ Church, Oxford. He was the author of several works on chemistry and he was an acknowledged authority on coal gas and photometry. For a time he acted as general secretary of the British Association, and he served on several Departmental Committees, including the Home Office Committee on the Health of Workers in Potteries.

Personal.

Madame Curie has been elected Professor of Radiology at the Warsaw University.

The President of the Board of Trade has appointed Mr. W. J. Hands, O.B.E., to the Controller of the Profiteering Act Department. Communications in connection with the administration of the Act should be addressed to the Controller, Profiteering Act Department, 1, Queen Anne's-gate Buildings, Westminster, S.W.1.

The staff and employees of the South Shields municipal electricity works have presented Mr. Harry S. Ellis, who has resigned in order to take up the position of borough electrical engineer at Southampton, with a travelling case and slide rule. Mrs. Ellis has also been presented with a handsome table lamp of oxidised silver.

Developments in Electric Iron and Steel Furnaces.*

By J. BIBBY.

The author refers to some recent developments in the manufacture of iron and steel by means of electric furnaces. Iron occurs in nature in the form of oxides, which can be reduced in contact with carbon at certain temperatures. In the electric furnace the function of electricity is to bring the ores and agents to the reduction temperature, and melt the resulting metal together with the fluxes.

The manufacture of pig iron in a blast furnace requires, on an average, 1 ton of coke per ton of pig iron produced. Given the same ore, an electric furnace would require 0·3 ton of coke per ton of pig iron produced, thus effecting a saving of 0·7 ton of coke per ton of iron. Against this saving in coke must be set the consumption of electrical energy, which averages 0·3 H.P.-year per ton of iron. Thus the costs of the two systems balance when 1 H.P.-year can be obtained for the price of 2·3 tons of coke.

Electric pig iron contains less impurities than pig iron from the blast furnace, owing chiefly to the smaller quantity of coke used and to the higher temperature obtainable, which makes it possible to work with a more basic slag, and favours the elimination of sulphur. There are over 20 electric furnaces working on the manufacture of pig iron, and about 12 more are being installed.

The general appearance of the electric reduction furnace follows that of the blast furnace fairly closely.

The iron ore, coke and flux are charged at the top of the furnace, and these, in descending, are heated by the ascending gases generated at the base of the shaft and top of the crucible by the final reduction which takes place in this region. When the temperature of the ore, Fe_3O_4, has reached about 250°C., it is reduced to a lower oxide, FeO, by part of the ascending CO, forming CO_2. In the electric process the whole of the gas is produced from the oxygen in the ores and the carbon in the fuel, neglecting fluxaction, where as in the blast furnace a large quantity of external air must be introduced to provide the balance of oxygen necessary for the combustion of the fuel for heating. In the electric furnace the gas generated is only one-eighth of that generated in a blast furnace for the same duty, but its calorific value is nearly three times as high, inasmuch as it contains no nitrogen. Besides the melting and final reduction operations in the crucible, we have to melt the flux and at the same time eliminate as much as possible the sulphur introduced by the ore and the coke. This necessitates a high temperature, owing to the high melting point of lime; the heating system must be arranged so as to develop a uniformly high temperature throughout the central and lower portions of the crucible.

It appears, so far, impossible to obtain as high a voltage drop across the crucible as we should like; and the drop does not increase quite in proportion to the distance, indicating, as would be expected, that there is a considerable drop between the electrodes and the material, which drop is constant for any given electrode and current. The effect is to have a higher rate of heat generation around the electrodes than in the intermediate spaces. However, it does not materially affect matters if we consider that the resistance between the electrodes is uniform throughout the space between them. The following table gives the number of electrodes used on various sizes of furnaces and the outputs :—

Horse-power.	No. of electrodes.	Yearly output.
2,500	4	7,000 tons.
4,000	6	11,500 tons.
6,000	8	18,000 tons.
10,000	12	31,000 tons.

Commercially the smallest furnace is the 2,500 H.P., with an out put of 7.000 tons of pig per year. In this furnace we have four electrodes coupled to the secondary terminals of a Scott group. The next size of furnace, viz., the 4,000 H.P., requires six electrodes, and the idea on the early furnaces was to employ three single-phase transformers, delta-connected on the primaries, and the terminals of the secondaries connected to diametrically opposite electrodes. Subsequently the improved device was adopted of connecting the neutrals on the secondary side as so to secure the three phases being relatively fixed, and obtain the equivalent of six equal phases at 60 deg. The next size of furnace, the 6,000 H.P., has eight electrodes and, for many reasons, it appears that this is destined to be the most popular size. For this furnace we require to transform three-phase current into eight equal phases consecutively at 45 deg. Five transformers are connected on the primary side. The neutrals are connected as on the smaller furnaces. When correctly proportioned, we obtain eight equal voltages induced between every electrode and the neutral.

The securing of a uniformly distributed high temperature gives the electric furnace an advantage over the blast furnace in this respect. In the blast furnace the temperature of the hearth is fixed by the possible temperature of the combustion at the tuyere zone, say, 1,800°C., and this determines the melting point of the flux, that is, the possible proportion of lime. Now, in the electric furnaces we have no such limiting temperature, and it is possible to have a flux with a melting point of 2,000°C., which permits of its being more highly basic and therefore more effective as a refining agent.

It might appear that the current passes horizontally between the electrodes, but this is not exactly what takes place in the crucible, as a portion of current is deflected through the molten metal on the hearth. Consequently, as the bath of metal rises, the resistance decreases, until a point is reached when it is impossible to get sufficient energy into the furnace, and the bath must then be tapped. This limit corresponds to that set by the height of the tuyeres in a blast furnace; but the growth of the bath is much slower, owing to its greatly superior width. An electric furnace is tapped every four or five hours to suit the shifts.

The high temperature in the crucible would be destructive to the roof, and to avoid this a portion of the outgoing gases is extracted from the main, taken through coolers and dust extractors, and blown against the roof through the free space between the charge and the roof. The gases are cooled to a temperature of about 70°C., and if about two-thirds of the gases are circulated the roof is effectively preserved. This circulation assists in carrying the heat from the crucible into the shaft so as to effect the first reduction of the ore at a higher level. All the gas generated passes, on the average, three times through the shaft; but there is a distinct thermal loss by the amount of cooling necessary.

To ensure the proper working of the furnace under the inevitably varying conditions of the charge, it is necessary to have full control of the circulation gases and the electric energy delivered to the crucible. Regarding the energy supplied, it is not possible to have regulation of current, but the transformers are arranged with tappings on the primary side so as to give about eight steps of voltages on the secondary, varying from 25 to 50 between the electrodes and the neutral. The circulating gases are regulated by a direct-current motor-driven fan with wide speed regulation.

One of the most important points for consideration on the electrical side is the arrangement of the low-tension leads. The greatest care must be taken to avoid induction. As an example of the losses which may occur in the low-tension leads, it was found, in a test on an early furnace, that the output from the transformer was about 4,000 kw., but the input to the electrodes was 3,400 kw., showing a loss of 600 kw. The losses are distributed as follows :—

In the contact clamps at the electrodes	120 kw.
In the resistance of the leads	165 kw.
By induction	315 kw.
Total losses	600 kw.

The heavy induction losses were chiefly caused through the leads having to pass near the structural ironwork of the furnace. By re-arranging the leads and interleaving the bars the induction losses can be brought down to about 50 kw. On well-desinged plants a power factor of 90 per cent. is obtained, and a load factor of 80 per cent.

The power consumption per ton of pig-iron produced depends chiefly on the percentage of iron in the ore, on the percentage of CO_2 in the waste gas, and on its temperature.

Fig. 1 shows the consumption of energy for various percentages of iron in the ore, and various percentages of CO_2, by volume in the waste gases. In a good case of 27 per cent. CO_2 and 70 per cent. iron content, the consumption was only 1,320 kw.-hours per ton. The average obtainable, however, is 22 per cent. of CO_2, and with, say, 60 per cent. iron content the consumption is about 1,500 kw.-hours per ton. For 22 per cent. CO_2 the consumption of coke is only about 6 cwt. per ton of pig, excluding that required for carbonising the iron, and this is a common figure in practice.

The working of the electric reduction furnace requires quite as much skill as the working of the blast furnace, but it is under better control and has greater possibilities for the production of various grades of iron.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

ELECTRIC STEEL REFINING FURNACES.

The application of electricity to steel-refining has become much more general than to the manufacture of pigiron, inasmuch as in the former the price of electrical energy, although an important factor, is not the predominating one.

In steel-making, electricity has advantages which place it well ahead of other heating systems. The heat can be supplied in easily regulatable quantities and intensities, free from contaminating gases. The process can be carried on in a reducing atmosphere, which is of capital importance. Of the many methods of applying electricity tried, the only one which has survived is the direct arc type, in which the metal is heated by arcs struck between electrodes and the bath of metal itself. An incidental advantage of this system is that the slag is brought to a higher temperature than the metal, which is desirable on account of its higher melting point; further, it is the most direct method of getting the heat into the metal

Two types of furnaces have been developed on these lines, one in which all the electrodes are above the bath, and the other in which the electrodes are both above and below the metal. The resistance between any two upper electrodes is equal to the resistance of two arcs, whereas the resistance between an upper electrode and a lower electrode is equal to one arc plus the resistance of the hearth. Now, in order that a number of phases may be in balance, it is necessary that the resistances in the phases be equal, *e.g.*, if we have a three-phase furnace system we must have three equal resistances. In the Héroult three-phase system there are three upper electrodes connected to the outside terminals of three single-phase transformers. In this system the resistance between each pair of phases is equal to that of two arcs, so that the arrangement gives a balanced system when correctly regulated.

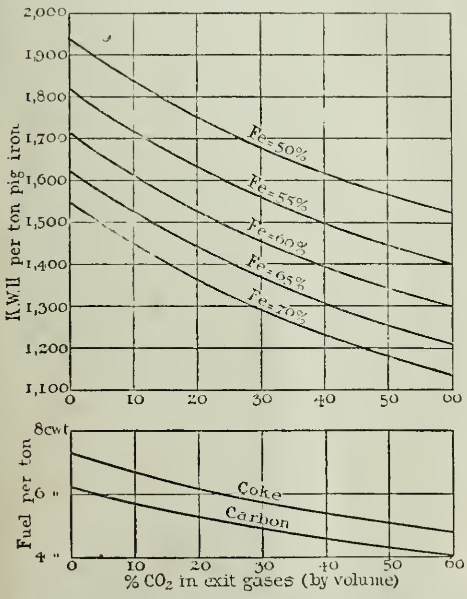

FIG. 1.—FUEL AND ENERGY CONSUMPTION FOR ELECTRICAL REDUCTION OF MAGNETITE (Fe_3O_4).

If we have a three-phase system with two upper electrodes and one lower electrode, the resistance between the two upper electrodes will be equal to that of two arcs, and the resistance between either upper electrode and the lower electrode will be equal to that of one arc, plus the resistance of the hearth; so that, in order that the system may be balanced, the resistance of the hearth must be equal to that of one arc to bring the total resistance to two arcs, and this results in one-third of the energy being dissipated in the hearth. Now a basic hearth is a conductor of the second class, and the resistance decreases as a function of the rise in temperature. The resistance on the hearth surface in contact with the metal, where the temperature is about 1,800°C., is small, but increases rapidly towards the bottom of the lining; so that the heat generated in the hearth, through its resistance, is principally towards the outside, away from the metal. The horizontal lines in Fig. 2 show the rate of heat generation throughout the depth of the lining. Thus there can be no benefit to the metal through the generation of heat in the lining. A three-phase furnace, or a furnace having any other number of phases, so connected, and depending on hearth resistance for balance, is bound to be wasteful in current consumption. For any system to be balanced, without the introduction of resistances other than the arcs, the number of arcs must be a multiple of the number of phases.

This brings us to the determination of the number of arcs which should be used in an electric furnace. From a mechanical point of view the fewer the arcs the simpler the system; but the minimum number is determined by metallurgical considerations. There must be sufficient heating zones to melt the raw material rapidly, without necessitating undue exertion in pushing the unmelted metal towards the melting zones. In refining, the metal and slag should be brought to a high and uniform temperature, since the basicity of the slag depends on its lime content, which fixes its melting point. The higher the content of the lime the higher the melting point, so that the higher the temperature the more possible it is to have a fluid, high basic slag. The extent of the chemical action is limited by the minimum temperature of the slag. In order to get a uniformly high temperature, we must have no place in the furnace too far away from an arc, thus necessitating an adequate number of arcs to secure this condition.

Small furnaces have been made having a single arc, but they are simply employed for melting. There is the further difficulty of obtaining single-phase current from the usual three-phase supply without employing rotary transformers. Two arcs sufficiently cover a bath up to about 6 tons' capacity, and there is no necessity to employ more than two upper electrodes for furnaces up to this size. In order to satisfy the conditions for balance the two-arc system employed must only have two phases with a common neutral and as little hearth resistance as possible. Fortunately, a dolomite hearth is a fairly good conductor at the working temperature, and the loss through a depth of 12 in., involves a drop of only two or three volts at a current density of 3 amperes per sq. inch.

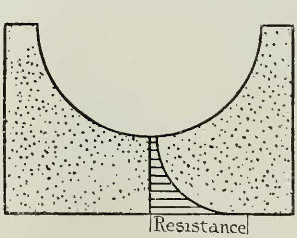

FIG. 2.

The main field for these small two-arc electric furnaces is in small foundries manufacturing better quality castings, such as motor-car parts, &c. The castings made from the electric furnace are superior to those made from small converters, since the metal is thoroughly deoxidised and the sulphur content is reduced to a minimum. The chief defects in steel castings, apart from moulding errors, are due to the presence of oxides, and the freedom from oxides in electric furnace metal is a positive step forward; also, owing to the reduction in sulphur, the metal is much more ductile and uniform in composition, so that electric steel castings are freer from contraction tears and are much more easily machined. Waster castings, which figure so largely in ordinary steel foundry work, are reduced to an almost negligible quantity. These small electric furnaces are also rapidly displacing the ordinary crucible furnaces for the manufacture of higher quality steels such as ordinary tool, spring, tungsten, nickel-chrome steels, &c. The electric furnace is able to manufacture accurately to specification all kinds of steel from the cheapest raw material, since the reducing atmosphere permits of the alloy additions being made practically without loss.

An important use for the small furnace of about ½-ton capacity is in melting ferro-manganese for use in conjunction with open-hearth furnaces. When solid ferro-manganese is added to molten steel in the ladle, it is only reluctantly absorbed, and at least 30 per cent. of the manganese content is lost by oxidation. Portions of the manganese unabsorbed by the steel form ghost-lines in working, and hard places which appear in machining. Ferro-manganese can be melted in the small furnace specially designed for this purpose with a manganese loss of not more than 5 per cent. Thus the saving soon pays the cost of the furnace, and the steel product is of higher value. These small furnaces have a capacity of 10 cwt. and will deliver molten ferro-manganese at the rate of 400 lb. per hour. The current consumption is 1.000 kw.-hours per ton of ferro-manganese delivered.

Although there are profitable fields for small furnaces, the principal technical developments will take place in larger furnaces. These furnaces may be used either for the complete process of melting, refining and alloying, or may be run in conjunction with Bessemer or open-hearth furnaces, being used to refine the cruder metal from those furnaces. In this case, advantage is simply taken of a feature of the electric furnace, viz., that which permits of working under a non-oxidising atmosphere at any desired temperature. These larger furnaces require a greater number of heating zones, that is, a greater number of arcs.

One furnace described in the original Paper, of 30-ton capacity, has four upper electrodes. The furnace is circular in plan. There are as few openings as possible, and so placed that every portion of the hearth can be surveyed and be accessible for any necessary lining repairs between the heats. Three doors are sufficient, one for teeming and two for charging; if the doors are correctly placed and there are no obstructions to the men working at the doors

The electric system on the large furnace requires, for the reasons given, four equal phases, preferably with only one variable resistance in each phase to facilitate definite regulation. We therefore require four phases with a common return through the hearth, so that the resistance in each phase is equal to the varying resistance of one arc plus the constant resistance of the hearth. In the original Paper the arrangement, used for a three-phase supply, which involves the use of three single-phase transformers with primaries delta-connected, is described in detail. The four-phase five-wire system must be so arranged that the current through the hearth will be a minimum, and this can be taken as the current in one phase, so that when starting the furnace one full arc can be struck independently of the other three upper electrodes.

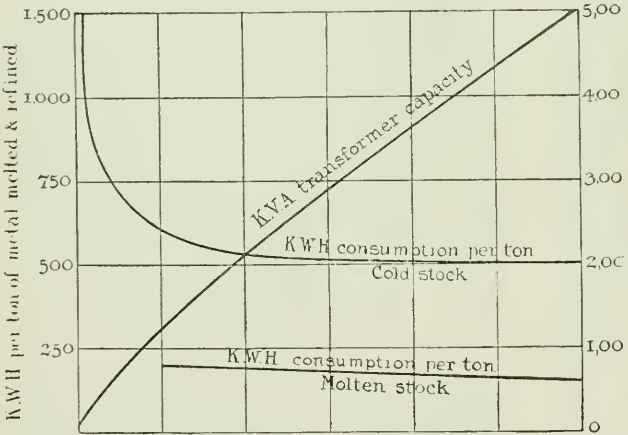

Fig. 3.

An electric furnace is frequently subjected to abnormal conditions. As far as the electrodes are concerned, the worst condition is when one arc breaks, as is so often the case. The author shows that though the primary system may not be balanced under this condition, it is quite tolerable. Another extreme case is when one of the transformers has, for some reason, to be disconnected; but even here satisfactory conditions are secured.

Energy dissipated in the hearth is so much loss, and it is therefore important to reduce both the voltage drop and the neutral current to a minimum. In this four-phase system the volume of current through the hearth is about one-quarter the arithmetical sum of that in the whole of the electrodes. In the small two-arc furnace the current density is about 3 amperes per sq. inch; but on the four-phase furnace it is only 1 ampere per sq. inch, so that the drop in voltage is less than 1 volt, and the loss of energy in the hearth with this system does not exceed 0·3 per cent.

Among the first considerations in any proposal for installing electric furnaces are the available electric power and the price at which it can be obtained. Fig. 3 shows the capacities of transformers which must be supplied for given sizes of furnaces. The capacity of the transformer required per ton decreases as the size of the furnace increases, because the radiation losses are proportionately greater in the smaller furnaces; also, the consumption of current per ton decreases as the size of furnace increases. On a well-designed furnace the power factor is in the neighbourhood of 0·8, but it is necessary to have a large reactance, say, 10 per cent. or 12 per cent., in the system to choke the unavoidable fluctuations of current in the arc. The most severe trial to which the plant can be put is when it is required to melt rough cold scrap, and when working on this duty momentary overloads of from 50 per cent. to 70 per cent. may occur, so that the transformers must be designed for such an emergency. The load factor on a single furnace working night and day is about 35 per cent., but when working two furnaces it is 50 per cent., which compares favourably with other loads on electric generating stations. It is unlikely that there will be much decrease in the consumption of current in the steel furnace of the future, since the thermal efficiency of a modern plant is about 65 per cent. Improvements will rather tend toward mechanical reliability and more durable refractories, especially for the roof. The electric furnace is practically always lined with a basic hearth, which shows it up to greater advantage in sulphurising. The average life of the roof is 100 heats, melting and refining, or about 400 working hours. During the war, when the cost of refractories was abnormally high, it was found that the average total refractories, including periodic relining, amounted to less than 8s. per ton of metal melted and refined.

Electrodes.

One of the most important items in the cost of running an electric furnace is that of electrodes, both because of their initial cost and the time lost in renewing them. In the reduction furnace the electrodes are embedded in the loose material. They are not regulated as in the steel furnace, but are simply pushed down every two or three days as they burn away. Now, on a 4,000 h.p. furnace, with electrodes 28 in. in diameter embedded, say, 6 in., the area exposed to the material is about 1,000 sq. inches. When passing 20,000 amperes the drop between an electrode and the material is about 20 volts, that is, the contact resistance is equal to 0·001 ohm. Since, in the reduction furnace, it is desirable to have as great a voltage drop between the electrodes as possible, in order to get sufficient energy into the furnace, and as the distance between them cannot be increased conveniently, the only way to increase the voltage is to increase the drop between the electrode and the material; and to do this we must decrease the contact surface, that is, the size of the electrode. We therefore require an electrode which has a greater conductivity than the carbon electrodes now being used. With carbon electrodes, when working at 40 amperes per sq. inch on the large 28-in. size, we have a voltage drop at each electrode of 20 volts, and about 40 volts in the resistance of the intermediate material, giving a total drop of 80 volts. If we had an electrode which would work at 120 amperes per sq. inch, the diameters would only be about 16 in., and the contact area about 500 sq. in., so that the electrode contact drop would be 40 volts, giving a total drop between the electrodes of 120 volts. This would mean that, for the same size of electrodes and the same current, there would be 50 per cent. more energy delivered to the furnace. Graphite electrodes will work at a density of 120 amperes per sq. inch, but, unfortunately, they have not been made, up to the present, more than 12 in. in diameter. Electric reduction furnace builders are, therefore, waiting for the graphite electrode manufacturers to turn out much larger electrodes.

The skin effect on the large carbon electrodes is detrimental and would be reduced with the smaller graphites. Also, graphite electrodes will allow of smaller holes in the roof. However, the thermal conductivity of graphite is five or six times that of amorphous carbon, whereas it has only three times the electric conductivity, so that the drainage of heat from the furnace by graphite is twice that by carbon for the same current-carrying capacity. In steel furnaces, where the resistance is simply the single arc, the surface is of no importance; the determining factor is the cost of electrodes per ton of steel.

Electric Welding: Its Theory, Practice, Application and Economics.*

By H. S. MARQUAND.

(*Continued from page* 196)

Summary—In this article the author concludes his description of various methods of preparing welds and gives some further illustrations of various kinds of work that is now undertaken. He then passes on to the economies effected by machine welding, and to the testing and strength of electric welds.

Machine Welding.

In electric arc welding, as in resistance welding, machines are only adaptable for standardised operations and repetition work. When a welder is trained and reaches a state of proficiency in arc welding, operations on standard work tends to become mechanical. Welding machines at this stage can take possession of the work, and supplement the welder, and release hand labour for work that cannot be effected by machines.

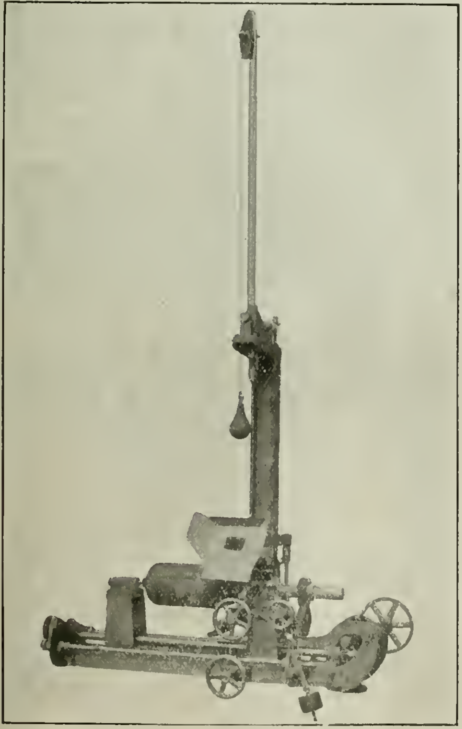

Fig. 80.

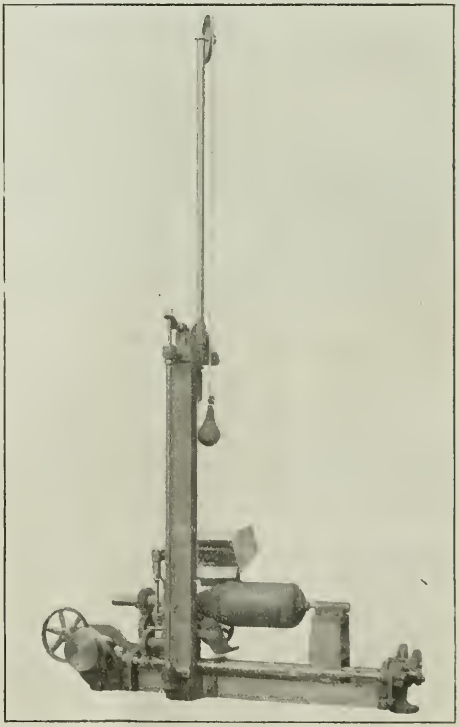

Fig 81

Machine welding has the following advantages over hand welding :—

1. Unskilled labour can be quickly taught to operate the machines efficiently, and here female labour can be employed.
2. The finished weld is more regular in appearance.
3. The homogeneity of the weld is more certain and uniform than with hand labour.

The author recently inspected a number of improved machines designed and made by Messrs. Tweedales & Smalley, in operation at their works. The machines have been extensively employed on welding aerial torpedoes and for welding together of the two hemispheres of the H. H Mines. Figs. 80 and 81 show these machines designed for the above processes. A detailed description of the machines has been published in the "Ministry of Munitions Journal" for October, 1917, and therefore it is not thought necessary to repeat the description. Suffice it to say that with these machines as a basis, it is easy to see that a machine could be designed to carry out many standard operations.

Economies of Machine Welding.

Tables I., II. and III. show the speeds of welding and the cost per foot of weld, including time, power and electrodes. The costs given in the table are all calculated on the length of weld, including all factors of operation.

On examination of these tables it will be found that :—

1. Machine welding is slower than hand welding.
2. The cost per foot is approximately the same for each method of welding on similar material.

As we have already stated, machine welding is more regular in appearance than hand welding. Numerous tests where hydraulic pressure could be applied prove that the percentage

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of leaks in the case of machine welds were considerably less than when hand welded.

However, contrasted against these advantages it will be seen that, although in the case of machine welding the cost per foot of weld almost equals that of hand welding, in the latter case the number of feet welded per hour is very much greater, consequently, in the former cases the number of feet of electrode deposited per hour is less, the power consumed is less, and the total cost per hour is less. Thus, the output per hour in the former case is considerably less than with hand welding.

Nevertheless, it is quite within the range of possibility that the machines could be speeded up in several directions, and still turn out reliable work.

Testing and Strength of Welds.

The question is sometimes asked, Can welding be correctly tested to give results of any practical value to an engineer?

The subject is a very broad and complex one. In the great majority of cases where welding is performed, the line of weld cannot be tested, and consequently there always remains the element of chance whether the repair is efficient, and will stand up to its work or fail immediately work is put upon it, or give out after a short working endurance.

For this very reason engineers in the past have been, and, indeed, a large number to-day are, suspicious of welding when the result of a failure would entail serious or costly consequences.

This attitude is not surprising when it is considered that the past record of the application of welding, taking all methods into account, has been anything but reassuring. Moreover, the technique and science of welding has been, and in the majority of cases even to-day is, little understood.

In the case of gas welding and smith's welding, the army of so-called experts has grown to a surprising figure, yet out of this huge number of professional welders in this country the writer could not pick out 1 per cent. who could prove that they were really experts and understood thoroughly the technique of their profession.

Electric arc welding suffers much in the same way, but has the additional guarantee of average efficiency in that the equipment is far too expensive in first cost and maintenance for the individual craftsman to set up on his own, and hence arc welding is mostly carried out by a company and under the supervision of trained engineers.

Nevertheless, even under these conditions, it is seldom found that the operators are fully trained and periodically tested to ensure that their work is uniform and of the highest quality.

The process of arc welding, given well-designed machinery, pure materials and expert training, is to a very great extent a more mechanical and fool-proof operation than either of its contemporary systems, yet the influence of the human element is clearly shown from results in Table IV. Each of the welds was carried out by different operators, but as exactly as possible under equal conditions of working.

The operators who made the above welds were considered good welders, though the results of the test pieces were anything but satisfactory except No. XI., which broke beyond the line of weld.

Tables V. and VI. show what can be obtained by arc welding, and are not record results, being average results obtained by operators in the writer's firm, and which form a standard of proficiency. No operator is allowed to touch important work until he can maintain this standard of competency.

Thirty-one specimens were cut off the same plate, and 30 cut into two equal halves, each 9 in. long, scarfed and welded by the metallic arc process. The unwelded specimen was tested against the welded specimens. The results for the carbon welds were obtained in the same manner. The 30 welded specimens in each case were divided into two lots of 15, the better results in one lot, and the poorest results in the other

Table I.—*Speed of Welding for Different Thicknesses of Metal.*

Method of welding.	Form of joint.	Thickness of plate.	Energy consumed.		Speed of welding. feet per hour.	Electrodes.		Feet of electrodes deposited. Per ft. of weld
			Volts.	Amps.		Size S.W.G.	Length consumed.	
Machine	Butt straight	0·120	100/110	50/60	25·50	12	42·1 ft.	1·65
Machine	Butt circular	0·120	100/110	50/60	15·90	12	37·5 ft.	2·38
Hand	Butt straight	0·120	100/110	90/95	57·50	12	90·0 ft.	1·56
Hand	Butt circular	0·120	100/110	90/95	36·40	12	51·3 ft.	1·42
Hand 1st layer	V. straight	0·315	100/110	100/110	55·00	10	80·0 ft.	1·45
Hand 1st layer	V. circular	0·315	100/110	100/110	40·60	10	51·2 ft.	1·20
Hand 2nd layer	V. straight and circular	0·315	100/110	130/140	12·25	8	33·0 ft.	2·69

See Paper, "Notes on Electric Welding," by E. Tweedale, Manchester, October, 1917. *See* Section of these Articles on Comparative Costs.

Table II—*Piecework Price Paid for Welding, Approximate Time taken and Cost of Electrodes.*

Method of welding.	Form of joint.	Thickness of plate.	Size of electrode.	Length and form of weld.	Piecework price.	Approx. time.	Length of • electrode consumed.	Price per foot of electrode.
Machine	Butt	0·120	No. 12 S.W.G.	11·5 straight	1·5d.	2·25 min.	19″	1·275d.
Machine	Butt	0·120	No. 12 S.W.G.	25·5 circular	2·0d.	8 min.	60″	1·275d.
Hand	Butt	0·120	No. 12 S.W.G.	11·5 straight	1·2d.	1 min.	18″	1·275d.
Hand	Butt	0·120	No. 12 S.W.G.	25·5 circular	2·5d.	3·5 min.	36″	1·275d.
Hand	V. 1st layer	0·315	No. 10 S.W.G.	16·5 straight	1·5d.	1·5 min.	24″	1·581d.
Hand	V. 1st layer	0·315	No. 10 S.W.G.	28·5 circular	2·5d.	3·5 min.	36″	1·581d.
Hand	V. 2nd layer	0·315	No. 8 S.W.G.	73·5 straight and circular	13d.	30 min.	198″	2·193d.

Table III.—*Feet of Weld per Unit of Power and Approximate Cost Based on Tables Nos. 1 and 2.*

Method of welding.	Size of electrode.	Kilowatt hours.	No. of feet welded.	Cost at, say, 1d. per unit.	Welder's wages.	Cost of electrodes.	Total cost.		
							Per hour.	Per ft. of weld.	
					s. d.	s. d.	s. d.		
Hand	No. 12. S.W.G.	9·660	57·50	9·660d.	6 0	9 6	16 4	3·4d.	
Hand	No. 10 S.W.G. 1st layer.	11·025	55·00	11·025d.	5 0	10 6	16 5	3·58d.	12·76d
Hand	No. 8 S.W.G. 2nd layer	14·175	12·25	14·175d.	2 2	6 0	9 1	9·18d	
Machine*	No. 12 S.W.G.	5·775	25·50	5·775d.	3 4	4 5	8 3	3·5d.	
Machine*	No. 12 S.W.G.	5·775	15·90	5·775d.	1 3	3 11	5 8	4.3d.	

* Does not include Power for Machine. *See* Section on Comparative Costs in these Articles.

lot. The average result was then taken of each 15, and recorded as the extreme latitude which would be allowed to a welder as a proof of his proficiency.

Before proceeding further with the question of testing of welds it will, perhaps, be advisable to briefly enumerate the principal defects to which a weld is usually prone.

Penetration.—One of the most prevalent defects is that of lack of penetration. This occurs in all classes of welds, and is usually caused by trying to weld with insufficient power behind the arc, by using too low a current density to properly fuse together the added electrode or filling metal and the work. On the other hand, it may be the result of not keeping the electrode (metallic) down to the work and allowing the metal to be deposited in granular form, which will cover portions of the work which is not at a fusion point.

The result is twofold. The strength of the weld is very considerably reduced and that portion of the work not properly welded constitutes a vulnerable point at which the weld will first commence to tear, and will quickly extend. Again, the bending and fatigue resisting properties of the welded joint will fall to a low figure.

These defects can be avoided by choosing the correct size of electrode or diameter of filling rod, regulating the current density to suit the electrode and the work according to the heat conductivity of the work being welded as explained in a previous section, and keeping the end of the electrode just in the molten surface and feeding down at a uniform rate.

Adhesion.—The defect of adhesion is generally produced by welding with too low a current density, or a too heavy electrode for the section of the metal in the pieces being joined. The former case deposits the metal in a too vicious form, with the result that slag or foreign matter present cannot rise to the surface as the weld proceeds, and consequently gets imprisoned in the molten bath.

Table IV.—*Mild Steel Specimens Welded with No.* 10 *S.W.G. Gauge Electrode.* 90 *Amperes.* 60 *Volts.*

Mark on specimen	Unwelded	X1	X2	X3	X4	X5
Dimensions in inches ...	1·482	0·706	1·1	1·09	1·17	1·19
Yield. Tons per sq. in.	15·52	18·700	15·5	17·02	14·75	14·28
Max. load per sq. inch .	25·44	26·400	21·3	19·68	18·75	16·70
Elongation per cent. ...	32·5	—	4·9	3·25	3·60	2·50

Table V.—*Mechanical Tests on Boiler Steel Plates Welded by the Metallic Arc Process.*

Mark on specimen..............	Unwelded	( )	(˙˙)
Original dimensions on line of weld	(A) 2·0 × 0·51	2·05 × 0·511	2·05 × 0·5111
	(B) 2·0 × 0·51	2·00 × 0·565	2·05 × 0·5411
	(C) 2·0 × 0·51	2·01 × 0·510	2·01 × 0·516
Original cross-section where fracture occurred............	1·02	1·10	1·10
Yield—			
Total load tons	16·80	20·45	...
Stress tons per sq. inch	16·47	18·61	...
Maximum load—			
Total tons....................	27·71	28·375	32·549
Stress tons per sq. inch	27·17	25·795	29·59
Contraction of area, per cent.	46·30	15·03	51·6
Elongation on 8 in.	2·52	1·74	2·13
,, p.c. in original length	30·05	18·40	24·60

Table VI.—*Mechanical Tests on Mild Steel Specimens Welded by the Benardos Arc Process.*

Mark on specimen..............	Unwelded	X	XX
Original dimensions on line of weld	(A) 2·9 × 0·509	2·02 × 0·50	2·01 × 0·51
	(B) 2·9 × 0·511	2·03 × 0·54	2·00 × 0·565
	(C) 2·9 × 0·511	2·03 × 0·51	2·01 × 0·51
Original cross-section where fracture occurred............	1·482	1·09	1·13
Yield—			
Total load, tons..............	23·00	18·55	15·80
Stress, tons per sq. inch ...	15·52	17·02	13·98
Maximum load—			
Total, tons	37·70	21·45	23·76
Stress, tons per sq. inch ...	25·44	19·68	21·03
Contraction of area, per cent.	29·76	12·00	12·73
Elongation on 8 in.	2·60	0·276	0·451
,, p.c. in original length	31·25	4·15	7·00

Even if the current density is correctly chosen, adhesion may be caused by careless workmanship by building up the weld too quickly, and by failure to keep the bath of metal in the weld perfectly free from dirt and slag.

Gas Bubbles.

We have already warned the would-be welder against troubles likely to accrue through the absorption of gas in a weld. Molten metal at the welding temperature readily absorbs gas, and hence the welder must be most careful to protect his bath of metal from the surrounding air and from gases formed during the process of welding. The point of the electrode should be kept well down to the molten metal, and fed in at a uniform and continuous rate. Each time the arc is broken and restruck, a bubble of gas tends to form, and during the interval of stoppage gas is liable to be absorbed by the hot metal, unless well protected, and tends to escape during the process of solidification, but often becomes trapped, due to the fact that the top layers solidify first.

Air bubbles in a weld very considerably affect the ultimate strength of the weld and its power to resist fatigue and vibration.

The finish of a weld is a very fair guide to determining an operator's skill without actually testing his work; for if the finish of his work is good, then very probably the interior is likewise. There are welds which are insufficiently filled. The added metal has not penetrated right through if it is a V-eed joint or a fracture; consequently the section of effective metal at the line of weld is less than the original section, with resulting decrease in strength.

Welds are sometimes hollow, or have valleys and peaks; this is generally the result of using too high a current density and the bath of molten metal has been too mobile.

A neat finish of a weld can be usually obtained by the judicious use of a light hammer while the metal is still at a red heat; but hammering should never be applied once the metal has cooled below a dull red heat.

In the case of copper and certain of its alloys, this latter precaution need not necessarily apply.

It is a good practice to briskly hammer up the weld as it proceeds. This is a most effective treatment, it increases the fatigue resisting properties of the material and gives the metal a more fibrous nature and consequently increases its tenacity. However, it has the effect on metal at a black heat of causing brittleness.

If resort is had to annealing to relieve possible internal strains set up during welding, it is worth noting that reheating above 800°F. has a detrimental effect.

Now, one must bear in mind that the majority of the defects which we have outlined are hidden in the body of the weld, and the welder himself is often ignorant of their presence. The operator therefore requires to know whether his welds are good, bad or indifferent, so that he can estimate his attempts, correct his faults, and gradually train himself up to the high state of efficiency which it is possible to obtain with the electric arc process.

In practice, of course, it is not usual, or, indeed, even practicable, to break the joint in order to measure its strength or examine its internal constitution and appearance. However, the welder can carry out trials on similar metals to those he has to work on, and submit these test pieces to the various tests.

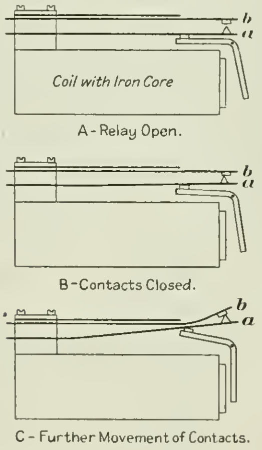
(To be continued.)

Revision of Specifications for Overhead Systems.—We notice that the National Electric Light Association in the United States contemplates the revision of its specifications bearing on overhead lines during the present year, and has sent out a request for suggestions and co-operation. The matter is of timely interest in view of the probable extension of such systems in this country.

Contacts and Contact Material.*

By H. VON FLEISCHBEIN.

It is very important with the contacts on relays that the contact should be good; in fact, any contact that is used for testing or controlling purposes, in cases where the current and voltage are relatively low, must be very certain, if any reliance is to be placed on the results. Platinum is undoubtedly the best metal, since it never oxidises under chemical or electrical action: it is, moreover, sufficiently hard, and has a very high melting point. Yet, in spite of the use of platinum, there are a good many complaints about the uncertainty of contacts. The principal causes of this seem to be that the contacts get dirty and dusty, that the contacts get burnt away, or that the contacts stick together. It is possible with great care to keep the contacts clean, and something can be done by shaping them properly. If one contact is below the other, the lower one should preferably be sharply pointed, so that dust does not tend to collect on it. If sparking can be prevented the contacts ought not to burn or stick. The spark can be entirely suppressed by placing a suitable resistance-capacity in parallel with the spark-gap, always provided that the contact is made under constant conditions—*i.e.*, that the current, voltage and rate of vibration (with vibrating contacts) remain fixed. If these things are not constant, then it is only possible to suppress the spark for some value of them, which would presumably be the mean between the extremes. It would, therefore, in the latter case depend on the conditions as to the rate at which the contacts would burn away, and a certain amount of supervision would be necessary from time to time. A much more unsatisfactory state of affairs arises when the contacts stick together by fusion or otherwise. This may arise in the following way: The spark on opening the contact causes a sharp point to form on one of the contacts; the next passage of the current through the contacts produces such a current-density in this sharp point that a certain local heating takes place, sufficient to fuse it and to weld the contacts together at the point where they touch one another. The contacts then refuse to open in consequence of this welding together. No certain method of avoiding this has yet been discovered, but the number of cases in which this arises can be notably decreased by using rubbing contacts. The effect of dust on the contacts can also be neutralised to some extent in the same way.



A - Relay Open.

B - Contacts Closed.

C - Further Movement of Contacts.

Fig. 1.

A few characteristic devices of this kind may be mentioned. In Fig. 1 is shown a contact of the kind much used in connection with telephone installations. In the position *A* the contact is open. The spring *b* is shown to be slightly stiffened on the left-hand side by a second spring, which covers the lower one to about half its length. The spring *b* will therefore tend to bend at the end rather than about the point of clamping. The lower contact *a* does the reverse, and bends along its whole length when pressed upward. The two contacts, therefore, move according to different laws, and there must consequently be a slight tendency towards a rolling movement at the instants of closing and opening the contacts. In position *B* the armature is attracted, and the springs *a* and *b* make contact with one another. In the position *C* the armature is shown to be fully attracted. Here can be seen the motion of the rubbing contact. The lower contact is noticed to pass across the face of the upper contact from left to right as the pressure between the contacts increases. The essential point to notice is that the point of contact slides, as it were. In this way the small sharp points tend to grind themselves away, and small particles of dust are removed, which would otherwise tend to form a good dielectric. And yet it has been found by experiment that, though the track of frictional contact is relatively short, it produces excellent results.

In spite of such devices, it will never be possible entirely to prevent the sticking of contacts. For years countless attempts have been made to improve contacts, and substitutes for an expensive material like platinum are much to be desired. And this last point is more than ever important nowadays, when substitutes of all kinds have become necessary. The author has lately conducted a number of tests with tungsten, and has found that it makes a very reasonably good substitute for platinum, though it can hardly be regarded as perfect. Tungsten has very peculiar properties, being very brittle at ordinary temperatures, and yet capable of being worked under the hammer at a red heat. At ordinary temperatures it is not attacked either by acids or gases. In Fig. 2 there is shown another kind of rubbing contact in connection with a vibratory movement. The experiments with tungsten were undertaken because it was found that if contacts, as shown in Fig. 2, were made of platinum, there was an occasional tendency for them to weld together, and in the case under consideration it was essential that the contacts should work steadily over continuous periods. The current passing through the contacts varied from 0·5 to 10 amperes; there were about 20 vibratory contacts per second. A condenser and resistance were placed in parallel with the spark-gap, and the spark was thus suppressed as far as possible; but in consequence of the variation of the current it was not possible to suppress the spark entirely. At first there were considerable difficulties about working the tungsten on account of its brittle character. Short pencils of tungsten 3 mm. in diameter were secured in collars, and used as contact *b* in Fig. 2. The other contact was made of platinum. At the end of six months no change could be noticed in the surface of the tungsten contact. The vibrating spring, which was made of steel, showed signs of discoloration; this was evidence of the existence of considerable temperatures. The construction was slightly altered in order to remove the heat more easily; the discoloration was not thereafter noticed. After this, communication with the tungsten laboratory at Berlin produced contacts of the metal 3 mm. in diameter and 0·5 mm. thick, welded on to small iron cylinders, and it now became possible to make the contact *a* of tungsten as well. It was then found that two contacts of tungsten worked as well as the previous ones of tungsten and platinum, in spite of the fact that for days at a time for testing purposes the current was increased to three times its previous value. A very marked arc was formed, and yet after long periods there was no essential change in the nature of the surfaces of the contacts. There was around the contacts a slight deposit of the lower oxides of tungsten, which formed after a time; but the contact surfaces themselves remained perfectly clean.

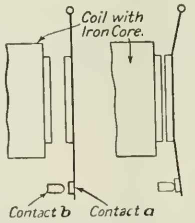


Fig. 2.—Tungsten with Vibratory Contact.

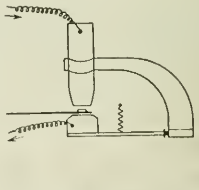


Fig. 3.—Apparatus for Welding the Tungsten Contact to its Support.

It must be admitted that these tungsten contacts, welded to an iron support, are expensive—they cost quite as much as platinum; in spite of this, it was determined to replace all the platinum contacts. At the same time attempts were made to weld the tungsten directly to its support. For this purpose the apparatus shown in

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* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 45, 1918.

Fig. 3 was used. At a red heat tungsten oxidises on the surface. At first, therefore, an atmosphere of hydrogen was used; later, carbon monoxide was tried, to which a small amount of hydrogen was added. In this way contacts 0·5 mm. thick, and varying in diameter from 1·5 to 3 mm., were welded to springs of brass, german-silver or steel. This welding requires some practice, as the current must be switched off at the right instant. Tungsten has a much higher fusing point than the metal of which the spring is made; the contact may in this way be pressed through the spring. The contacts carrying the current must be of sufficient size to prevent any dangerous heating. The current was supplied by a normal arc-lamp transformer, round the iron core of which there were several turns of stout copper wire. The terminal voltage at the free ends of this auxiliary winding varied from 5 to 10 volts. The main difficulty seems to consist in this electric welding; seeing that this can be overcome, the use of tungsten contacts may in many cases be regarded as a substantial improvement on the use of platinum. It may be mentioned that tungsten is a poor conductor; it therefore heats on the passage of current and also through the formation of the spark. It is, therefore, well not to make the contact thicker than necessary. If heavy currents pass, it may be desirable to use some sort of cooling device. The method of welding by points must be regarded as a positive advantage, inasmuch as there is no difficulty in dealing with the smallest contacts.

The Use of Impedance, Capacity and Resistance Couplings in High-Frequency Amplifiers.*

By J. SCOTT-TAGGART.

Fig. 1 shows a receiving circuit capable of good amplification and utilising a pencil-line resistance to couple the two valves together. Both valves are used as rectifiers and have leaky condensers in their grid circuits. In the case of the second valve, the "leak," which is of about 4 megohms resistance, is of necessity connected directly across grid and filament instead of across the grid condenser. The resistance R is fixed, and has a value of 75,000 ohms, which has been found to give good results. It consists of a pencil-line drawn on ebonite. If convenient, however, it should preferably be variable about that value. It will be seen that only one high-tension battery of 100 volts and one lighting accumulator is used for both valves. The telephone receivers are connected in the plate circuit of the second valve. With this arrangement oscillating potentials are set up across the resistance R having a frequency equal to the frequency of the incoming signals. At the same time there are comparatively slow pulsating voltages, due to the rectifying action of the first valve. The frequency of these pulses is equal to the spark-frequency of the transmitting station of the beat-frequency of heterodyned continuous-wave signals, as the case may be. The magnitude of this pulsating voltage across R is proportional to the square of the voltage on the grid of the valve due to incoming signals.

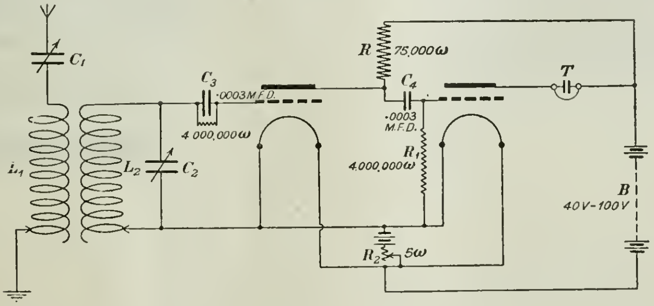

Fig. 1.

At the foot of R we have, therefore, voltage impulses of both high and low frequency, and these are communicated to the grid of the second valve, in the plate circuit of which the amplified low-frequency pulses are detected by the telephones T.

Fig. 2 is a four-valve amplifying circuit of great efficiency. We are now using three coupling resistances, each of 80,000 ohms resistance. The arrangement is simply a development of the Fig. 5 circuit. The first valve is adjusted by means of a potentiometer P and a separate rheostat R to a point on its plate and grid characteristic curve suitable for pure amplification of the oscillations taking place in the closed receiving circuit.

High-frequency pulses are produced at the foot of R_1, and are impressed on the grid of the second valve. This valve and the two remaining ones act as high and low frequency amplifiers and have leaky condensers in their grid circuits for rectification purposes. Since their functions are alike, their filament currents are controlled by a rheostat R_4, common to all; the telephones are connected in the usual way in the plate circuit of the last valve.

A very interesting and valuable effect may be obtained in circuits of this type. The strength of signals is appreciably increased by producing a reaction effect from the plate of the last valve to the grid of the first one of the series. This may be accomplished by means of a very small variable condenser, or by a very high resistance. The former method is an example of capacity reaction coupling which is frequently met with in circuits which tend to oscillate of their own accord. By increasing the value of the small variable condenser the system can usually be made to pass through the regenerative stages prior to the point of instability at which maintained oscillations establish themselves. The dotted line in Fig. 2 shows the connections. A two-way switch allows for either the use of a very small reaction condenser or a resistance variable about a mean value of 10 megohms.

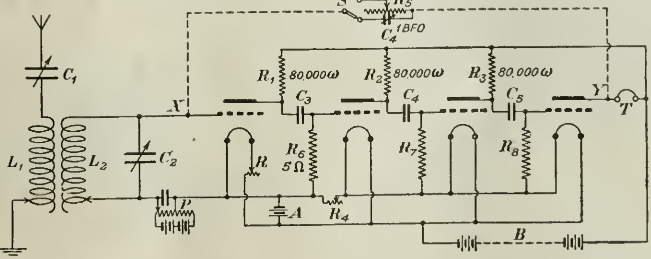

Fig. 2.

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* Extract from an article in the "Wireless World."

Heating and Cooking Notes.

Small Capacity Fires.

There is evidently a growing tendency on the part of manufacturers of electric heaters to provide small capacity fires consuming up to 1,000 watts, for use in small offices, bedrooms, bathrooms, ship's cabins and the like. In addition, such small heating units afford a useful and economical means of obtaining heat occasionally in a local area, such as in a drawing room for piano practice.

Messrs. Quead, Ltd., have produced three new patterns of small unit fires. Each fire consists of a 1-kw. standard Quead fire-bar mounted in a sheet metal frame. The first, shown in Fig. 1, is the more elaborate and most pleasing in appearance and the frames are supplied finished bright nickel, copper and satin black. An open-mesh wire guard protects the elements from accidental contact and a convenient handle contributes toward making the fire a portable device.

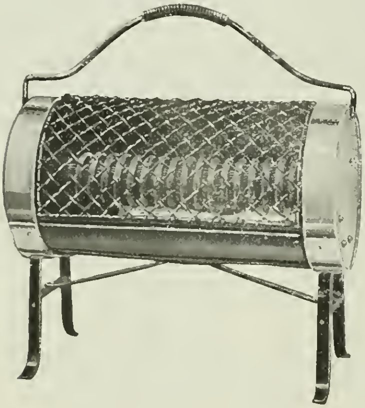

Fig. 1.—Quead Fire.

The second fire, shown in Fig. 2, was first designed to meet the requirements of consumers desiring a cheap but effective and reliable heater. The only essential difference is that the frame is of more simple design and well but plainly finished in satin black with copper end-bands and knobs. The selling price is only about two-thirds that of the first fire.

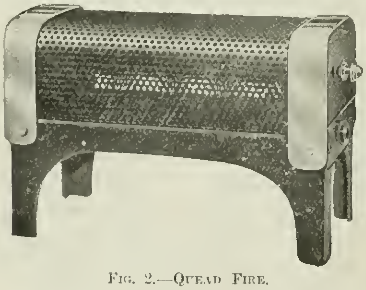

Fig. 2.—Quead Fire.

The third fire is an industrial type heater suitable for wall mounting in factories, greenhouses, cellars, lifts, &c., and is of a pattern which is becoming more or less general for this class of apparatus. The price, 22s., seems very reasonable in these days of high labour costs.

Messrs. Quead, Ltd., are also producing a number of pleasing designs of two, three and four kilowatt radiators. The original advantage of the Quead design in the form of a standardised element frame is retained in all these patterns. The elements, complete with switches and connections, are mounted on a metal frame which can be quickly removed from the main heater frame. Fig. 3 shows a Quead element frame removed from the heater.

A New Electric Iron.

There is yet another newcomer to the field of manufacturers of heating and cooking apparatus in the shape of the Rochdale Electric Company, Ltd. This firm have commenced with a six-pound electric iron, which has one or two features to justify its entry as a competitor. Special grinding and polishing plant has been installed to provide a very smooth and highly polished surface, a detail in finish which appeals to women and which has often been neglected by British manufacturers. Dome-shaped nuts are employed to secure the cover of the iron to the base another small detail which adds to the general appearance of the iron and removes the likelihood of the user scratching her knuckles on a rough screw thread. Particular care has been taken in designing the element and connections to remove any danger of a "short" occurring.

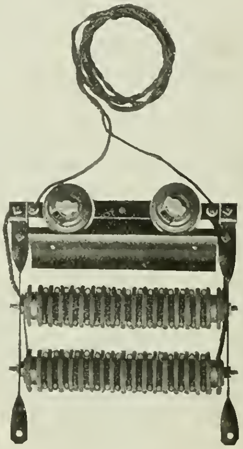

Fig. 3.—Quead Element Frame.

Hay Box Electric Cookery.

Some time back Mr. Edwards, of Twickenham, first invented a hay-box electric cooker, since which he has named it the "Quidos" oven. It formed quite an interesting and attractive exhibit at the recent British Scientific Products Exhibition. The heating element is a carbon filament lamp inserted in a lamp-holder fixed at the bottom of the oven. The oven itself is heavily lagged with a special heat insulating medium, which the inventor claims is quite fireproof at high temperatures. The sides of the door are wedge-shaped, and fit into the front end of the oven, the four sides of which are also wedge-shaped. A tube is inserted in the top of the oven and can be used either as a ventilating duct or as a means of inserting a thermometer for temperature indication. It is claimed that automatic cooking can be carried out to a nicety with this apparatus in conjunction with thermostatic control, but it remains to be seen whether the average consumer will have the patience to allow the time required for operation of such a lightly loaded oven.

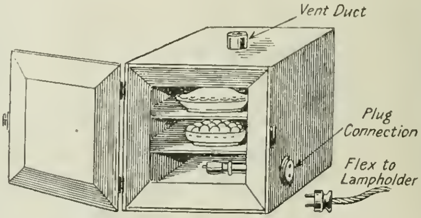

Fig. 4.—"Quidos" Hay Box Electric Oven.

Water Power.*

By Prof. MAGNUS MACLEAN.

It is little wonder that, with the termination of the war, there has developed a movement for the fuller utilisation of our latent resources. The utilisation of water-power is an instance, of interest not only as an industrial proposition, but because it affords a possible means of elevating the national life, restoring its man power and relieving congestion in large centres. Further, it has a bearing on the re-settlement of people on the land and the development of agricultural operations. The Highlands of Scotland, where the main sources of water-power in this country are located, have for many years been going out of cultivation, and there has been a continual efflux of population to the towns. For the cultivation of local industries to check this tendency, water-power, and the distribution of electricity which it makes possible, is of great importance. Strange to say, in spite of the tremendous advances in the use of power in industry, water-power is less used in the Highlands to-day than in the old days, when the north was entirely dependent upon this agency for driving its mills.

The report of the Conjoint Board of Scientific Societies has shown how greatly countries vary in the completeness with which they have utilised latent water-power resources. Germany heads the list with 43·4 per cent. of possible power used, Switzerland follows with 25·5 per cent., and the United States with 24·9 per cent. Of the 10 countries tabulated, Great Britain comes last, with only 8·3 per cent. It is instructive to look back over two Papers read by Lord Kelvin (then Sir William Thomson) in 1852 and 1881, in which he discussed the sources of natural energy available to man. Natural sources of energy may be summarised under the heading of tides, food, fuel, wind and rain. Sir Wm. Thomson showed that the conception of building vast tanks to enclose rain and enable it to be subsequently used for power generation is apparently quite impracticable; but the use of the water-power in the Highlands stands on a different footing, and Mr. A. Newlands, engineer-in-chief to the Highland Railway, has furnished me with various pamphlets and lectures which he has delivered on this subject. The project of developing these powers was discussed by him in 1914, but the intervention of the war prevented any consideration being given to the claim that in the Highlands a policy of industrial development should be associated with the Government's land policy, and that funds should be available for the development of water possibilities and power transmission. The matter, however, has since been considered by a Government Committee, and in their interim report nine possible water schemes in the Highlands were considered. It is regarded as practicable to transmit electrical energy from these various suggested water-power stations to industrial centres, such as the Clyde Valley, Edinburgh, Glasgow, &c., and it was estimated that the nine schemes might furnish at least 1,000 million units per annum within a radius of supply of 80–85 miles, which would be equivalent to a coal saving of 1·85 million tons of coal per annum.

In the Highlands such power might be used for many special industries—saw-milling, meal-milling, laundry and dye works, and for the making of yarn and woollen and tweed cloth, as well as for transport. The data relative to these nine schemes may be conveniently assembled as follows :—

Group	Scheme.	E.H.P.	Estimated cost. (£)	
			Total.	Per E.H.P. at power house.
A	Lochs Laggan, Treig	38,000	1,742,000	45·8
B	,, Ericht, Rannoch, &c.	42,000	1,580,000	37·6
C	,, Quoich, Loyne ...	27,000	1,069,000	39·5
D	,, Clunie & Morriston River	9,200	393,000	42·8
E	,, Monar	7,200	315,000	44·0
F	,, Farrar	7,600	288,000	38·0
G	,, Affric and Mullardoch	31,000	1,133,000	36·5
H	Kilmorack Falls	9,500	160,000	17·0
L	Lochs Awe, Nant	12,000	395,000	32·9
	Totals	18,350	7,075,000	38·5 av.

While in progress the schemes would afford employment for a considerable number of men, 250 on the smallest and 2,500 on the largest in the first year, and by the third year the largest scheme (B) might even be employing some 6,000 men. In addition to transmitting power to industrial centres, local industries dependent on cheap power (*e.g.*, calcium carbide or cyanamide manufacture) might be established sufficiently near to the source of power, and yet also in the vicinity of means of transport. Their effect in retarding the depopulation of these regions would be considerable. In Inverness-shire, in which most of the schemes are located, the population in 1901 was 90,105, and in 1911 87,273—*i.e.*, the diminution has still been proceeding. The rainfall in many parts of north-west Highlands is over 5 ft. per annum. Mr. Newlands, assuming an average rainfall of 42 in., and that two-thirds of this could be usefully employed, has found a total of 375,000 H.P. for a number of lochs in Caithness, Sutherland, Ross, Inverness, Perth and Argyll, excluding numerous rivers on the west coast. Some discussion has taken place regarding the industrial values of the chief rivers, the Spey and the Dee both being claimed as the most useful. The former is 100 miles long and falls 1,144 ft., the latter 90 miles long falling 4,000 ft.

Finally, I would not leave out of consideration the use of wind-power and tides. Some 150 years ago all our imports and exports were obtained by wind-power, and even 40 years ago the ratio of sailing ships to steamers was 3 : 1. It is still possible that the windmill may prove useful as a supplement to water-power in hilly countries and to coal in flat districts.

As regards the tides, a scheme for the utilisation of tidal energy in the river Severn has been seriously put forward, and is being considered by the Committee referred to previously. In general, schemes for building reservoirs to receive and release tidal water appear prohibitive in cost. There may be some places in the world where it would be advantageous to build a sea wall across a natural basin and to utilise the energy involved in filling and emptying it through sluices; but in many such cases it would probably cost little more to keep the water out altogether, and reclaim and make fertile the land in the basin. The question may, in fact, resolve itself into an inquiry whether 40 acres or the 100 H.P. theoretically obtainable therefrom are the more valuable.

In the report of the Conjoint Board of Scientific Societies comment is made on the lack of educational facilities for training young engineers in hydro-electric work. I may mention that the Royal Technical College, Glasgow, has an extensive hydraulic plant, and that this and other institutions are prepared to co-operate in the training of the hydraulic engineer. It would be too much to expect that there should be available adequate staff and equipment for such instruction on a large scale the moment that the country awakes to the need for study of this subject.

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* Abstract of a lecture delivered before the Institution of Electrical Engineers at Aberdeen.

Import Restrictions and Key Industries.

We drew attention in our issue of the 15th inst. to the fact that the existing Import Restrictions were, in our opinion, illegal and that it was desirable to place the matter on a legal basis. The Board of Trade now state that when Parliament re-assembles in the autumn legislation will be introduced (*a*) for the protection of British goods against dumping by taking power to prevent the sale in this country of similar goods beneath their price in the country of origin; (*b*) to enable the Board of Trade to check any flood of imports (*e.g.*, from Germany) that might arise from a collapse of exchange so disproportionate to costs of production in the country of origin as to enable sales to take place here at prices altogether below cost of production; and (*c*) to deal with unstable "Key" Industries. A limited number of unstable "Key" industries will be scheduled, the products of which will be prohibited from importation except on licence.

Pending legislation, a general licence under the Prohibition of Import Proclamations will be issued by the Board, having effect as from the 1st prox., and authorising the importation into the United Kingdom of all goods, except those set out in a list issued by the Board, which will be treated as unstable "Key" industries. In this list are :—

(1) All derivatives of coal tar generally known as intermediate products capable of being used or adapted for use as dye-stuffs, or of being modified or further manufactured into dye-stuffs.

(2) Synthetic drugs and perfumes and certain chemicals, analytical reagents, and various fine chemicals, including barium compounds, cerium fluoride and fluorides of other rare earth metals, molybdic acid and its salts, phosphorous oxides and halogen compounds, salts of per-acids and artificial peroxides, tungstic acid and its salts, &c.

(3) Also optical glass, including lenses, prisms and like optical devices; scientific and illuminating glassware, laboratory porcelain, scientific and optical instruments, tungsten powder and ferro-tungsten, thorium nitrate, magnetos, gauges, &c.

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Electricity in Chicago During the War.

An interesting article by Mr. L. A. Ferguson appeared recently in the "Electrical Review" (U.S.A.) upon the war services rendered by the Commonwealth Edison Company in Chicago. In a general way we are familiar with what has been done by our electricity undertakings in this country during the war; but, owing to the way in which our power supply is, generally speaking, distributed among a large number of comparatively small stations, the work that they have done does not always make such an impressive story as it would if the undertakings were much more combined. Moreover, in the public eye, one of the most common features has been an unfortunate increase in tariffs, which has been inevitable.

In the case of Chicago, on the other hand, the whole of the supply is in the hands of one company, which to some curiously minded individuals in this country will be considered a most undesirable feature. A striking diagram is given by Mr. Ferguson showing that, although the cost of food and clothing since 1915 has increased enormously, and that the cost of fuel has also risen very considerably, yet the price at which electric power is supplied has fallen since 1915, and has been about stationary from 1916 to 1918. This result, which is remarkable, has been accomplished in spite of the fact that in four of the principal departments of the Company the salaries and wages of the men have been increased by 52 per cent. during the war.

One reason why this increased economy has been possible is due to the fact that the undertaking has increased rapidly in size, and the economy of the large and more recent sets has off-set the increased costs in other directions. In the North-west station, for instance, there are 20,000 kw. vertical units and 35,000 kw. horizontal units. In this country we should consider the former units as already large, and they are certainly economical. Provided, however, that the station output is sufficient, the still larger units become quite practicable, though many of our engineers very much doubt the desirability of going to these larger sizes. Actually, the saving in Chicago has been found to be very material, and the output generated by means of the 35,000 kw. sets results in a saving of $19,000 (say £3,800) per month in operating labour over what would be required for machines of the old type. Further, there is the saving of fuel. In the larger units the water rate curve is nearly flat, and the steam consumption of one of these sets at the North-west station is on the average 10·5 lb. per kilowatt-hour. Taking into consideration the larger type of boilers now being installed, this is equivalent to 2 lb. of coal per kilowatt-hour for the larger sets, as compared with 3·13 lb. per kilowatt-hour for the older and smaller sets. These figures should receive the attention of station engineers in this country.

As regards coal, the Commonwealth Edison Company has the advantage of owning mines, so that an average saving in price of about 1s. 11d. per ton was gained, which on a large consumption means an appreciable amount.

Although the question of lamp renewals does not interest our engineers to any great extent, as we are not given to handling that part of the business, it is worth noting that before the war any customer in Chicago could secure renewal lamps, delivered to his door, within 24 hours of his request, and apparently free. With depletion of staffs this became impossible. Consequently the lamp renewal stations were increased in number to 27, so that most customers could obtain lamps by going not more than a mile. As Mr. Ferguson remarks, many people are rather thoughtless in handling lamps and demanding renewals when new lamps may be obtained by mere telephone calls; but they become much more careful when it is necessary to make a trip to a renewal station. As a result, the company saved about 600,000 lamp renewals last year. It was also decided to make a charge of about 1s. 6d. to cover the cost of calling at the customer's premises to replace fuses, &c.

Just as in this country, so in the United States, questions of finance became difficult. It is remarked that nearly 10 per cent. of the new capital is expended per year in line extensions. As new capital was not obtainable directly, it became necessary for the customer to pay for all except minor extensions. This was only a temporary expedient, as in most cases the money will be entirely refunded, but it is a device which seems to have worked extremely well.

Electricity supply in the United States is not on all fours with that of Great Britain, and, as far as war conditions are concerned, the United States were able to prepare in a way which was impossible for us, and war has been with them for a very much shorter period. Nevertheless, they have experienced some of the economic effects, and it has been necessary to adopt certain expedients to meet the changing conditions. At all times there are many interesting points in American methods, and it is worth while to see if some of these cannot be applied with advantage to our own circumstances.

Review.

Methods of Measuring Temperature. By Ezer Griffiths D.Sc. (London: Charles Griffin & Company.) Pp. xi.+176. Price 8s. 6d. net.

The precise measurement of high temperatures may be said to date from the year 1887, when Callendar published the results of his now classic research on the platinum resistance thermometer. Attempts at measurement with thermocouples had been made since Becquerel in 1830 first tried to utilise Seebeck's discovery for the purpose; yet, even in 1891, Le Chatelier, who, with Barus, may fairly claim to have popularised the method, wrote to Sir Robert Hadfield that "Je ne crois pas que mon pyromètre électrique puisse jamais etre, soit d'une façon courrante, entre les mains des ouvriers." The optical pyrometer was first devised by Le Chatelier in 1892 for use in the Hecla Steel Works, and the Féry telescope total radiation pyrometer was not invented until 1903; but since that date the practical value of these several methods has been widely appreciated, and the use of pyrometers has increased by leaps and bounds, more especially as an outcome of the needs of war. Some idea of this increase may be gathered from Sir Robert Hadfield's statement that at his works alone some 50,000 determinations of high temperatures are made each week, a task demanding the services of about 60 assistants.

In spite of this rapid growth—or perhaps, indeed, because of it—there was, until Dr. Griffiths' book appeared, only one treatise on the subject in the English language, that written by G. K. Burgess, of the Bureau of Standards, which was published in 1912 and based on an earlier volume by Le Chatelier. That that work is of outstanding merit cannot be denied, but inasmuch as it, from its very completeness, is rather bulky and to-day somewhat out of date, there was an obvious need for a compact text-book describing the latest practice and the results of the more recent high temperature researches. This gap Dr. Griffiths has set out to fill, and, as a member of the staff of the Heat Department of the National Physical Laboratory, he is obviously well qualified for the task. Moreover, let it be said at once before passing to minor criticism, that he has produced a book which will fully satisfy the demands of the industrial worker who wishes to understand, not merely the how, but also the wherefore, of the methods he is using. The book contains an account of the five chief methods of temperature measurement, which may be indicated briefly as gas, mercury, resistance, thermo-electric and radiation pyrometry. Space considerations, and possibly their rapidly lessening importance, have caused the omission of any reference to the more specialised methods (*e.g.*, those depending on fusible clays or calorimeter experiments, &c.); but rather more space might with advantage have been devoted to recording instruments.

For the first three chapters, which deal with the Fundamental Scale of Temperature, the Mercurial Thermometer (including a most interesting account of the method of testing such thermometers at the N.P.L.) and the Resistance Thermometer there can be little else but praise; albeit it is rather surprising that the author should be unaware of the latest determination by Eumorfopoulos of the sulphur boiling point (Proc. Roy. Soc., A. 90, 1914), which gives that temperature as 444·61°C. on the thermodynamic scale (the W.F.P. being 273·13°C. abs.), a result which is certainly more accurate than any of its predecessors. The later chapters, however, are not quite so satisfactory, the arrangement, and even the choice of subject matter, being open here and there to an adverse criticism, which reaches a climax when the index is arrived at—if the page and a half so headed is worthy of the name. There is a full description of the various types of built-up bridges and potentiometers used for resistance and thermo-couple work, and the chapter devoted to this latter subject contains also a good account of the methods of using the various "fixed points" available for the standardisation of thermo-couples; but there is not much information on the question of choice of thermo-couple material or on the trouble caused by inhomogeneity in the wires, and no discussion at all of the relative advantages of thermo-couples and resistance thermometers for different classes of work.

The rest of the book deals with the various aspects of radiation pyrometry and its applications, special stress being laid on the methods used for verifying the fourth power laws, on the effects of oxide films and on the emissivity of metal surfaces for light of various wave-lengths. In the section on Optical Pyrometers, absorption methods are altogether ignored, from which we may presumably conclude that they are no longer in general use; it seems hardly fair, however, to omit all reference to Le Chatelier's pioneer work. The final chapter deals with high temperature melting and boiling points, including a full description of the experiments carried out by Greenwood at the National Physical Laboratory. It is interesting to note that Lummer has shown (1913) that under a pressure of 22 atmospheres the temperature of the electric arc is about 5,700°C., as against 3,450°C. under ordinary conditions, an increase which is indicated by the theory that the arc temperature corresponds to the B.P. or sublimation temperature of carbon.

In conclusion, a word of commendation must be given to the very excellent diagrams prepared by the author's brother, and to the manner in which Messrs. Griffin have produced the book.

D. ORSON WOOD.

A Simple Derivation of the Formulae for the Resonance Curves of a Damped Vibration and Some Properties Thereof.

By BALTH. VAN DER POL, Jun., D.Sc. (Utrecht).

When in a primary oscillatory circuit, *I*, formed by a fixed capacity, inductance and resistance, a regularly spaced series of damped sinusoidal currents is set up, and if a secondary similar circuit, *II*, the capacity of which is variable, is brought in the neighbourhood of circuit *I*, so that a small magnetic coupling exists between the two circuits, a current will be induced in *II* consisting of a forced vibration having the period and damping factor of the primary current, *and* a free vibration the period and damping factor of which are the ones natural to the secondary circuit. When some thermal instrument (hot-wire ammeter, thermo-junction, thermo-galvanometer, &c.) is inserted in the secondary, and by altering the capacity of *II*, the natural frequency of *II* is varied, the R.M.S. current in *II* is found to be a maximum, as read off from the thermal instrument, when the natural frequency of the secondary is nearly equal to the natural frequency of the primary. The magnitude of the current in the secondary outside the point of resonance furnishes a valuable indication of the natural logarithmic decrements of the two circuits, and, in fact, the observation of the latter current is the usual way of measuring logarithmic decrements, for instance, in wireless telegraphy.

This method is due to V. Bjerknes,[*] who first gave the theory of it and afterwards applied it to the highly damped oscillations existing in a Hertzian radiator, and thus furnished a valuable contribution to the, at that time, much discussed question whether a single damped wave was sent out by such a radiator or rather a more or less extending continuous spectrum of continuous waves of different wave-lengths. As is now well known, it was soon discovered that both opinions were right, for a damped sinusoidal oscillation can be analysed by the aid of a Fourier integral in a continuous spectrum of oscillations of different amplitudes, the maximum amplitude having a frequency which is nearly equal to what is usually called the "frequency" of the damped oscillation. This spectrum of continuous waves could furnish a method, based on the ordinary well-known theory of alternating (undamped) currents, of calculating the R.M.S. current in the above-mentioned secondary circuit, though this method would be very complicated.

The analysis used by Bjerknes is rather involved as well, and, though the final formula is of the utmost importance in the greater part of the measurements in wireless telegraphy, the derivation of it is usually not completely given in the text books on this subject.[*]

Another (very elegant) derivation of the R.M.S. current in the secondary is given by Macku.[†] He shows that it is not necessary first to calculate the instantaneous values of the current in order to find the R.M.S. value. The final formula however, on which the actual measurements of decrements are usually based, is only valid under certain restrictions, viz.:—

(*a*) The coupling coefficient of the two circuits must be small.

(*b*) The square of the logarithmic decrements per complete period must be small in comparison with $4\pi^2$.

(*c*) The resonance curve obtained may be used, to find the decrements, for the part near the point of resonance only.

(*d*) (Usually not mentioned in the text books.) The spacing of the separate discharges, and the damping factors must be such that the former damped oscillation has fallen off nearly completely before the next one sets in. This must be the case in the secondary as well as in the primary.

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[*] V. Bjerknes, "Ann. der Phys.," 55 (1895), p. 121.

[*] It is, however, to be found in Tissot, "Les Oscillations Electriques," p. 377.

[†] "Phys. Zeitschr.," 9 (1908), p. 437.

Now, in the course of a more extensive investigation, it appeared to us that when part of these conditions and limitations are introduced at an early stage into the analysis the latter thus leads in a *very simple* way to the same result that is usually obtained only by a more (Mackû) or less (Bjerknes) general investigation and simplification afterwards of the more or less general result. The influence, however, of the coupling coefficient in the form of the resonance curve, as found by Mackû, will in the simple derivation be lost.

The condition *a*, which requires the coupling coefficient to be small, was already adopted by Bjerknes at the start of his investigation. This analysis, as already stated, is, nevertheless, of a complicated nature, and there seems to be some room for a simpler derivation of the important formula which forms the base of numerous measurements. This condition *a* can, further, always be approached experimentally as nearly as desired by using very loose couplings. In the same way the condition *d* can be satisfied experimentally by using not too high a number of discharges per second, otherwise the separate damped sinusoides in the primary and secondary would overlap.

All existing investigations into this matter apply the last-mentioned condition more or less tacitly.

It is with these two limitations (*a* and *d*) that we start our analysis, just as is done in Bjerknes' method. Up to our equations (14), however, we do not make use of the other conditions (*b* and *c*). These equations, moreover, appear to be of such a simple type that exact results could easily be obtained from them. As it is our intention to furnish as simple a derivation as possible of the final well-known formula, we shall introduce at this point the other conditions *b* and *c*, and so arrive in a straightforward way at the result required. In taking this course we obviate the necessity of solving two simultaneous differential equations with the still somewhat complicated analysis inherent to it. It will further appear that only a very limited amount of integration is necessary in order to obtain the final result; the evaluation of two definite integrals is all that is required.

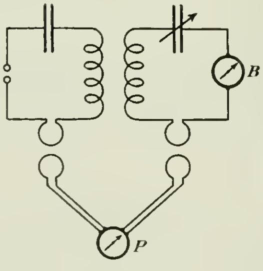

Fig. 1.

Before we expound this method, attention may first be drawn to a certain kind of resonance curve obtained theoretically, and afterwards confirmed experimentally by Mandelstam and Papalexi.* Instead of using a thermal instrument in the secondary, they coupled the two coils of a dynamometer of certain construction to the circuits *I* and *II* respectively (*see* Fig. 1). Theory and experiment then show that the deflection of this dynamometer is zero when the two circuits are in resonance, and in this way, therefore, a zero method was obtained to tune two oscillatory circuits, the advantage of which is considerable, it being independent of the fluctuations of the current. Moreover, the dynamometer deflections outside the point of resonance enable the sum of the damping factors or logarithmic decrements to be determined.

Anticipating the results, we here refer to Fig. 2. The general aspect of an ordinary resonance curve of the first type is represented by the curve *B*, the abscissæ giving the difference of the natural frequencies of the primary and secondary circuits, while the ordinates give the mean square current in *II* as approximately indicated by a thermal instrument in the secondary. $[\int_0^\infty i_2^2dt.]$ This curve has a single maximum at the point of resonance. The function this curve represents will further be called *B*. The other resonance curve (of the second type) is shown in the same figure—curve *P*. There the abscissæ give the same quantity as for the curve *B*, but the ordinates are made proportional to the deflection of the dynamometer, this being proportional to $\int_0^\infty i_1i_2dt$. The function represented by the curve *P* is seen to be zero when the primary and secondary are in tune. This function will further be called *P*. Though the two curves *B* and *P* have quite a different form, they are related by many properties, as will be shown later on.

We now proceed to the analysis of both functions *B* and *P*.

When the current in the primary circuit has the form of a series of damped oscillations the P.D. induced in the secondary during one train can be represented by $Ee^{-a_1t}\sin(\omega_1t+\varphi)$ provided condition *a* be satisfied. We therefore suppose that the coupling is made so loose that the current set up in *II* due to the variation of the current in *I* is not able in its turn to modify the current in *I*.

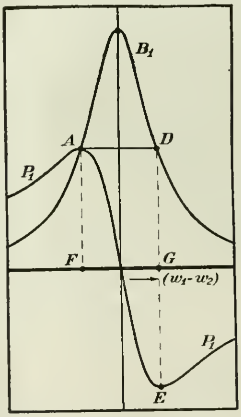

Fig. 2.

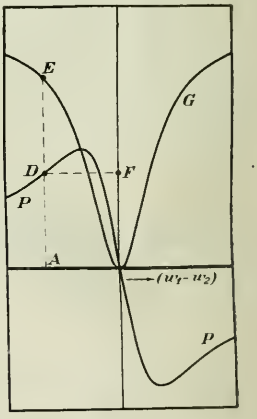

Fig. 3.

If, further, the capacity in the secondary be called *C*, the self-inductance *L* and the resistance *R*, the current i_2 in the secondary must satisfy the condition which makes the total line integral of the electric force equal to zero—viz.:

$$L\frac{di_2}{dt}+Ri_2+\frac{1}{C}\int i_2dt=Ee^{-a_1t}\sin(\omega_1t+\varphi)\quad .\ .\ .\ .\quad (1a)$$

As is seen from this equation, the impressed E.M.F. is given the most general form, with an arbitrary initial phase, φ. When, further, the natural damping factor a_2 and the natural frequency ω_2 of the secondary is introduced, we have

$$2a_2=\frac{R}{L},\quad \omega_2^2=\frac{1}{CL}.$$

(1*a*) can therefore be written

$$\frac{di_2}{dt}+2a_2i_2+\omega_2^2\int i_2dt=\frac{E}{L}e^{-a_1t}\sin(\omega_1t+\varphi)\quad .\ .\ .\ .\quad (1b)$$

The condition *d* furnishes the initial conditions that

$$\text{for } t=0:\ i_2=0 \text{ and } v_2=\int i_2dt=0\quad .\ .\ .\ .\quad (2)$$

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* "Ann. der Phys.," 33 (1910), p. 490.

If, now, in the primary, N damped oscillations are produced per second, the mean square current in the secondary will be

$$N\int_0^{\frac{1}{N}} i_2^2 dt.$$

But the condition d states that after the elapse of time $\frac{1}{N}$ no appreciable current is left in the primary *and* secondary. This allows the upper limit of the integral to be extended to infinity, since the so introduced second part of the integral, viz., $N\int_{\frac{1}{N}}^{\infty} i_2^2 dt$, contributes only a negligible amount to the total value of $N\int_0^{\infty} i_2^2 dt$. The total mean square current in the secondary to be found is, therefore, given by the latter integral. The problem is now wholly defined by the equation (1*b*) and the initial conditions (2).

It is now obvious that the total heat dissipation per second in the secondary is equal to N times the time integral takes between zero and infinity of the product of the impressed E.M.F. into the secondary current, or

$$RI_2^2 = NE\int_0^{\infty} i_2 \,.\, e^{-a_1 t}\sin(\omega_1 t+\varphi)dt,$$

no energy being stored at the instant $t=0$ in the secondary. Here I_2 means the R.M.S. current in II.

We now define two functions of t—viz., s and c—as

$$\left.\begin{aligned} s &\equiv e^{-a_1 t}\sin(\omega_1 t+\varphi) \\ \text{and}\qquad c &\equiv e^{-a_1 t}\cos(\omega_1 t+\varphi) \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The above equation can therefore be written

$$B \equiv N\int_0^{\infty} i_2^2 dt = N \,.\, \frac{E}{L} \,.\, \frac{1}{2a_2}\int_0^{\infty} i_2 s dt \quad . \quad . \quad . \quad . \quad . \quad (4)$$

This equation can further at once be found by multiplying (1*b*) by Ni_2 and integrating this product between 0 and ∞, and then applying the initial conditions (2) and the final conditions, yielded by the physical nature of the problem, that

$$\text{for } t=\infty \;:\; i_2 = \int i_2 dt = 0.$$

Since the impressed E.M.F. was taken as Es, the current i_1 in the primary, assuming the latter to vibrate in its own natural frequency, is represented by $\frac{E}{M}\int sdt$, M being the mutual inductance between the circuits. When the damping factor a_1 of the primary current is small, the current $i_1 = \frac{E}{M}\int sdt$ will very nearly be equal to

$$i_1 = -\frac{E}{M\omega_1}c,$$

and the deflection of the dynamometer coupled to both circuits is very approximately equal to

$$P \equiv N\int_0^{\infty} i_1 i_2 dt = -\frac{NE}{M\omega_1}\int_0^{\infty} i_2 c dt. \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Now, in order to find B and P, we first multiply (1*b*) with s and integrate over the time between 0 and ∞. Secondly, we multiply the same equation by c and perform a similar integration. We thus obtain

$$\int_0^{\infty} s\frac{di_2}{dt}dt + 2a_2\int_0^{\infty} si_2 dt + \omega_2^2\int_0^{\infty}\left\{\int i_2 dt\right\} sdt = \frac{E}{L}\int_0^{\infty} s^2 dt \quad . \quad (6)$$

$$\text{and} \int_0^{\infty} c\frac{di_2}{dt}dt + 2a_2\int_0^{\infty} ci_2 dt + \omega_2^2\int_0^{\infty}\left\{\int i_2 dt\right\} cdt = \frac{E}{L}\int_0^{\infty} scdt \quad . \quad (7)$$

By partial integration, bearing in mind the initial and final conditions, all six integrals occurring in the left-hand members of (6) and (7) can be reduced to the two simple forms,

$$\int_0^{\infty} si_2 dt \text{ and } \int_0^{\infty} ci_2 dt,$$

these being proportional to the functions B and P respectively to be found. The reduction is as follows:

$$\int_0^{\infty} s\frac{di_2}{dt}dt = \Big[\, si_2 \,\Big]_0^{\infty} - \int_0^{\infty} i_2\frac{ds}{dt}dt = -\int_0^{\infty} i_2\frac{ds}{dt}dt \quad . \quad . \quad (8a)$$

$$\int_0^{\infty}\left\{\int i_2 dt\right\} sdt = \int_0^{\infty} v_2 sdt = \Big[\, v_2 \int sdt \,\Big]_0^{\infty} - \int_0^{\infty} i_2\left\{\int sdt\right\} dt$$

$$= -\int_0^{\infty} i_2\left\{\int sdt\right\} dt. \quad . \quad . \quad . \quad . \quad . \quad . \quad (9a)$$

Similarly, we have

$$\int_0^{\infty} c\frac{di_2}{dt}dt = -\int_0^{\infty} i_2\frac{dc}{dt}dt \quad . \quad . \quad . \quad . \quad . \quad (8b)$$

$$\int_0^{\infty}\left\{\int i_2 dt\right\} cdt = -\int_0^{\infty} i_2\left\{\int cdt\right\} dt. \quad . \quad . \quad (9b)$$

Now the following four functions still occurring in (8) and (9) have to be reduced, viz.,

$$\frac{ds}{dt},\quad \int sdt,\quad \frac{dc}{dt},\quad \int cdt.$$

They can all four be written as algebraic functions of s and c. Referring to the definitions (3) of s and c, we find by a simple differentiation,

$$\frac{ds}{dt} = \frac{d}{dt}e^{-a_1 t}\sin(\omega_1 t+\varphi) = e^{-a_1 t}\left\{-a_1\sin(\omega_1 t+\varphi) + \omega_1\cos(\omega_1 t+\varphi)\right\},$$

which can be written as

$$\frac{ds}{dt} = -a_1 s + \omega_1 c. \quad . \quad . \quad . \quad . \quad (10a)$$

In the same way we have

$$\frac{dc}{dt} = -a_1 c - \omega_1 s. \quad . \quad . \quad . \quad . \quad . \quad (11a)$$

In order to find $\int sdt$ and $\int cdt$ it is, perhaps, the simplest way to remember that the damped oscillations s and c both obey the ordinary differential equation for damped oscillations—viz.,

$$\frac{dy}{dt} + 2a_1 y + (\omega_1^2 + a_1^2)\int ydt = 0.$$

Therefore

$$\int sdt = \frac{-2a_1 s - \frac{ds}{dt}}{\omega_1^2 + a_1^2} = \frac{-a_1 s - \omega_1 c}{\omega_1^2 + a_1^2}, \quad . \quad . \quad . \quad (10b)$$

$$\text{and}\qquad \int cdt = \frac{-2a_1 c - \frac{dc}{dt}}{\omega_1^2 + a_1^2} = \frac{-a_1 c + \omega_1 s}{\omega_1^2 + a_1^2}. \quad . \quad . \quad . \quad (11b)$$

Substituting the equations (10) and (11) thus obtained into (8) and (9), we have

$$\int_0^{\infty} s\frac{di_2}{dt} = a_1\int_0^{\infty} i_2 sdt - \omega_1\int_0^{\infty} i_2 cdt \quad . \quad . \quad . \quad . \quad . \quad . \quad (12a)$$

$$\int_0^{\infty} c\frac{di_2}{dt} = a_1\int_0^{\infty} i_2 cdt + \omega_1\int_0^{\infty} i_2 sdt \quad . \quad . \quad . \quad . \quad . \quad . \quad (13a)$$

$$\int_0^{\infty}\left\{\int i_2 dt\right\} sdt = \frac{1}{a_1^2 + \omega_1^2}\left\{a_1\int i_2 sdt + \omega_1\int i_2 cdt\right\} \quad . \quad (12b)$$

$$\int_0^{\infty}\left\{\int i_2 dt\right\} cdt = \frac{1}{a_1^2 + \omega_1^2}\left\{a_1\int i_2 cdt - \omega_1\int i_2 sdt\right\} \quad . \quad . \quad (13b)$$

And. now, finally substituting (12) and (13) in (6) and (7), we arrive at the two simple equations for $\int_0^{\infty} i_2 sdt$ and $\int_0^{\infty} i_2 cdt$

$$\left\{2a_2 + a_1\left(\frac{\omega_2^2}{\omega_1^2 + a_1^2} + 1\right)\right\}\int_0^{\infty} i_2 sdt + \left\{\omega_1\left(\frac{\omega^2_2}{\omega_1^2 + a_1^2} - 1\right)\right\}\int_0^{\infty} i_2 cdt$$

$$= \frac{E}{L}\int_0^{\infty} s^2 dt \quad . \quad . \quad (14)$$

$$\left\{2a_2 + a_1\left(\frac{\omega_2^2}{\omega_1^2 + a_1^2} - 1\right)\right\}\int_0^{\infty} i_2 cdt - \left\{\omega_1\left(\frac{\omega_2^2}{\omega_1^2 + a_1^2} - 1\right)\right\}\int_0^{\infty} i_2 sdt$$

$$= \frac{E}{L}\int_0^{\infty} scdt \quad . \quad . \quad (15)$$

The coefficients of the integrals occurring in the left-hand members of both equations are seen to be equal in absolute value. They can further be reduced by the aid of condition *b*, which is equivalent to

$$\alpha_1^2 << \omega_1^2$$
$$\text{and} \quad \alpha_2^2 << \omega_2^2.$$

The definition of ω_1, moreover, so far used for simplification of notation does not exactly correspond to the definition adopted for ω_2. The natural frequency of the *damped* oscillation in the primary was taken as ω_1: the same quantity for the secondary is, with the notation used, not ω_2, but $\sqrt{\omega_2^2 - \alpha_2^2}$. In order, therefore, to make the two definitions concordant, we shall further replace $\omega_1^2 - \alpha_1^2$ in the denominators of the coefficients in (14) and (15) by ω_1^2. When we leave the *factor* ω_1 in the second coefficients unaltered we only apply a valid approximation based on the condition *b*, which states that the damping is assumed to be so small that the change of frequency due to the resistance in the primary circuit may be neglected.

Applying this approximation to the two coefficients occurring in (14) and (15), they can respectively be reduced to

$$\left\{ 2\alpha_2 + \alpha_1 \frac{\omega_1^2 + \omega_2^2}{\omega_1^2} \right\};$$

and

$$\left\{ \frac{1}{\omega_1} (\omega_2^2 - \omega_1^2) \right\}.$$

But the limitation *c*, viz., that the curves are only to be considered near the resonance points, allows us to write in these expressions $2\omega_1^2$ instead of $\omega_1^2 + \omega_2^2$ and $2\omega_1(\omega_2 - \omega_1)$ instead of $\omega_2^2 - \omega_1^2$.

(To be concluded.)

Correspondence.

THE TECHNICAL SUPPLEMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Relying upon the traditional fairness of British technical journalism, I ask, with full confidence, space in your columns to deal with your editorial reference to the "Technical Supplement," for which I am solely responsible.

In my editorial statement published in the "Supplement" for August 19th, I have described fully its origin, organisation and aims, and to this statement I would refer those of your readers who wish to have an accurate account of a very interesting experiment. It was not a "natural process of evolution," but a scheme carefully devised in the interests of engineers, and after long experience of their needs, and pressed upon apathetic authorities.

First, let me acknowledge the tribute which you, in common with a great body of engineers and competent authorities throughout the country, pay to the usefulness of the "Technical Supplement" during the war (and we are scarcely at peace yet), and then permit me to deal with your points in detail.

1. In the editorial statement referred to I have, I hope, clearly differentiated between societies' abstracts and the work of a journal such as the "Supplement," but would add here that on the morrow of the Armistice a scheme was placed before technical societies and other bodies concerned, for the co-operative publication of abstracts, covering the whole field of engineering science, whilst avoiding the many defects of present unrelated and often conflicting efforts. Many to whom this was submitted were in favour, some apparently were not, but refrained from giving reasons, and a few so far have expressed no view either way. Had the societies united to press some such scheme (not necessarily that submitted) upon the Government, is it not conceivable that official support would have been secured, especially as the "Technical Supplement" had paved the way? But you, Mr. Editor, know as well as I do the considerations which often prevent societies effectively uniting for this and similar purposes. The document in question was never official, and is now no longer confidential. Will you print it, and let it be examined and discussed on its merits in the light of day rather than in the seclusion of council chambers and committee rooms?

2. I am rather surprised to find a competent technical journal repeating misleading statements current in the popular press. I am not concerned to defend the "Weekly Review of the Foreign Press," because I have nothing to do with it (as explained elsewhere, the "Technical Supplement," although nominally connected, is really a distinct service), but let me say at once that *not one of the* "120 *experts*" has *been, is, or would have been employed on the* "*Technical Supplement.*" It is most necessary for me to say this in the interests of those professional engineers who have been associated with me in this work, and to whose disinterested and not very generously remunerated labours during the past 18 months the engineering community owes a lasting debt of gratitude.

3. Since the taxpayer scarcely *pays* them for their work, it is only fair to the abstractors that their specially prepared abstracts, if quoted, should be acknowledged now that war conditions have ceased. The technical press has always been welcome to quote freely, and it is only ordinary courtesy to quote the source. Why do editors acknowledge, *e.g.*, the "Board of Trade Journal," which certainly *is* paid for by taxpayers?

4. There is no mysterious "campaign" to push the "Supplement"; it has stood squarely on its own merits. The circular you refer to is, I am informed, a legitimate routine action of the Stationery Office in their capacity as publishers and agents. It was never proposed, and has not been decided, to make the "Supplement" (or for that matter the "Weekly Review") a permanent War Office publication: quite the contrary, despite the newspapers! In fact, the latter have unwittingly (as usual) rendered a service in possibly accelerating a decision which removes the "Supplement" from the control (necessary during war) of the General Staff.

5. The cost of the "Supplement" is less proportionately than that of any similar publication. I speak with full knowledge of both sides. The editor and his soldier clerical assistants have received no pay at all, the work having to be done in the interval of more urgent military duties, and the only other cost, apart from printing, has been the very modest rate paid for published matter to outside engineers. Even the journals, except enemy publications, were mostly free.

You will not expect me to deal in detail with your "examples." In fairness to others, however, I must observe that electrical abstracts are almost entirely prepared by members of the staff of "Science Abstracts," and I have always been as careful not to overlap with that publication as with the "Journal" of the Society of Chemical Industry, between which and the "Supplement" cordial relations have always subsisted. It would be absurd and presumptuous for me to protest the competence of my staff, who are all engineers accustomed over long years to do this very work for the leading engineering bodies. The obvious fact is that the "Supplement" is not a specialist production; it covers the whole field of engineering science, and is not compiled exclusively for the benefit of electrical engineers or even solely for engineers. How much do "civil" engineers know of electrical engineering? During the war military considerations governed its preparation, and while I accept responsibility for verbal slips, I think it can claim to compare very fairly, despite the conditions of its compilation, with any technical journal or similar publication of much older standing. If you seriously doubt its value, ask its many readers; they would willingly pay far more than sixpence, although I do not agree with the distinguished engineer who said it was "the only good thing that came out of Whitehall!" But I have ample evidence on my files of the services it has rendered not only to the engineering industry of this country, but also to the English technical press.

I will not characterise a reference to an alleged desire to "retain positions" further than to say that the writer of that has evidently not served in the Army! Let me only add, especially on behalf of my soldier assistants, that, having done our duty, we shall be heartily glad, when the time comes, to doff khaki once and for all !—I am, &c.,

THE EDITOR OF THE "TECHNICAL SUPPLEMENT."

London, Aug. 19.

[We have pleasure in publishing the above letter, which came to hand just too late for inclusion in our last issue. It does not call for any detailed reply. The chief point we wished to emphasise was the view that the Government should not duplicate work which is already being done by various societies. As to whether the societies are working sufficiently in co-operation in their efforts is another question ; we do not think they are, and we shall be pleased (as far as our space will permit) to publish details of the scheme to which our correspondent refers if he will send them.—ED. *E.*]

COST OF STREET LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : May we say a word in regard to your comment (p. 187) on our joint report on this subject.

Your criticism to the effect that a part of the management cost should be allocated to the street lighting, in respect of the supervision of the user's installation, so to speak, seems incontestable, though it introduces an arbitrary figure, and consequently a loophole for the entrance of that suspicion of rosiness of colouring which, with you, we wish to preclude. We are indebted to you for the criticism which is noted, and which quite accords with our declared intention of charging on the basis of "cost."

Your suggestion that an addition should be made for the purpose of providing a reserve seems to us to be not quite so well reasoned. We are in favour of the provision of an adequate reserve fund ; but we look upon a reserve as merely an equalising or steadying device, a kind of accumulator battery for the purpose of smoothing out any big irregularities between the account periods, so that any necessary changes in prices may always be as small as possible. To make an addition for reserve (which would have to be a plus and minus arrangement) would be in direct conflict with the principle which we adopted of charging on the basis of the actual total cost for the account period.

We may perhaps add that our formula for the amount to be charged per kilowatt-hour is such that, if it were applied to every user, the exact amount of the total cost for the year would be received. We do not, of course, suggest its general application in this way ; it must be clearly understood that we were considering inter-departmental charges only. The formula does, nevertheless, furnish at least a preliminary test of the financial profitableness of any particular part of the output.—We are, &c ,

Peterborough, T. ROWLAND,
Aug. 25. H. G. ROWLEDGE.

[In speaking of a reserve fund, we had in mind something more comprehensive than the equalising device mentioned by our correspondents—namely, a fund to provide for obsolescence and unforeseen contingencies, which have a crippling effect if provision is not made to meet them. This is in the nature of insurance, and it is preferable to regard it as a working cost. In due time, if no call is made on the fund, the contribution ceases, and there is an item of revenue in its place.—ED. *E.*]

HIGH VOLTAGE TESTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Mr. Wedmore's letter in your issue of August 15th introduces an interesting and debatable subject.

In general, anything which alters the wave form of the applied high tension E.M.F. is objectionable ; it is no doubt with the idea of eliminating any chance of this that it is usually specified that the charging current of the apparatus as a condenser shall not exceed a definite proportion of the ratio output of the testing transformer. For the same reason a resistance in series with the primary of the testing transformer should not be used.

Should a relatively large leading current be taken from the secondary of the testing transformer, a rise in secondary voltage will probably result. This should not be objectionable if a meter is used to measure the applied voltage, and means are at hand to regulate so that it does not increase beyond the desired amount.

I do not think that objection should be taken to any high-tension test, no matter what size of testing transformer is used, provided that it can be proved that the E.M.F. wave is not distorted, and that the R.M.S. value is accurately measured.—I am, &c.,

London, Aug. 18. THOMAS MITCHELL.

Conference of Research Organisations

Dr. Fisher, M.P., presided over this conference, which was held at the Board of Education (Whitehall, S.W.) on the 29th ult. Among those present were Sir Wm. S. McCormick, LL.D., chairman of the Advisory Council, Sir Frank Heath, K.C.B., secretary to the Department of Scientific and Industrial Research; representatives of the Diesel Engine Users' Association, the British Non-Ferrous Metals, the British Motor and Allied trades, the British Refractories and the British Scientific Instrument Research Associations : also the Hon. Sir Chas. A. Parsons, K.C.B., F.R.S., Sir Geo. T. Beilby, F.R.S., Sir M. FitzMaurice, C.M.G., Prof. J. A. McClelland, F.R.S., Mr. A. P. M. Fleming, O.B.E. (British Westinghouse Company), Sir T. K. Rose (Tin and Tungsten Research Board), &c.

Sir Wm. MCCORMICK opened the proceedings in the temporary absence of Dr. Fisher, and stated that nine research associations were in being, eight had been approved by the Department and only awaited the licence of the Board of Trade, and they had another dozen for discussion. He thought it a very good record for three years, considering the novelty of the experiment and the many difficulties which had to be encountered in the formation of these associations. The reason for calling the meeting was that there were one or two matters which had cropped up, and which they thought would be very much better discussed than written about. The first was an obvious one—the formation of a Records Bureau. The second head was with regard to the conditions of employment of research workers by Research Associations. One of the great difficulties which the new Research Associations were finding was that they had not sufficient scientific workers to go round. The Department was doing its best to encourage research workers, to encourage the universities to train research workers, and by a scheme of assistance through scholarships and fellowships. But that was not all that was required. They must assure to a research worker that he would earn such emoluments as would enable him to continue a life free from financial worries. The third head, co-operation amongst Research Associations for the study of accessory materials or equipment, was one that had cropped up in the course of the work of the new Research Associations already formed. As to the fourth head, subscriptions to Research Associations, there were certain questions which also required consideration.

Mr. FLEMING, speaking on the question of the formation of a Records Bureau, said the Department had adopted the wise policy in the first place of limiting their efforts to what they could economically handle ; to make sure that their information was reliable, and also to deal with that particular part of the problem efficiently. He would have liked to see some extension of that work, which was at present to be confined to the handling of records principally from Research Associations. In addition to becoming a Records Office for the fruits of industrial research from the different associations operating as finished records, he would like also to see some attempt made to collect the side lines of research. There were very valuable data which often arose in pursuing some research to a conclusion, and which might be only incidental to the research itself—often of a very fleeting kind—and unless they were recorded in some fashion they might be lost altogether. With regard to the proposal to deal with the indirect or incidental features of information, he was a little in doubt as to the advisability of that ; provided it was confined to dealing with information from, say, overseas research organisations or research or other Government organisations, he should think it might be a very good thing, or, in fact, anywhere where the information came from possibly obscure sources, or sources not always accessible to the public, but there was a grave risk in launching out and forming a central bureau extending to work of that kind, of making it, instead of a live intelligence department, really a dead museum.

With regard to the other proposals, such as those dealing with the question of materials, by-products and so on, work of that kind was extremely desirable, but it was secondary. One of the most important aspects of the whole problem seemed to be any means which would serve to link up those persons engaged in industrial research. Both for geographical and other considerations, research workers in associations could not participate in any corporate life. He would urge that not only should means be taken to enable directors of research to come together and meet the officers of the Department, but that, as far as possible, means be devised to bring every industrial worker into contact with the big bodies of other industrial workers. He would like to see an inquirer for information brought right into contact with the man who could supply it. He was usually not necessarily the director of research, but a man further down. For a long while to come a great deal of the research in industry would be conducted more and more along lines of solving problems incidental to improving processes and methods and the toning up of efficiency generally, and the research knowledge relating to that sort of thing existed only in the minds of men, and there was very little written about it. There was one other point in the memorandum which struck him very much, and which he very cordially supported, and that was the question of education, the educative influence of any means which could be taken by the bureau in enlightening public opinion.

Major Bliss (Woollen Research Association) said there was only one library in the United Kingdom which could be regarded as at all representative, and that was the Patent Office Library. We were not in the position in which they were in Germany, of having really good technical libraries in all the provincial cities. He thought that if such a Bureau was formed provision should be made by which a reference could be sent to the Bureau and a copy of the Paper or an extract from the Paper obtained.

Mr. Beck (Scientific Instrument Makers' Research Association) stated that on the formation of his Association it was pointed out that the results of research would be retained for the benefit of its members, except in such cases where the Department might decide that it was of national importance that they should be disclosed. He would like to know the method on which the Department thought that it would be advisable to act in order to safeguard the interests of the associations who were at present disclosing a great many facts which they would not otherwise disclose. There was the further point as to what precautions would be taken to safeguard the information, thus obtained and placed in the Bureau, from getting out into the hands of competing companies of different nationalities.

Mr. Williamson (British Scientific Instrument Makers' Research Association) asked whether the expenses of the Bureau would come out of the funds of the Department, or would be provided for by a special grant in another way.

Mr. Heathcote (British Non-Ferrous Metals Research Association) said he was continually being faced with the need of reading the originals of works of research. At present it was only with the greatest difficulty that one could obtain sight of originals, and he was sure that that Bureau, if it could secure for the advantage of research workers the sight of original works would be a very great advantage.

Mr. Marlow (Boot and Shoe Research Association) pointed out that in his industry the most valuable information could be obtained from America. They found that the research associations of America had adopted the system of declining to give any information until it was two or three years old. He did not know whether there could be any interchange through the suggested Records Bureau by which they could get quicker information from America.

In reply, Sir Frank Heath stated that they had declared officially that the ownership in scientific results was that of the members of the association , the association held that property in trust for its members. Accordingly, the Records Bureau would be organised in two sections, a confidential section and a non-confidential section. They would ask research organisations in forwarding information to indicate which part of the information they considered confidential and what not confidential. Information in the confidential section of the Bureau would be communicated to nobody without agreement with the body that sent it. It might be quite easy to negotiate the transference of that information to another association on reasonable terms, but there would be no breach of confidence. He was glad to see representatives of the Research Committees and Boards of the Department, who also were often in possession of information which was confidential. That information would similarly go into the confidential section of the Bureau and be dealt with in the same way. Their intention was that the service of the Bureau should be a national service common to the whole country in so far as the country came into touch with the Department in connection with research. Beyond any grant they should make to the association, there was no proposal to make any claim on the finances of the Research Association for running this Bureau ; that would be a burden on the fund of the Department, and not on that of the Research Association. It was because the Advisory Council had felt so very strongly the danger of devoting themselves merely to the collection of the dead dry bones of knowledge that the proposals of the Bureau were so limited and so clearly defined. It would not be financed out of the million fund which was available for research associations ; they hoped to be able to persuade the Treasury to allow them to carry the burden of the Bureau upon the vote and not upon the million fund. Referring to Mr. Heathcote's question about the need for getting at original Papers, he said that they must never forget that it was a primary duty of a research association to have its own library and its own records bureau. It was not intended that the central organ should relieve the association for collecting their own information and from having their own library. At the same time, anything that the Department through the Records Bureau could do to help research associations to get a sight of scarce or rare publications they would do. He was not sure whether the Department would be more successful in getting rapid interchange with America than other organisations had been in the past. They were getting into relationship with the National Research Council in America. They were already in active intercommunication with the Bureau of Standards, and, so far as published information was concerned, the Records Bureau would have that information as rapidly as anybody. If they could break down the suspicion between firms in an industry in our own country they would have gone a very long way ; but rapid intercommunication of new knowledge between firms in different countries would take longer to establish.

(*To be concluded.*)

Patents in 1918.

According to the 36th report of the Comptroller-General, there was an appreciable increase in the number of patent applications in 1918 compared with the years 1917 and 1916.

Proceedings Under Emergency Legislation.

During the year 168 applications were made for the avoidance or suspension of patent rights. In 146 cases licences have been or will be granted, and in six cases the patents have been suspended. Of the remaining applications, one was refused, five were withdrawn or abandoned, four were not being required by reason of the patents having expired, and the rest have not yet been decided. Four applications for the avoidance or suspension of the registration of trade marks were received. One application was refused, one withdrawn and the remaining two cases were allowed to stand over.

Of the 31 applications for the grant of licences under patents vested in the Custodian under sec. 6 of Trading with the Enemy (Amendment) Act, 1916, two were withdrawn, and the remainder have been granted. During the year it was decided that the benefit of all enemy owned patents should be vested in the Custodian, and under the Trading with the Enemy (Amendment) Act, 1918. an order was made on Oct. 31, 1918. From the date of the vesting order to the end of the year five applications for licences were received ; one was returned, as the patent had expired, and in the remaining four cases licences will be granted.

The number of notifications relating to foreign patents, designs and trade marks deposited was 662, against 346 in 1917, and the fees received amounted to £82 15s.

General Business.

During the year 21,839 applications for patents were made, compared with 19,285 in 1917 and 18,602 in 1916 ; there were 15,662 provisional specifications (against 13,990 and 13,641 in 1917 and 1916 respectively), and 13,263 complete specifications (against 11,539 and 10,700). The number of patents sealed was 10,809, compared with 9,347 in 1917 and 8,424 in 1916. The applications for the registration of designs were 10,019 (compared with 13,208 and 15,399 in 1917 and 1916 respectively), and the number registered was 9,597, against 12,729 and 14,766 respectively. The trade mark applications were 6,968, compared with 5,502 and 5,837, and the registered marks numbered 3,055, against 2,744 and 2,878 respectively.

The patents fees amounted to £314,431 and the designs fees to £5,767, being increases of £22,216 and £355 over the respective amounts for 1917. The total receipts were £345,405, compared with £318,149 in 1917. The surplus of receipts over expenditure was £135,890, compared with £124,427 in 1917. The total number of persons employed by the Patent Office is 695 ; 193 of these have served or are serving with H.M. forces, and 69 were loaned to other departments. The number of readers who made use of the free library was 65,076, compared with 66,195 in 1916. The number of volumes added was 6,128, of which 298 were volumes of patent specifications or patent journals, and 2,101 were trade catalogues. The remaining 3,729 volumes were scientific text-books or periodicals, 2,361 being obtained by purchase and 1,368 by gift or exchange. The number of works in the library at the end of the year was 56,719, and the approximate number of volumes (exclusive of duplicates) was 172,600.

Fees, Etc.

There was again a large increase in renewal fees, which amounted to £232,629, against £219,693 in 1917. The number of patent applications (21,839) showed an increase of 13·2 per cent., and the number of complete specifications filed (13,263) showed an increase of 14·9 per cent. The applications received from women inventors numbered 286, compared with 253 in 1917. The applications made by way of communication from abroad numbered 787, compared with 927 in 1917. Under the provisions of the International Convention for the Protection of Industrial Property, 1,369 applications were made, against 1,661 in 1917, a decrease of 292. The number of applications post-dated in consequence of disconformity between the complete and provisional specification was 175, and the number of applications for patents of addition 428, compared with 182 and 416 respectively in 1917. The number of cases in which complete specifications were filed in respect of cognate provisional specifications was 355, compared with 366 in 1917.

Restoration and Revocation, Etc.

The number of applications made for the restoration of patents which had lapsed in consequence of non-payment of renewal fees was 23, of which nine are still pending. One application was not proceeded with, and in the remaining 13 cases the patent was restored. In 1917 there were 15 applications, 14 patents were restored, and one application was withdrawn.

There were five applications under sec. 26 for the revocation of patents ; one was withdrawn, one was out of time, in two cases orders were made requiring an amendment of the patentee's specification, and one is still pending. The number of hearings upon oppositions to the grant of patents was 57, compared with 49 in 1917. There were 13 appeals to the Law Officer, with the result that in three cases the Comptroller's decision was supported, two appeals were withdrawn and the remaining eight cases are outstanding. Of the six petitions for extension of term, four related to patents of the year 1904 and two to patents of 1905. In one case the patent was extended for seven years ; in one case the petition is being withdrawn, and the remaining cases have not yet been decided. The names of four patent agents were added to the register during the year, making the total number 238.

Fire Fighting by Floodlight.

The B.T.-H. Floodlight Projector and its various applications has already been described in the technical press. Our attention has, however, been drawn to still another way in which this projector unit can be usefully employed. A recent demonstration by the Dundee Fire Brigade Department has shown the possibilities of floodlighting as an aid to fire fighting at night. The B.T.-H. projector used in this demonstration was of the ordinary portable type, mounted on a tripod, and was fitted with a 1,000-watt Mazda half watt lamp. It was possible by its powerful beam to identify a fireman working at a height of 400 ft., and to illuminate his work.

In some cases the light of the fire provides sufficient illumination for the work of the firemen, but usually the fire brigade are compelled to work in comparative darkness, to the detriment of their salvage efforts. The B.T.-H. Floodlight Projector provides an ideal lighting unit for such conditions, because it is portable, and infinitely adjustable in the sense that its beam can be projected at a moment's notice in any desired direction. The projector could be operated from a small generator coupled to the pumping engine, or, better still, facilities for connecting to the electric mains should be provided at every fire hydrant position. The projector could also be easily connected to any electrically-lighted house in the neighbourhood, or to a street lighting standard.

Gattie's Goods Clearing House Scheme.

The Committee appointed to inquire into Mr. A. W. Gattie's scheme for improving the methods of handling goods and traffic commenced to take evidence on the 20th inst.

Sir J. Fortescue Flannery, M.P., presided, and Sir Philip Nash, Sir J. Aspinall, Mr. A.W Burgess and Mr. F. T. Hopkinson were also present.

Counsel for Mr. Gattie (Mr. W. H. Gattie) claimed that the scheme would enable the work done at 74 goods railway stations in London to be carried out at one central clearing house. The proposed goods yard would occupy an area about equal to that of Lord's Cricket Ground, and engineers had stated there were no engineering difficulties.

Mr. A. W. Gattie gave evidence on oath, and said the scheme, which had been before the public for 11 years, applied the principle of the bankers' clearing house to the business of goods transport. His system was (1) to introduce a three dimensional continuous compound movement in substitution for a one dimensional intermittent movement; and (2) to substitute electric apparatus for manual handling. He proposed to substitute one properly designed and adequately approached compact building for the 74 scattered goods stations of London. The present cumbrous arrangements required the assistance of 800 firms of carmen and carriers, and 100,000 vehicles to do the work of collection and delivery in London, but his system would require only 5,000 motor lorries. Shunting work in and near London would be almost eliminated, and the man with the hand truck would be supplanted by the electric truck, which could travel at a speed of 4½ miles an hour, and in 24 hours could probably do the work of 12 men. A goods clearing house could only be run at a profit where a large turnover of goods could be secured. The site he suggested was a tract of flat land of suitable elevation in Clerkenwell, between Goswell-road and John-street. The width of each of these thoroughfares would be increased by 100 ft. Auxiliary to each of the roads were Clerkenwell-road and Old-street, and, in addition, 26 smaller streets converged on the precincts. Six tubes (railway approaches) would link the clearing house up with the different railway systems, and as many as 300 trains a day could be dealt with. The motive power would be electricity, and a generating station might be set up on a suitable site, say at Barking. Mr. Gattie proceeded to describe the machinery, which would be capable of loading, unloading and sorting 80,000 tons of goods in 24 hours and of dealing with 3,000,000 packages. The area of the clearing-house yard would be 416,800 sq. ft., and the total available space would be over a million square feet.

In answer to Sir J. Aspinall, Mr. Gattie said elaborate precautions would be taken against fire. The building would be of steel and ferro-concrete. Special arrangements were suggested for the rapid delivery of milk churns, of fish to Billingsgate, and of other perishable goods. It was not proposed to ask any railway company to scrap rolling stock or to make any outlay as a conditon of the adoption of the scheme.

On Tuesday Mr. Gattie continued his evidence, and described the mechanism by which trays of goods would be transferred automatically from one part of the clearing house to another. Dealing with the objection that the setting up of any clearing house would lead to a strike, he said that in the suggested labour-aiding devices, he had in view an improvement in the condition of the working classes. While transport would be cheaper, there would be ample wages for the workers and good dividends for shareholders. There would be rather more than less labour employed with the machinery he proposed; it would do away with casual labour, and there would be regular work and good wages. A strike, if continued for any length of time, would starve London, but so also would a railway strike if it lasted long enough. With a well-contented staff the possibility of a strike would be remote.

He had been in communication with the engineer of the Mersey Docks and Harbour Board, and had considered the want of proper facilities for loading and unloading at some of the Liverpool docks. His impression was, from conversation, that the officials were favourable to his proposals. At the London docks the conditions were different from those on the Mersey. In the Thames there were opportunities for loading and unloading in the river which should be made use of. Docks were sources of expense and delay, which would be avoided by deep-water wharves. If the present practice of the Port Authority were persisted in, London's position as a leading port would be endangered. The methods employed in unloading were obsolete.

After answering questions as to the risk of fire owing to the use of petrol for the lorries at the clearing house, Mr. Gattie stated that the mobility of a railway waggon on the track was only 3 per cent. of its existence, and put in statistics to show that the cost of haulage of a ton of goods from Leeds to London would be only 8d., the remainder of a charge of 57s. being for collection, delivery, terminal charges, shunting and handling; a large amount of locomotive energy being wasted in shunting.

In the afternoon members of the Committee visited the works of the New Transport Company at Battersea.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1917 Specifications.

111 298 Deutsche Gasgluhlicht Akt. Ges. (Auerges.) Manufacture of incandescent electric lamps. (14 11 16.)
112,446 Chemische Fabrik Weissenstein Ges. & Walter. Diaphragms for electrolytic cells. (19/12 16.)
129,665 Wates. Electric signalling apparatus. (17 11 18.)
129,670 Fessenden & Leslie. Methods and apparatus for eliminating undesired vibrations of particular frequencies. (8/6 17.)
129,680 Yorke. Magnetic deflectors for electric arcs in lamps, searchlights and the like. (23 11/17.)
129,686 Marelli & Co. Ignition magnetos. (28 9 16.)
129,700 Marino. Spark-gap apparatus for use in wireless telegraphy. (29 11 17.)

A spark-gap apparatus is provided wherein the section for the passage of the air is not limited by the necessities of mounting, and a very large extension of the electrodes can be effected with plates of limited surface by the feature that the ridges that constitute the electrodes, which ridges may be annular, rectilinear or of any other shape, are arranged on polygonal plates assembled by means of bolts or the like situated outside the zone occupied or enclosed by the electrodes.

129,702 Cornu. Mercury vapour lamps. (5/6/17.) (Addition to 13,807 17.)

The lamp is provided with an arc-striking device comprising a bulb communicating with the highest point of the illuminating tube through the medium of a tube provided with small condensing chambers, a heating spiral traversing the arc-striking bulb being connected in series with the lamp, while the damper employed in combination with such a lamp comprises a tube inserted in the path of the mercury between the illuminating tube and the compression bulb connected to the anode, the tube of the damper being traversed by a metallic conductor which effects electrical connection between the two parts.

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

July 9, 1919.

17,142 Jones. Method of generating electricity.
17,148 Pollock. Arc welding generators.
17,150 Edwards. Electric ignition systems for engine.
17,195 B. T.-H. Co. & Wheat. Electric light fittings.
17,208 Armstrong. Method for receiving wireless signals.
17,210 Bennett & Parsons. Searchlight, &c., projectors.
17,215 Kenn. Magnetic attachment for engines, &c.
17,216 Marks. (Spardon Electrical Products Co.) Electric fire alarms.
17,228 Foster & Pocklington. Controlling electrical machinery.
17,237 Kalushika Kaisha Tsukamoto Denki Kenkyusho. Signal system for telephones.
17,243 Bazley. Electromagnetic brake.
17,247 Ashcroft. Electrolytic decomposition of anhydrous magnesium chloride and production of magnesium, &c.

July 10, 1919.

17,255 Chow. Electric hammers.
17,265 Cunliffe. Electric switch.
17,294 Brook & Hirst. Switchgear for controlling motors.
17,301 Knowles. Electric lighting systems combined with ignition systems for internal combustion engines, &c.
17,334 Townsend. Apparatus for conversion of currents.
17,335 Varley. Power interchanging and generating devices.
17,337 Redrup. Magneto electric machines.

July 11, 1919.

17,365 Stevens. Electric ignition apparatus.
17,384 Taylor. Obtaining single-phase currents from three-phase systems.
17,388 Smith. Self-regulating dynamos.
17,399 Grimaldi & Rosati. Photo-electric reproduction of sound.
17,422 Connaughton & Railing. Electric signalling apparatus.
17,424 B. T.-H. Co. & Clinker. Static electrical condensers.

Commercial Topics.

The Tube Combine.

Some further particulars are now available of the important combination of firms in the tube and conduit industry. The capital of Tube Investments, Ltd., which is to effect the combination of the interests of Accles & Pollock, Credenda Conduits Company, Simplex Conduits and Tubes, Ltd., is £1,250,000, equally divided into ordinary and 7 per cent. cumulative preference shares. In addition, Messrs. Babcock & Wilcox has acquired 100,000 shares, and its manageing director, Mr. James Kemnal, has joined the board of the new company. The shareholders of the various companies will be entitled to exchange their holdings, according to agreed basis, for shares in Tubes Investments, Ltd.

* * * *

The Athens Exhibition.

We are informed that the King of Greece has consented to open the important Exhibition of British Manufactures, which is being organised by the Federation of British Industries in Athens. It is expected that the official opening will be Sunday, Oct. 19, but the exhibits will be arranged and the Exhibition open to trade visitors on Oct. 13 (Oct. 1). Nothing approaching the Exhibition in importance and size has ever been held in Greece, and its novelty, together with the high patronage it is receiving, will make it the daily meeting place of Greek society. This should have its due effect on the business side of the Exhibition and add greatly to the opportunities of exhibitors for making acquaintances and friendships valuable in the future.

* * * *

The Polish and Rumanian Markets.

Inquiries are being made by firms in Poland for various machinery and tools, internal combustion and steam engines, electric cables, electrical supplies, mining plant, hardware, chemicals, &c. British manufacturing manufacturers should communicate with the Secretary of the Polish Commercial and Financial Agency, Commission Internationale de Ravitaillement, 88, Kingsway, London, W.C.2.

According to a report by H.M. Commercial Secretary at Bucharest, a certain amount of machinery is required for Rumanian industries, and it is satisfactory to learn that British manufacturers seem to have already realised the need. There are several representatives of British firms here to sell such goods. The needs of the railways of the country should not be overlooked. The articles in demand include industrial machinery, winches, pumps, tubes, tools, lamps, electric power plants, &c.

A correspondent, with considerable experience of Rumanian conditions, states that there is an acute lack of all electrical apparatus, from dynamos and internal combustion engines to electric fittings, and domestic telephone sets and electric bells. There is a vast amount of undeveloped water-power and there should be a good field for hydro-electric plant. Immediate requirements includes insulated wires and cables, tubing, switches, motors, transformers, metal filament lamps, telephones, electrical heating and cooking apparatus, fans, electro-medical apparatus, &c.

* * * *

Long Term Credits for Exports.

We are glad to learn that the Board of Trade is realising the importance of assisting the export trade, for it is announced that an Office will shortly be opened under management appointed by the Board for furnishing sterling credits in accordance with the scheme for assisting the exportation of goods to certain disorganised parts of Europe. The credits will be based on bills drawn in this country by the seller of the goods and accepted by the buyer, and will be subject either (*a*) to the deposit with an approved bank in the country of purchase of currency to an amount required by the office, or (*b*) to a guarantee of currency of a required amount by an approved bank, or (*c*) to arrangements for the handing over of produce of the buying country, or (*d*) to the deposit of securities with the approved bank or the office under the scheme. The Office will fix periodically the amount of currency required to be deposited per £100 sterling, and will have power to vary its charges according to the nature of each transaction. The credits will continue for such periods as the Office may determine in each case, having regard to the economic prospects of the country concerned and the character of the business, but the maximum period will be three years.

The Office will be entitled (*a*) to take over and liquidate collateral pledges, (*b*) to have recourse against the acceptor of the bill for any deficiency, and (*c*) to have recourse against the guarantor. The credits furnished will not, as a rule, exceed 80 per cent. of the prime cost of the goods sold, plus freight and insurance. In special cases, however, at the discretion of the executive, the amount may be increased, but in no case will it exceed the prime cost plus freight and insurance. If the proceeds of the bill are less than the prime cost plus freight and insurance the loss will be divided between the Office and the drawer of the bill in the proportion of four-fifths to one fifth.

Business will be taken only through banks and on the reports of banks, and the aggregate amount of credit to be granted will not exceed £26,000,000. The area and classes of goods to which the scheme relates will be settled from time to time by the Government, but credit will not be furnished either for the export of raw material or for the sale of stocks held by Government departments.

Our main objection to the present scheme is that it is somewhat vague and indefinite: no particular trade or business is specified, and it leaves too much to be settled by Government departments.

Electricity Supply.

Lye and Wollescote Urban Council will light the streets electrically in future.

Belfast Electricity Committee has increased the charges for electric current by 7½ per cent.

An approximate increase of about 15 per cent. for current is proposed by Oldham Electricity Committee.

Heywood Electricity Committee has decided to increase the charges for electric energy by another 20 per cent.

Unrest has manifested itself at Blackpool electricity works, where 80 men are out on strike for improved terms.

The public electric lighting scheme recently adopted by Annfield Plain Urban Council is estimated to cost £17,000.

Gravesend Corporation has applied to the Board of Trade to fix the legal maximum rate at 1s., instead of the existing 8d. per unit.

Woking Electric Supply Company has asked the Board of Trade to fix the minimum charge for electric current at 13s. 4d. for a consumption of 20 units per quarter.

A company with a capital of £40,000 is being organised for the purpose of establishing electricity supply works at Portadown, and already promises to subscribe £20,000 have been received.

A public inquiry has been held into the application of Downpatrick Rural Council for the powers of an urban sanitary authority in regard to the public lighting of Ballynahinch by electricity.

Peterborough City Council have asked Mr. W. M. Selvey, of Sheffield, to report to them upon the organisation and working of their electricity department and as to the suggested extensions of the generating plant.

Salford Corporation has sanctioned the following increases in the prices of electricity: Lighting, from 30 to 65 per cent. over pre-war rates; power and heating, including bulk supplies, from 50 to 90 per cent.

Thurstonland Urban Council are negotiating with the West Riding Asylums Committee as to the electric lighting of the streets, electricity to be supplied from the plant at Storthes Hall Asylum. An electrical engineer is to be asked to prepare plans to lay before the Asylums Board.

The accounts of the Croydon electricity department for the year ended March 31, 1919, show revenue £105,374, working and general expenses £74,391, gross profit £30,983 and net profit £5,981 (compared with deficit of £1,640 from previous year). Units generated were 11,080,080 (11,914,707) and sold 8,858,641 (9,437,943). Total maximum demand was 4,476 kw. (3,986 kw.).

A dispute recently arose between the Bromley (Kent) Electric Light & Power Company and one of its consumers in the Bickley district. The consumer (Mr. Douglas) obtained an interim injunction restraining the company from discontinuing the supply of electricity to his house, but subsequently the parties agreed that the interim injunction should be discharged, the company agreeing not to cut off the supply on account of an alleged debt due by plaintiff in respect of the increased charge.

The accounts of Colchester electricity department for the year ended March 31, 1919, show revenue £23,947 (compared with £23,420 in previous year), total costs £21,125 (£17,002), and gross profit £2,822 (£6,417). Interest required £1,983 (£2,070) and sinking fund and redemption £4,329 (£4,234), the net result being a deficit of £3,734 (£49). Total costs were 2·642d. (2·027d.) per unit sold. Maximum load was 1,008 kw. (1,048 kw.) and load factor 21·72d. (21·8d.) per cent. Units sold were 1,918,428 (2,012,931).

Wimbledon electricity department's accounts for the year ended March 31, 1919, show revenue £50,560 (compared with £50,211 in previous year), and working expenses £35,755 (£31,306). Interest and sinking fund required £17,828 (£18,524) and the net result was a deficit of £3,023 (compared with a surplus of £380). Average price obtained was 3·431d. (3·144d.) per unit, and total cost, including capital charges, &c., was 3·884d. (3·208d.). Units generated were 5,642,900 (5,181,030) and sold 3,310,281 (3,727,097).

Wimbledon Corporation supplies electric current in the Maldens and Coombe district, and by its order the maximum charge for lighting is 10s. up to 20 units, and 6d. for each unit over; and for power 2d. a unit. It is now proposed to ask the Board of Trade to sanction the following new charges: Lighting, 13s. 4d. up to 20 units and 8d. after; and power, 3d.

Walsall electric supply department's accounts for the year ended March 31, 1919, show revenue £56,362 (£40,252), working costs £32,440 £26,302), and net profit, after providing for capital charges, £896 (compared with a deficit of £3,998). Average price obtained was 2·19d. (1·94d.) per unit, and total cost, including capital charges, was 2·15d. (2·13d.). Maximum load was 2,800 (2,300) kw., and load factor 25·2 (24·8) per cent. Units generated were 8,734,010 (7,172,758), and sold 6,176,270 (4,991,795).

The President of the Board of Trade recently stated that a great majority of the principal Railway Companies in the United Kingdom still possess stock lighted by gas, but they concur with the inspecting officers of railways in regarding Electricity as preferable to gas for Lighting Rolling Stock, and are fitting their new carriages accordingly. A number of companies are also converting their existing stock to make it suitable for electric lighting, and considerable progress had been made with this work before it was necessarily interrupted by the war.

The revenue of the Hereford electricity undertaking for the year ended March 25, 1919, was £20,930 (compared with £17,166 in previous year), and gross profit was £3,996 (£3,180). Interest required £4,868 (£5,286) and sinking fund £7,627 (£7,627), and there was a net profit of £613 (against a deficit of £370). Total costs, including capital charges, were 1·744d. (2·12d.) per unit. Units generated were 4,850,658 (3,345,654) and sold 4,050,000 (3,043,382). Maximum load was 2,200 (1,610) kw., and load factor 21 (21·57) per cent.

In our issue of the 25th ult. we announced that MATLOCK Urban Council had been advised by Mr. H. D. Cook that there was sufficient water power available at the Bentley Brook for generating electricity for lighting the town. We are informed that this is inaccurate, as Mr. Cook has not been consulted by the Council. Mr. Hall, of Glasgow, who originated the water power scheme, has asked for the Council's support, but the members decided first of all to ascertain from the Board of Trade what the position of local authorities will be under the National Electric Supply scheme.

The revenue of the WEST HAM electricity department for the year ended March 31, 1915, was £230,741 (compared with £181,704 in 1917-18, including £4,267 (£5,994) gross profit from sales department, and, after paying expenses, gross profit was £26,227 (£21,222), or £22,145 (£16,508 after providing allowance for men on military service); and, irrespective of such allowances, there is a deficit of £20,892 (£27,688) on the year's working. Working costs, including war allowances, were 1·30d. (1·10d.) per unit, gross profit being 0·14d. (0·11d.). Maximum load was 11,450 (12,072) kw., units generated were 45,750,681 (42,856,405), and sold 38,216,253 (35,836,900).

THIRSK Parish Council recently obtained tenders for supplying electricity to 60 and 110 public lamps from the Northern Counties Electricity Supply Company. The company offered to supply current and maintain 60 lamps for £1 18s. 6d. each for six months, or 100 lamps at £1 12s. each. As the existing lamp-posts and wall brackets are out of repair and do not comply with the Board of Trade requirements, the acceptance of a tender has been postponed until the Board of Trade conditions are ascertained and until representatives of the Thirsk and Sowersby Parish Councils can confer.

Owing to the uncertainty of the coal situation, there is a marked tendency on the part of provincial local authorities and engineers to investigate the possibilities of local water powers. A case in point is that of TORRINGTON Council, which is advised by Mr. G. H. Reed, of Chagford, that a company is prepared to erect hydro-electric works provided the Council give leave to erect overhead cables, standards, &c. The scheme is estimated to cost about £5,000. A provisional agreement has been arrived at for using water-power at the Town Mills. The members of the Council have unanimously decided in favour of the principle of electric lighting.

The inhabitants of the village of HOLME (Yorks) are in a very enviable position so far as lighting is concerned, and the coal strike has no terrors for them. Situated on a hill some 3 miles above the railway station, its houses are illuminated by the electric light, and even the moorland highway leading to the woollen mill in the valley is lighted electrically. On the other hand, the gas supply in the valley is cut off at six every night, because of the coal shortage due to the Yorkshire strike. Current is supplied from a small hydro-electric plant, which was erected in 1915 by the Holme Electricity Company. The inhabitants pay 30s. per annum for the cottage lighting, which is effected by three lamps of 25 c.p. each. For four lamps the price is 28s. per year.

BIRKENHEAD Corporation is much exercised over the refusal of the Ministry of Health to sanction its extension scheme, and a resolution has been passed viewing with concern the suggestion that Birkenhead should receive electricity supplies from adjoining towns or private firms. Two large firms have been given permission to enlarge their plant to supply Birkenhead. The Corporation had had an application from a roller mill company for 6,000,000 units a year, but the company has now gone elsewhere, and at present there is an application for another 6,000,000, which it is suggested should be handed over to Wallasey Council. It is feared that the industrial development of the town will be handicapped owing to the action of the Ministry.

Owing to a dispute over the dismissal of a jointer, 13 members of the staff of the EPSOM electric supply undertaking came out on strike on Thursday night last. The jointer became a member of the staff during the war, but when the engineer and assistant engineer returned from the Army the Council decided to reduce the staff, and gave the man two months in which to look out for another position. The men contend that there is enough work for them all to do. Despite the strike, the undertaking is now maintaining a normal supply of electricity. On Friday evening, however, thewhole town was placed in darkness for a time owing to someone tampering with the feeder boxes and disconnecting the supply. The Council is determined not to re-engage the strikers.

ABERDEEN Corporation has agreed to give a supply of electrical energy to the Mugiemoss Paper works for five years, the minimum annual consumption being 400,000 units. Three-phase current will be supplied at 400 volts for power and 230 volts for lighting; the current will be metered on the low-tension side, and the Corporation will provide transformers, &c. The charge is to be £4 5s. per annum per kilowatt of the average registered maximum demand (based on monthly readings), plus a running charge of 0·59d. (less 5 per cent.) per unit. The charge of 0·59d. per unit is based on an average price of coal of 28s. 6d. per ton delivered at the electricity works, and will be increased or decreased by 0·01d. for every complete 6d. by which the average price of coal, as certified by the city electrical engineer, is higher or lower than the basis price of 28s. 6d.

Electric Traction.

A Committee of the LLANDUDNO Urban Council is negotiating with Great Orme Tramways Company for the purchase of its undertaking, and should terms be agreed upon the Council will adopt electric traction on the line.

SUNDERLAND and SOUTH SHIELDS Councils are to confer with reference to the proposal to link up the tramway services on the Tyne and Wear. It is proposed to construct a 160 ft. highway, along which a light railway will be laid.

The accounts of the CROYDON Corporation tramways department for the year ended March 31 last show traffic receipts £132,951 (increase £23,408), total revenue £136,443, and working expenses £99,377, and after providing £5,286 for war allowances the gross balance was £31,779 (increase £3,410). Average total revenue was 16·46d. per car-mile and working expenses, including power, were 11·989d. Passengers carried were 23,578,514 and car-miles run 1,989,352.

The revenue of the ROCHDALE tramways department for the year ended March 31 was £118,033 (compared with £108,472 in previous year) and working expenses were £60,711 (£56,591). Interest, &c., increased the receipts by £1,936 (£2,118), and after providing for capital charges, rent of leased lines, war bonus, &c., the net profit was £662 (£8,351). Passengers carried were 18,721,524 and car-miles run 1,533,513. Revenue per car-mile was 18·532d., and working expenses, including power, were 12·386d.

On the 21st inst. 11 demobilised soldiers were granted licences (two as drivers and nine as conductors) on the Edinburgh Corporation tramways, and Bailie Stuart, in granting the licences, regretted that "so many intelligent, respectable and physically fit demobilised soldiers seemed to be finding no more attractive occupation than that of conductors on tramcars. He was afraid that the high pay and the want of skill required was attracting men who would be better in occupations tending more directly to increased production."

The accounts of the NOTTINGHAM tramways dept. for the year ended March 31, 1919, show revenue £307,904 (compared with £238,867 in previous year), working expenses were £263,916 (£155,484), interest required £16,062 (£16,638), and repayment of capital £24,286 (£24,174), leaving £63,639 (£42,569), of which £30,000 (£16,000) has been contributed in aid of rates, and £33 639 (£26,569) carried to reserve. Average receipts per car-mile were 20·68d. (15·18d.), and expenses were 13·7d. (9·88d.). Passengers carried were 46,415,421 (52,690,881), and car-miles run 3,572,973 (3,776,275).

There is a feeling among members of ROCHDALE Council that discharged soldiers ought to be paid whilst being trained as motormen and conductors on the Corporation tramways. The Tramways Committee, however, reply that this is a matter for the Government, and point out that with application a man can become efficient after a month's training and is then able to draw a full journeyman's wage. Moreover, quite 20 per cent. of the disabled men who start training find the work too arduous and drop out after a week or two. Of the 390 employees of the tramways department no less than 22 are ex-service men, and of these 86 were in the employ of the department prior to enlistment and the remaining 138 have been trained since their discharge from service.

ABERDEEN and GLASGOW Corporations enjoy the distinction of possessing the only tramway undertakings in the kingdom which are operating with pre-war fares, but it is probable that increases will have to be made by both authorities in order to meet the increase in wages, &c. For the past year there was a net surplus of £6,836 on the Aberdeen tramways, and one-third of the surplus has been voted to the Common Good and for city improvements. Tthe receipts of the tramways department were £140,901, against £116,397 in the previous year. The working expenses were £108,451, against £76,997, leaving a gross profit of £32,450, compared with £39,400. The net profit is 44 per cent. less than for 1917-18.

The accounts of GLASGOW Tramways Department for the year ended May 31, 1919, show revenue £1,531,319 (compared with £1,412,635 in previous year) and working expenses, including war expenditure, £1,249,988 (£1,044,183), leaving net balance £14,772 (£177,552), which has been handed over to the Common Good fund. Revenue per car-mile was 14·366d. (12·912d.), and working expenses, including power, war expenses and amount spent in permanent way renewals, were 11·398d. (8·853d.). Average fare charged per mile was 0·434d. Passengers carried were 462,246,677 (430,946,566), car miles run 25,581,547 (26,261,231), and units used 39,984,597 (41,054,757). Gross capital expenditure is £3,880,299 and £3,835,156 has been repaid, while general reserve fund amounts to £31,003 and depreciation and permanent way and renewals funds to £449,005.

Negotiations are proceeding between the National Transport Workers' Federation and the Associations representing the municipal and company owned undertakings for an increase in the WAGES OF TRAMWAY EMPLOYEES, and for the war increases to be merged in permanent wages. The Federation has applied for a fresh increase of 12s. a week for all employees over 18, and 6s. for those under 18.

This fresh demand of the tramway workers, which is based on the increased cost of living, has been refused by the Tramways & Light Railways Association, but it is willing to negotiate on the question of reducing the qualifying period for payment of the maximum from seven years to six months. Though one or two municipal authorities (including Bradford Corporation) have conceded the men's terms it is probable that the Municipal Tramways Association will adopt a similar attitude.

Miscellaneous.

The members of the Three Towns Wireless Club, Plymouth, have asked the president (Major Astor, M.P.) to make representations to the Government respecting the existing restrictions on wireless telegraph research.

A fire recently occurred at a factory in Bermondsey, and, as usual, it was reported to have been caused by defective electric wires. As a matter of fact, the supply of electricity to the premises had been disconnected from the premises at least five hours before the fire took place.

The Western Telegraph Company has lodged a protest with the Argentine Government against the concession which has been granted to the Central and South American Telegraph Company to lay a submarine cable between Buenos Aires and Montevideo. The Western Company has a concession from the Government, which gives exclusive rights from 1907 for 25 years' submarine telegraphy.

On the 15th inst. the Royal Assent was read to the following (amongst other) new Acts of Parliament: Merchant Shipping (Wireless Telegraphy), Expiring Laws Continuance, Electric Lighting Order Confirmation, Tramways Orders Confirmation, Birmingham Corporation Tramways and the London Electric Railway Acts. On the 19th inst. the Royal Assent to the Clyde Valley Electrical Power Order Confirmation Act and the City and South London Railway Act was read.

The Etablissements Arbel (S.A.), 24, rue du Rocher, Paris, propose to re-establish and re-equip their steel works and rolling mills at Douai and Couzon. It is proposed to erect open-hearth furnaces of 30 tons capacity for Thomas pig iron and scrap, mechanical apparatus for handling ingots up to 60 tons, gas producers, accessories for making open-hearth steel, slabbing rolling mills for ingots of 3,000 kg., plate mill for widths up to 3 metres, rolling mill for light plates, furnaces, electric motors, overhead travelling cranes, machine tools, forging presses, &c.

The National Health Insurance Act, 1919, has received the Royal Assent, and in future employers will be required to pay Health Insurance Contributions in respect of persons employed as follows: For non-manual workers, where the remuneration (including any regular bonus, &c.) does not exceed £250 a year. For manual workers, irrespective of the rate of remuneration. A non-manual worker whose remuneration is over £160 a year, but not over £250 a year, may, within a limited period and under certain conditions, claim a certificate of exemption, and on the grant of such a certificate the employer's contributions (3d. a week) are alone payable.

Every effort is made by the General Electric Company to train the lads in their workshops and offices to become not only efficient engineers and business men, but in addition healthy and active citizens. One agency which does much to promote this object is the G.E.C. Boy Scout Troop (184 Midland), which consists of "Witton" boys. The summer camp this year was held during August holiday week at Hunstanton, the camp being pitched on the golf links adjoining the beach. Particularly favourable weather was experienced, and the 51 members who attended had an enjoyable time. A full programme of events was carried out with a maximum of success. In the intervals of ordinary camp routine there were cricket matches, athletic sports, a football match, a boxing tournament, an excursion to Sandringham, and a camp concert, which was lustily appreciated. Great credit is due to the indefatigable efforts of Scoutmaster W. Wilson for the success enjoyed.

The Court of Arbitration has made a wages award concerning Messrs. Leo Ripault & Company and the women workers employed by them. The question as to the rate of pay of the women came before the Metropolitan Munitions Tribunal on the 10th ult., and the proceedings were adjourned in order that the Court of Arbitration might determine the question. The firm are manufacturers of sparking plugs, &c., and the women are employed on turning lathes, capstan lathes, &c. Prior to May, 1919, they were paid the rate provided for under Order 546, plus 11s. a week war advance. From May 1, 1919, the firm paid a further advance of 5s. a week. It was now contended that Order No. 260 extended award No. 174 of Jan. 25, 1919 (Engineering and Allied Trades, &c., Women Workers) to all non-federated firms, who were not parties to that award, but were engaged in engineering and allied trades, and that, therefore, women of 18 years and over were entitled to the advance of 5s. a week from Jan. 1, 1919, granted under that award. The court now award that the women are entitled to the 5s. a week claimed.

Although during the war there was no break in the continuity of Messrs. Lundberg & Sons' scheme of Examinations in Electric Light Switching, unavoidable circumstances occurred which adversely affected the pre-war regularity. Chief among these was the death of Mr. W. Perren Maycock, M.I.E.E., the popular examiner of the papers sent in. His loss was keenly felt, as the success attending the scheme since its inauguration over six years ago, was largely due to his enthusiasm and conscientious work. In addition, many past and prospective examiners obeyed the call of active service. The new edition of the booklet "Lekrik Lighting Connections," which was in preparation at the time of Mr. Maycock's death, was delayed through the necessary revision and extension of the matter in the absence of the guiding hand, but the new and enlarged sixth edition of the work is now available. Mr. W. H. Bray, A.M.I.E.E., who succeeds Mr. Maycock in the examinership, is one of the most successful London teachers of electrical engineering and electrical installation work under the City and Guilds of London Institute's examination schemes. He was also closely associated with Mr. Maycock in the preparation of his later popular text-books. We have received a set of the current preliminary, intermediate and advanced papers set by Mr. Bray.

The British Industries Fair, which will be held in Birmingham in February, will have considerable interest for the electrical and allied industries, and intending exhibitors would do well to consider the question of securing space in good time. In regard to the Birmingham section the conditions obtaining are entirely different to those which govern London and Glasgow. In the latter cities, the Fair will be located in single buildings, but in Birmingham we shall come nearer to the Leipzig model, and every available building will be utilised. The organisers intend to group the various trades in one or more buildings in close proximity to one another, and thus economise time and trouble on the part of the buyer. This grouping has already been mapped out, and the allotment of space is steadily proceeding. Early application will, therefore, materially assist the Stands Committee and ensure the exhibitor's position in his group, but last-minute applications will almost inevitably entail the applicant being located apart from his recognised group. Firms interested should apply to the General Manager, British Industries Fair (Birmingham), 1920, Chamber of Commerce, Birmingham.

Educational.

Sir William Beveridge, K.C., has been appointed director of the London School of Economics.

In the engineering departments of the University of Birmingham the full courses extend over four years and lead to the degree of B.Sc. in Engineering. The Session 1919-20 will commence on Oct. 7. Facilities will be given for practical work and research, &c. Detailed syllabus may be obtained from the Secretary.

The next session of the Edinburgh University will commence on October 8, and the entrance examination will be held in September. Complete courses of instruction are provided in civil, mechanical and electrical engineering, qualifying for the B.Sc. in engineering and extending over three years. Particulars of the courses can be obtained from the Matriculation Offices of the University.

At the Bradford Technical College, diploma and part-time courses are provided by the departments of mechanical and electrical engineering in motor engineering and in power production and transmission. Courses of instruction are also provided in other branches of engineering, chemistry, textile industries, &c. The next Session commences on Sept. 22nd, and evening course registration begins on Sept. 15th.

Business Items.

Mr. W. A. Roderick, Russel-buildings, St. Mary-street, Swansea, has been appointed South Wales agent of Electrical Components, Ltd.

The specification (No. 130,805) accompanying an application (No. 13,622/18) by Messrs. T. A. Pembrey, A. Kirby and W. H. Kirby, of the Empire Welding Company, Birmingham, for letters patent for "Radiators for liquid cooling systems, transformer tanks, &c.," has been accepted.

Capt. H. J. Groves-Webb, A.M.I.E.E. (late R.E.), has just returned from France after serving since Sept., 1914, and has now joined Messrs. Johnson & Phillips, as assistant engineer, at their city office (12, Union-court, E.C.). Capt. Groves-Webb saw service in Gallipoli, Egypt, France and Belgium, at first in the ranks of the R.N. Divisional Engineers, later with R.E "Signals," while for the last year he has been in charge of extensive electrical schemes in France.

Messrs. Siemens Bros. Dynamo Works, Ltd., have issued a revised edition of the section of their catalogue (210-6) relating to "Zed" Fuses. A clear and well-illustrated description of the "Zed" fuse system, together with particulars and prices of the various patterns of fuse, and of spare gauge rings and screw caps are given. Among the special advantages claimed for the "Zed" fuses are quick and easy replacement of a "blown" fuse, perfect safety and silent operation, reliable and distinct indicating device, the gauging device prevents the use of incorrect fuses, and the fuses can be replaced by unskilled labour.

Commercial Electrical Accessories, Ltd., has been registered with a capital of £20,000, in order to carry on business as wholesale export merchants. The company, which has temporary offices at 9, Diana-place, Euston-road, N.W., has taken over the wholesale and export electrical supplies department of Messrs. Tredegars, Ltd. The chairman is Mr. H. A. Bartlett, of 56, Victoria-street, S.W., and the managing director Mr. A. W. J. Bedbrook. The new company will commence business at an early date on the assembly of electrical accessories of all kinds, especially 5-ampere polished brass tumbler switches, for which it has taken large contracts. It has also secured the agency for Fuller's No. 2 dry cell and for Cryselco electric lamps. At its new premises the company will carry large stocks of accessories, and it will have spacious show-rooms and a trade counter.

"Installation News," the house organ of Simplex Conduits, Ltd., which was suspended during the war, has resumed publication. No. I. of the new series (for August) is brightly written, and contains some interesting items of domestic news. We are reminded that this year the company comes of age, as the Simplex Steel Conduit Company, the pioneers of the conduit steel tube system of electrical installation, was established in 1898. The founders can feel justifiably proud of the part the conduit system has played in the great development of the electrical supply industry which has taken place in the 21 years of the company's existence. The number also contains a short article on "Better Conduit Wiring," and some interesting statistics regarding the great development in the use of domestic electric heating and cooking appliances in the United States, where it is stated there is a total of 5,530,000 appliances, in use, including electric irons, grills, toasters, percolators, heaters and radiators, &c.

Tenders Invited.

Croydon Corporation invite tenders by noon Sept. 1 for the construction of a cooling tower pond at the electricity works.

Salford Corporation require tenders by Sept. 1 for six top covers and vestibule ends for bogie tramcars. Particulars from the Tramways General Manager.

London County Council invite tenders by 4 p.m. Sept. 2, for four electrically drawn wagons with towers. Forms of tender, &c., from the Clerk of the Council, County Hall, Spring Gardens, S.W.1.

Annfield Plain (co. Durham) Urban Council require tenders by Sept. 12 for construction of overhead l.t. electricity distributing system for public and private purposes. Specification, &c., from the Clerk.

Tenders are required by first post Sept. 15 for six months' supply of electrical goods, ironmongery, &c., to the Cheshire County Asylum, Parkside, Macclesfield. Forms of tender from the Clerk of the Asylum.

Portsmouth Tramways Committee invite tenders for 12 months' stores, including insulating materials, lamps and motor windings, overhead line material, oils, &c. Tenders to the Town Clerk by Sept 2. Specifications from the Engineer.

Lincoln Corporation require tenders by 11 a.m. Sept 2, for the supply and erection of a 25-ton overhead electric crane for St. Swithin's power station. Specifications from Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W.1.

Ilford Urban District Council invite tenders for the supply and erection of one 500 kw. rotary converter, transformer and switchgear. Specifications from the engineer, Mr. A. H. Shaw, and tenders to clerk of the Council, Mr. Adam Partington, Town Hall, Ilford, by Sept. 8.

West Ham Corporation invite tenders for the supply of lead-covered, paper-insulated underground cables. Specifications and forms of tender from the engineer and manager, Mr. Frederick W. Purse, M.I.E.E., 84-86, Romford-road, Stratford, E.15, and tenders to the Town Clerk by 4 p.m. Sept. 9.

Grimsby Corporation invite tenders for the supply and erection of two 1,000 kw. converters and c.c. and a.c. l.t. switchgear, e.h.t. switchgear and cables ; coal and ash-handling plant and a 30-ton electrically-driven travelling crane. Specifications from the borough electrical engineer, Lieut.-Col. W. A. Vignoles, and tenders by Sept. 25.

Edinburgh Corporation invite tenders for three 10,000 k.w. turbo-alternators and six water-tube boilers. Specifications from the engineer (Mr. F. Newington), Dewar-place, and specifications and drawings may be seen at the office of Sir Alex. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders to the Town Clerk by Sept. 11.

Manchester Tramways Committee invite tenders for various stores, including permanent-way points, tongues, and hardened steel centres, wood paving blocks, ampere-hour meters, motor and controller parts, resistances, commutator segments, trolley poles, bases, wheel brushes and spindles, lamps, insulating material, carbon brushes, overhead equipment, cable, copper and steel wire, &c. Schedules from the general manager, Mr. J. M. McElroy, 55, Piccadilly, Manchester, and tenders, addressed to the Chairman of the Committee, by Sept. 2.

Appointments Vacant and Filled.

A senior lecturer in electrical engineering is required at the Woolwich Polytechnic. Salary £350, rising to £490 per annum. Applications to the Principal.

The delegacy of the City and Guilds (Engineering) College require three demonstrators in electrical engineering. Salaries £150–£200, with special bonuses of £120–£135. Applications to Prof. T. Mather, Exhibition-road, S.W.7., by Sept. 6.

Applications are invited for the position of lecturer in electrical engineering at the Aston Technical School, Birmingham. Salary £250–£300, rising to £380, exclusive of war allowances. Particulars and forms of application from the Principal.

A full time chief assistant (salary £350-£400, rising to £440) and two assistant lecturers and demonstrators in electrical engineering (£350 to £350-£440) are required at the Battersea Polytechnic, London, S.W. 11. Particulars from the Secretary.

Mechanical and electrical engineers are required in the Military Works Services of the Government of India. Salary R.750 per month. Forms of application from the Secretary, Public Works Department, India Office, Whitehall, London, S.W.1. Applications by Sept. 30.

The London County Council requires a rolling-stock engineer, a permanent way engineer, an assistant electrical engineer, a traffic operation superintendent, a traffic statistics assistant, a publicity assistant and two sub-station superintendents. Applications to the Clerk of the L.C.C. by 4 p.m. Sept. 25.

Applications are invited for the following posts at Rutherford Technical College : Head of mechanical and marine engineering department (salary £500), lecturer in mechanical engineering (£300), engineering drawing (£250), and head of mathematics and physics department (£350). Forms from the Acting Director of Education, Northumberland-road, Newcastle-on-Tyne. Applications by Sept. 8.

Mr. Harry P. Stokes, electrical engineer and manager of the Bexley Council electricity and tramways undertakings, has been appointed manager of the Plymouth Corporation tramways at £700, rising to £800 per annum. Mr. Stokes was recently offered a similar position at Doncaster, but he decided not to accept the offer.

Companies' Reports, &c.

The General Electric Company of New York has declared a quarterly dividend of 2 per cent.

An interim dividend of 1s. per share has been declared by Vickers Limited, for the half-year ended June 30.

Electro-Bleach & By-Products, Ltd., has declared an interim dividend of 3½ per cent. on the preference shares.

The directors of the Cambridge Electric Supply Company have decided not to pay an interim dividend.

The directors of the Blackpool & Fleetwood Tramroad Company announce a dividend of 4 per cent.

The directors of Clarke, Chapman & Company, Ltd., announce an interim dividend of 5 per cent. (1s. per share), less tax, on the ordinary shares.

The Para Electric Railway & Lighting Company has declared a half-yearly dividend on the ordinary shares at the rate of 6 per cent. per annum.

The net profit of Societe Anonyme Westinghouse (Paris) for 1918 was 1,475,549f., against 2,646,526f. in 1917. With 1,174,488f. from the previous year, the available total is 2,650,037f. After deduction of the legal reserve quota and of the directors' remuneration, the shareholders take 8f. per share, equal to 1,280,000f., leaving 1,242,927f. to be carried forward.

At the meeting on Wednesday it was reported that for the half-year ended June 30 the surplus of receipts over expenses of the Tyneside Tramways & Tramroads Company was £6,943, and with £2,295 brought forward the available total is £9,238. After deducting interest on debentures, loans, &c. (£1,031) the balance is £8,306. The directors propose to pay dividends on both the preference and ordinary shares at the rate of 5 per cent. per annum (less tax), to place to reserve for renewals and depreciation £2,500, and to carry forward £1,758.

The gross receipts of the North Melbourne Electric Tramways Company for the past year increased from £39,361 to £44,203, and the expenses increased from £30,429 to £33,825, due mainly to increase in wages and cost of materials. The net revenue was £10,379, against £8,932. Passengers carried numbered 3,542,092 (3,455,011), car-miles run 472,903 (482,461), consumers connected 2,626 (2,333), units sold 844,490 (647,546). Under the provisions of the Melbourne and Metropolitan Tramways Act, 1918, which came into force on Jan. 7 last, certain existing tramways undertakings in Melbourne are vested in the Tramways Board to be appointed under the Act, and no further tramways or extensions are to be constructed, except by or under the direction of the Board in pursuance of a general scheme which is to be prepared by the Board and authorised by Parliament. The company has entered into a contract with the local authorities for the public lighting of Flemington and Kensington, and the necessary installation is being proceeded with.

At the recent annual meeting of the Pernambuco Tramways & Power Company, the chairman (Mr. Follett Holt) said the year 1918 was a difficult period, owing to the exorbitant prices for fuel and all materials. The gross revenue continued to expand : it had almost doubled during the last four years. Unfortunately the high prices of fuel and stores swallowed up the whole of their gross increase last year. The total net receipts were about the same as in the previous year, and after transferring £10,229 to capital reserve, £10,000 to renewal and reserve account and £1,500 to amortisation account, the directors were able to recommend a dividend of 3½ per cent. on the preference shares. They had still to face the aftermath of war, with its labour troubles and high prices, so that they could not afford to be optimistic, but the directors were confident that the company would prove to be a successful concern when they got back to anything like normal times The Telephone Company, in which they had a substantial interest, was making good progress and gave them a return on their investment. The telephone concession required revision, and when it had taken place they would endeavour to give Pernambuco a first-class telephone service. The extension of the tramway concession by ten years was the principal change incorporated in the new contract with the Council. In order to complete their system they would require to obtain more capital. The report was adopted, and a resolution was also passed giving the directors borrowing powers to the extent of £500,000 over and above the amount at present authorised.

The 19th annual general meeting of the Soc. anon. Brown, Boveri & Company, of Baden, Switzerland, was held on the 25th inst. The net profit for the year was 11,811,689 fr. (against 11,049,838 fr. in 1917-18) and a dividend of 9 per cent. was declared, as in the previous year. Regret was expressed at the slow progress made with proposals for developing the water power in Switzerland, and the company, which was interested in war materials is not directly concerned in re-construction or transformation schemes. Prices ruled extraordinarily high for the company's products, and a rapid reduction is not to be expected for the present, as, in spite of the cheapening of some raw materials, the general level is high. Among Swiss central station and electric railway work executed by the company were orders for 28 electric locomotives. The French branch (the Cie Électro-Mécanique, of Paris) showed a considerable increase of business, necessitating the issue of 5,000,000 fr. new share capital, and a further 10,000,000 fr. debentures. The Lyons works were enlarged and the dividend was 8 per cent., as in pre-war times. The Tecnomesio Italiano, Brown, Boveri & Company, Milan, also increased its capital from 6,000,000 lire to 12,000,000 lire, and maintained its dividend at 8 per cent., the maximum permitted by the Italian laws. The German companies reduced, or will reduce, their dividends. The capital of the Norsk Elektrisk A.S., Christiania, has been raised from 2,000,000 to 4,000,000 kroner, and its dividend was maintained at 8 per cent. for the last three years. The Dutch and Spanish works and selling agencies did extremely well throughout the war. The full activity of the Belgian Company did not commence until after the evacuation of the city by the Germans. Business was quiet at the British branch (Brown, Boveri & Company, London). Pending orders are normal, but, in view of the higher working capital required owing to the general level of prices, the board proposes to increase the capital from 36,000,000 fr. to 50,000,000 fr., and to issue at an early date 12,000,000 fr. new shares.

BENN BROTHERS, LIMITED.

The 23rd annual general meeting was held on the 21st inst., Sir John Benn, Bart., D.L., J.P., L.C.C. (chairman of the company), presiding.

In moving the adoption of the directors' report the CHAIRMAN said: The accounts which are presented to you indicate the very satisfactory position in which the company finds itself at the end of a year which has been in part a war-time and in part a peace-time year. The profits available for distribution have increased very slightly over the figures presented to you a year ago, and our reputation for steady progress is thus maintained. This figure, however, gives no indication of the very considerable extra strain which has been placed upon the directors and the staff by the very remarkable growth of the business during the year under review. More particularly in the latter part of the year the increases in expenses and in revenue have been altogether phenomenal. As you have noticed, we have published issues of all our papers which, measured by size or circulation or advertisements, have beaten every record. In normal times such an expansion of our business would have meant a very considerable accession to the divisible profits of the company, but the times through which we have just passed are so thoroughly abnormal that the profits resulting from this extra business are to some extent disappointing. Nevertheless, it is extremely satisfactory to know that the turnover of the company is more than double what it was a few years ago, and that our position is in that way immensely stronger. It will, of course, be the endeavour of the directors to maintain and still further improve revenues, while at the same time exercising the utmost vigilance to bring expenses within reasonable limits.

"Bureaucratic Repression"

When the Armistice was signed in November last your directors looked forward with considerable thankfulness and relief to a period during which they would be able to carry on business in conformity with the unfettered traditions of British industry. The newspaper business had for four and a half years suffered to an extent possibly greater than most from Government interference and bureaucratic repression. So long as the war lasted the directors and the shareholders of this company were content to know that, however unwise the restrictions imposed upon them appeared to be, the imposition was at all events prompted by a desire to secure victory for our national cause. After eight months of peace it is, therefore, with a feeling not only of annoyance, but of astonishment, that I have to report to the shareholders that the peaceful and proper development of their business is still rendered very difficult if not impossible, by the continuance of a system of bureaucratic interference which completely thwarts the resumption of business upon normal lines. The trade paper is an essential part of the machinery of production and exchange, and so long as the smooth running of that machinery is rendered impossible by official ignorance or stupidity, it is useless to expect either trade or the trade paper to render their proper services to the community.

Growth of Advertising Revenue.

I have referred to the growth of our advertising revenues, and this is, of course, the most satisfactory feature of our report. This growth has been secured by a staff which is still depleted, and arises, therefore, not from any forcing process on our part, but from a general recognition among manufacturers and wholesalers of the enormous power of the trade Press as an agency for industrial progress. The war may be said to have opened the eyes of large numbers of British traders who were hitherto backward in this respect. We have not yet reached the stage when advertising by business houses is so general or so liberal as in America, but we are a good deal nearer to that condition than we were in 1914.

After referring to a point raised by the income tax authorities, Sir John said that since the war ended, and in the last few months, two new weekly papers had been successfully launched on their careers. "Ways and Means" was to some extent the outcome of the public work which had been done by their managing director in connection with the Whitley report, and after some 17 weeks' publication it was already possible to pronounce it a marked success. The enormous impetus which had been given to the chemical industry during the last few years needed the assistance of a technical paper to help it through the coming critical days. "The Chemical Age" had been received with open arms by the progressive side of the chemical industry, and they looked to it as one of their most important ventures.

True Aims of Industry.

The future of our company depends upon the future of British trade generally, and notwithstanding the many clouds that still darken the horizon I am a confirmed optimist. With a working population thoroughly alive to its powers and its responsibilities, coupled with an employing class rapidly awakening to a sense of the true aims and real purposes of industry, this great Empire will, I believe, resume its high function of leader in all that makes for progress and world happiness.

The report and accounts were adopted, and a dividend was declared upon the ordinary share capital at the rate of 15 per cent. per annum.

New Companies.

ALTON BATTERY COMPANY, LTD. (158,082.)—Private company; reg. Aug. 20, capital £20,000 in £1 shares (7,500 preference), to acquire freehold factory premises at Alton, Hants., from J. W. Williams and C. C. Rattey, and to carry on the business of mechanical and electrical or automobile engineers, &c. Directors, J. W. Williams and C. C. Rattey (both permanent).

BRITISH AMERICAN INDUSTRIES, LTD. (157,865).—Private company. Reg. Aug. 12, capital £10,000 in £1 shares. Objects: To carry on the business of vendors, dealers, factors and manufacturers of motor vehicles, aircraft, electrical apparatus and their component parts, manufacturers of and dealers in metal, celluloid, ebonite, glass, rubber, &c. First directors are A. S. F. Morris (chairman), F. J. Gordon, H. C. Adam and W. S. Wilkins. Reg. office: 75, Curtain-road, E.C.

BRITISH ELECTRICAL & ENGINEERING COMPANY (OF CHINA), LTD. (158,044.)—Private company, reg. Aug. 19, capital £30,000 in £1 shares. Objects, to carry on in China or elsewhere the business of commission, commercial and general agents, contractors, merchants, importers, exporters, manufacturers, electrical and general engineers, &c. The subscribers (each with one share) are A. E. Salmon, company secretary, and Brig.-Gen. C. H. Whittington, who will appoint the first directors.

CONSTANT SPEED SPRING COMPANY, LTD. (157,929).—Private company. Reg. Aug. 14, capital £1,500 in £1 shares. Objects: To carry on the business of founders, wire drawers, mechanical, wireless, electrical and mining engineers, manufacturers of and dealers in automobiles, &c. First directors are M. M. Gillespie, H. T. Harrison and H. B. Collins. The British Electric Equipment Company, Ltd., may, while holding any shares, appoint three directors, of whom M. M. Gillespie shall be the first. Reg. office: Amberley House, Norfolk-street, W.C.

Company Registered outside United Kingdom.

INTERNATIONAL GENERAL ELECTRIC COMPANY (INC.) (17,31 F).—Particulars were filed July 12, 1919, pursuant to Sec. 274 of the Companies (Consolidation) Act, 1908. Company was incorporated in New York on Jan. 17, 1919, for the purpose of manufacturing, exporting, importing and dealing in electrical and other goods, &c. Capital is $20,000,000 in $10,000,000 7 per cent. cumulative preferred and $10,000,000 common stock. British address is 83, Cannon-street, E.C., where W. C. Lusk is authorised to accept service of process and notices on behalf of company.

Prices of Metals, Chemicals, &c.

		Tuesday, Aug. 26.		
		Price.	Inc.	Dec.
Copper—				
Best selected	per ton	£109 0 0	—	—
Electrolytic bars	,,	£120 0 0	£2	—
H.C. wire, basis	per lb.	1s. 3$\frac{15}{16}$d.	$\frac{1}{4}$d.	—
Sheet	per lb.	1s. 3$\frac{11}{16}$d.	$\frac{7}{16}$d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	per lb.	1s. 4$\frac{11}{16}$d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 10$\frac{15}{16}$d.	—	$\frac{1}{16}$d.
Sheet, basis	,,	1s. 2$\frac{3}{8}$d.	—	—
Wire, basis	,,	1s. 2$\frac{1}{4}$d.	—	—
Pig Iron—				
Cleveland warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	£33 10 0	—	—
Lead Pig—				
English	,,	26 0 0	—	—
Foreign or colonial	,,	25 10 0	1 7 6	2s. 6d.
Tin—Ingot	,,	273 0 0	10 0 0	—
Wire, basis	per lb.	0 3 4$\frac{5}{8}$	$\frac{1}{8}$d.	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £21.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £43.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6$\frac{3}{4}$d.

Shellac.—485s. October delivery 490s.

Rubber.—Para fine, 2s. 5$\frac{3}{4}$d.: plantation grades, 1s. 11$\frac{1}{2}$d. lb

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W.T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From The Electrician, Aug. 26, 1882.]

The Telephone in the Barbadoes.—"The telephone service is being rapidly extended in Bridgetown, most of the mercantile offices being now in connection with the Exchange," says the "Colonies and India."

Electrical Exhibition at Munich.—We would remind any of our readers who may be holiday making on the Continent during the ensiung month that the Munich Electrical Exhibition opens on the 16th September.

The Crystal Palace Exhibition.—According to the "Journal of Gas Lighting" the amount already subscribed by various gas companies to help to defray the expenses of the gas interests at the forthcoming Exhibition of Gas and Electric Lighting, to be held at the Crystal Palace, amounts to £1,851. 6s.

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Notes.

Department of Scientific and Industrial Research.

ELSEWHERE we give some account of the annual report of the Committee of the Privy Council for Scientific and Industrial Research. It is a somewhat lengthy report, and indeed we think that many readers will regard it as more lengthy than is necessary. It deals to a large extent with researches carried out by various Government Departments or Government Committees which have been very necessary during the war, but at the present time what is required is research in very different directions. What may be regarded as the contentious parts of the report come near the end under the heading, for example, of "Aided Research." A reference is made to the Electrical Research Committee, with which the Institution of Electrical Engineers is connected. The Department are hopeful that an Electrical Research Association will be formed as a result of the work now in progress, but we gather that the Institution prefer their present arrangements. In any case, it appears that the Department is only prepared to give temporary assistance unless the official course is followed. We do not understand why this attitude is adopted. The main thing is to secure research, and if the scheme adopted by the Institution gives greater elasticity and better results it should remain, and not be superseded by some other organisation of an official character. In regard to societies generally, we are glad to note that the Department is giving assistance more liberally than we had in mind, and at the present time over £16,000 per annum is being given in grants to scientific and technical societies for research. This point was made in the report in order to meet the criticism that aid should be given far more freely than at present to trade associations. The Department are of opinion that societies are not well qualified to deal with funds, owing to their organisations, which are usually rather limited. There may be something in this view, but there is no reason why the Department should not act upon the recommendations of the various societies, as distinct from handing over funds. The actual handling of the money is a secondary matter. We feel that there is much to be said in favour of financial assistance to private individuals who are carrying on research, not as a whole-time pursuit, and the various societies among whose membership such workers must certainly be numbered are undoubtedly the best judges as to whether the work is worthy of support. It would be a simple matter to place a limit upon the aggregate sum that might be granted.

Patents.

THE question of patents is a fruitful source of difficulty in industrial research. The methods followed by Government Departments as regards the taking out of patents by members of their staffs vary very considerably, and this is the case not merely in this country but in other countries also. For example, in America, in some cases a patentee working under Government is compelled to dedicate all rights in his invention to the public. At present it is impossible for the United States Government to act as assignee of any patents, and where patent rights have been transferred they have been made over to a Minister in his personal capacity. This state of affairs may be varied in the near future. In the case of the Department of Scientific and Industrial Research, employees may not patent a discovery except with the leave of the Committee of Council, and where leave is given the patent is taken in the joint name of the inventor and the Department. Similar lines are followed in regard to those engaged in research under a Committee or Board of the Department. The difficulties, however, increase when the desirability of taking out foreign patents is considered. It is pointed out that the successful maintenance of foreign patents may involve the expenditure of large sums of money. Now that this difficulty is being experienced by a Government Department possibly the financial troubles of the ordinary patentee may receive greater sympathy on the part of the Government. It is pointed out that in dealing with such matters the Government cannot proceed with the single eye to financial advantage which commercial undertakings rightly use. So far, no solution appears to have been found, but it has been decided that patents shall not be taken out in the case of inventions for the preservation of health or life, or for inventions the use of which can be enforced by a Government Department. We must confess we feel this is a mistaken course, and in the report it is admitted that there are arguments in the opposite direction. It matters not whether an invention has a bearing on health or is of a more ordinary kind; the fact remains that it is desirable in any case to get a useful invention on to the market, and the most effectual way in which this can be secured is by having a strong patent which will protect the manufacturer. Any other course is merely due to lack of knowledge and to appreciation of ideals which really do not apply.

Outstanding Inventions and Discoveries.

The James Watt Centenary, which is to be celebrated in Birmingham on the 16th-18th of this month, is of interest as marking one of those rare cases in which a great invention or discovery is associated, more or less correctly, with the name of a single man. It may well be doubted whether any really epoch-making invention can be ascribed to one man alone, though in the case of discoveries such single-handed efforts are, perhaps, more frequent. But the tendency in this direction becomes less and less, and most of the important advances of the present day are really the work of quite a number of separate investigators. Even in the case of James Watt, the popular impression that he "invented" the steam engine is erroneous. The Newcomen engine, as Prof. Burstall remarks in his appreciation of Watt's work, which he has drafted in connection with this Centenary, was in regular use for quite a generation before James Watt's immortal discovery. Nevertheless the advance made by Watt was so great as to deserve recognition as one of the most important milestones on the road of discovery in this field. So it has been with other discoveries. Wireless telegraphy is associated primarily with Marconi's name, and justly so, although his success involved the preliminary researches of Hertz and others, and even they in turn built largely on work of previous investigators. In regard to the dynamo we seem to be fairly correct in dating progress from Faraday's great discovery of electromagnetic induction. Yet electrical engineers are all well aware of the many patient subsequent inventions, spread over many years, that went to make the dynamo a practicable machine. As the field of science and invention becomes wider the chances of individual effort become less, and the tendency towards co-operation greater. Although popular opinion will doubtless continue to associate inventions with particular names (though strangely capricious in this respect, for many inventions, such as the bicycle and the internal combustion engine, have failed to be so associated), men of science will continue to hold in honour many discoverers whose names are scarcely known outside a narrow circle. To the student this is by no means a discouraging fact. For if his chances of world-wide recognition are less he has the knowledge that his opportunities of contributing, in less or greater measure, to the building of the great mosaic of science are vastly greater than in the past.

Labour and Industrial Knowledge.

The timely letter of Mr. J. T. Brownlie, chairman of the Executive Council of the Amalgamated Society of Engineers, which was addressed last week to the Secretary of the Parliamentary Committee of the Trades Union Congress, called attention to the great responsibilities of trade unions at the present time. This responsibility is certainly very heavy, for these bodies have the power to ruin the country industrially or to enable it to return to its former industrial prosperity. Mr. Brownlie is perfectly correct in saying that a necessary condition to successful action is the dissemination of accurate and reliable information, and that the mere raising of nominal wages without an increased production in the necessaries of life is no solution of the difficulty. We have long felt that the trade unions were the proper bodies to impart such information. Knowledge that is brought forward by what is termed the Capitalist section of the community is necessarily suspect by the workers, and consequently ineffective. On the other hand, an educational movement by trade unions cannot be viewed in the same light. With regard to the knowledge that is necessary, this is largely economic. It is necessary to realise what is possible and what is impossible economically. Further, it would be an advantage, as was pointed out by Sir John Benn at the recent annual meeting of Benn Brothers, if the workers could be encouraged to read the technical and trade papers to a larger extent. These journals indicate the way in which industry is carried on and the conditions that are necessary for prosperity. Consequently the more such publications are read by the rank and file the more the difficulties of management will be appreciated. A most important fallacy, which should be immediately dispelled, is that increased wages coupled with reduced output can lead to the well-being of any section of the community. This policy can only lead inevitably to unemployment on the largest possible scale and to a great deal of misery; and consequently the sooner the facts can be appreciated the better will it be for the community at large.

Engineering Civic Associations.

We observe that the tendency in the United States towards forming "engineering civic associations" (*i.e.*, associations in which electrical engineers co-operate with mechanical, chemical and other engineers for some civic purpose) are becoming increasingly common. Various phases of the movement are reported from St. Louis, Milwaukee and other centres. In general, the organisation is in the nature of a club, at which local civic and engineering problems can be discussed, and a channel for the discussion of these matters with municipal authorities is provided. One factor which undoubtedly helps in the United States is the strong sense of local patriotism so often found in growing cities, and we could wish that this feeling was more in evidence in this country. However, the movement is now reaching a broader stage. Many of these local bodies are not content with their present limited sphere of action, and there is a tendency towards national affiliation, with a view to the exercising of an engineering influence on national problems connected with public works. The admitted extravagance of many Government Departments in this country, and the danger, at the present moment, that the country may be rushed into new, imperfectly considered schemes which may ultimately be regretted, makes it all the more necessary that the influence of engineers and technical men should be more strongly exerted. As we have remarked recently, there seems a great need for a movement in this country on the lines now being adopted by the engineering civic associations in the United States.

The "Technical Supplement."—According to the "Bulletin" of the Federation of British Industries, the "Technical Supplement," although discontinued officially, is to be published under private auspices.

Hydro-Electric Exploitation in Japan.—We observe that Japan, in common with other countries, is making a survey of the available water-power. The investigation, which began in June, 1918, is expected to last five years, and all power sites where there is a prospect of more than 1,000 h.p. being efficiently developed are to receive attention. It is stated that at present about 1,000,000 h.p. are being developed, while 2,000,000 h.p. are awaiting exploitation.

A Federation of Civil Engineering Contractors.—It has been decided to form a Federation of civil engineering contractors for the purpose of acting collectively, through an elected council, in relation to professional institutions and public authorities, and to deal with trade unions and other labour organisations in regard to hours of work, rates of pay, &c. The first Council of the Federation is: *President*, Viscount Cowdray; *Vice-presidents*, Sir John Jackson and Mr. James Railton; *Members*, Messrs. H. C. Baldry, H. F. Brand, C. R. Hemingway, T. Wilson Lovatt, Gerald G. Lynde, T. Malcolm McAlpine, T. Tyson Middleton, J. Harry Price and Sir E. W. Moir, Bart. The secretary is Mr. E. J. Rimmer, and the offices are at 10, Broadway, Westminster, S.W.1.

The "Radio Review."—It is announced that the Wireless Press is about to publish an independent monthly review with the above title, dealing with scientific progress in radiotelegraphy and telephony. The editor will be Prof. G. W. O. Howe, D.Sc., and the assistant editor Mr. P. R. Coursey, B.Sc. The first issue will appear in October and the price will be 2s. 6d. per month.

Association of Ex-British Westinghouse Men.—It has been decided to form an Association of Ex-British Westinghouse men in order to provide a means whereby they may keep in touch with each other. It is proposed to limit membership to men who were employed on the staff of the company for a period of two years prior to September 1919. The fee is to be 2s. 6d. per annum. A committee has been formed in order to settle the constitution and draw up by-laws, &c., for the Association.

Central Station Heating.—We notice that at the June meeting of the American Society of Mechanical Engineers, Mr. J. H. Walker gave an account of the central heating system which has been used in Detroit, Michigan, for some years. The Paper appears to be one that would be of considerable value to those interested in this subject, among the developments mentioned being the substitution of live steam for exhaust steam, a decision which seems to be due mainly to special local considerations.

State Administration.—Sir Charles Bright has contributed an article to the "Daily Telegraph" in which he points out that State enterprise should not be compared with private enterprise without crediting the former with meeting public convenience irrespective of the profit or loss that is entailed. For example, many telegraph offices in outlying districts have been added to the telegraph network, although such offices are not a paying proposition. The view is expressed that the Civil Service might be considerably reformed so as to have a higher commercial efficiency by stipulating two years' business experience as a preliminary to entry into the service, and by introducing other changes in the educational requirements.

A Mica-insulated Coil for 11,000 volt Alternators.—It is stated in the "Electrical World" that the Westinghouse Company has developed a form of mica-insulated coil which will withstand temperatures up to 150°C., and is regarded as very suitable for 11,000-volt alternators for hydro-electric work. The coil consists of two conductors, each composed of six 0·204 in. square bare copper wires in parallel. Each wire is painted with "bakelite" and insulated with one layer of mica tape to reduce eddy-current loss. Each conductor is then bound with thin cotton tape, followed by two layers of mica tape and another layer of thin cotton tape. The conductors are assembled with a reinforcing strip of mica between each. The complete coil is taped and treated with hydrolene, and there are other special processes. The percentage of mica in the wrapper is ultimately about 60 per cent.

British Non-Ferrous Metals Research Association.—This Association has been formed for the purpose of organising scientific and industrial research and collecting information essential for the present and future progress of all industries concerned in the production, treatment, manufacture and use of non-ferrous metals and alloys. It will also organise and maintain an information bureau of all important technical and scientific information directly or indirectly relative to the non-ferrous metals industries of the British Empire. The Association is appealing for the practical support of every individual firm of importance engaged solely in the non-ferrous metals industries and also of firms who are substantial users or workers of non-ferrous metals. Further information and particulars will be supplied by the Secretary, Provisional Committee, British Non-Ferrous Metals Research Association, 30, Paradise-street, Birmingham.

Courses of Instruction in Factory Organisation and Scientific Management.—We observe that a special course on the above subject has been arranged at the Pennsylvania State College during this month, and is intended primarily for cost accountants, store clerks, members of production and planning departments, superintendents, managers, &c. In addition to lectures during the morning on organisation, cost accounts, &c., there will be practical work in the college shops, which have been arranged and equipped with a special view to teaching scientific management, and such matters as the preparation of time schedules, instruction cards, tool lists, bills of material, &c., will be dealt with. In such a course much depends on the lecturers, who are stated to be experienced men, and we should imagine that the demonstration of these details in college workshops would present difficulties. However, the step is an enterprising one that might be considered by institutions in this country.

Industrial Lighting.—We notice that "The Organiser" for August has a special section devoted to industrial lighting, reference being made to both daylight and artificial systems. The provision of ample natural lighting is a factor of great importance in the modern factory. Mr. E. G. W. Souster illustrates typical American practice, according to which the building is virtually a shell containing large windows on all sides. Factories having 80 to 85 per cent. of their containing walls as windows are not uncommon. Great importance is attached to light received from the upper part of the windows, which should be run right up to the ceiling, but it is doubtful if any advantage is secured by bringing the lower extremity of the window below 2½ ft. above floor level. Mr. H. C. Wheat deals with the artificial lighting of machine shops, and Mr. L. Gaster contributes an article on the economic value of good illumination, in which the relation of good lighting to output is strongly emphasised. The illustrations in these two articles support the view that the modern tendency is towards general overhead lighting from units placed near the girders, a tendency which has doubtless been accentuated by the introduction of the gas-filled lamp.

Copper Conductors.—The British Engineering Standards Association has issued its revised (1919) Specification for dimensions of insulated annealed copper conductors for electric power and light. The wire gauge as a means of designating the conductors has been dispensed with, and the number of sizes has been reduced considerably. A table giving the values of the resistance of a conductor 1,000 yds. long and 1 sq. in. sectional area, at every degree between 40°F. and 120°F. and the constants to be employed in converting the resistance of a wire from any temperature between these limits to 60°F. has been included. In the tables at the end of the specification details of the conductors, the thicknesses of the dielectric, lead sheathing, armouring, bedding, &c., and the values of the test pressures are stated. The specification deals with circular wires from 0·0076 in. to 0·1030 in. diameter, solid and stranded conductors from 0·001 sq. in. to 1 sq. in. and with flexible conductors from 0·0006 sq. in. to 0·5 sq. in. The thicknesses of the dielectric and lead sheathing, and the values of the test pressures are given for paper, jute and rubber cables and various voltages. The price of the Report is 1s. 2d. post free, and copies may be obtained from the Offices of the Association, 28, Victoria-street, London, S.W. 1.

Personal.

Sir William H. Clarke, K.C.S.I., C.M.G., Comptroller-General of the Department of Overseas Trade, has resumed his duties after an absence of 11 months, due to ill-health.

We regret to learn that Mr. C. W. Mallins, general manager of the Liverpool Corporation tramways, has been compelled to tender his resignation on account of ill-health. By a unanimous vote, the Tramways Committee have requested Mr. Mallins to withdraw his resignation for the present, and to accept three months' leave of absence in order to take a complete rest. We sincerely hope that this period of rest will restore Mr. Mallins to good health, and enable him to resume his work in the department over which he presides.

The Lord President of the Council has appointed Prof. Joseph Ernest Petavel, D.Sc., F.R.S., M.I.Mech.E., to be Director of the National Physical Laboratory, in succession to Sir Richard Glazebrook, C.B., F.R.S., who retires on reaching the age limit on the 18th inst. Dr. Petavel is Professor of Engineering and Director of the Whitworth Laboratory in the University of Manchester. He was educated at University College, London, and undertook scientific research at the Royal Institution and at the Davy Faraday Laboratory until 1898. He was elected John Harling Fellow of the Owens' College, Manchester, in 1900, and was scientific manager of the Low Temperature Exhibit of the British Royal Commission at the St. Louis Exhibition, 1904.

The Supply of Electricity.*

By J. S. HIGHFIELD.

In recent discussions on the future of electric supply both the history and present position of the electric supply industry have been obscured. The general recognition of the great importance of developing electric power indicates a welcome change of opinion, but it should not be overlooked that before 1914 there was no town of any importance and no industrial area where electricity was not already supplied at prices sufficiently low to attract manufacturers, the ruling prices being about 1d. per unit for ordinary factory hours, ½d. per unit for continuous working and even lower prices for special purposes. Much has, therefore, been done, and the value of the early pioneering work of companies working under provisional orders was incalculable. Similarly in the field of long-distance transmission and distribution in extra-urban districts valuable work was done by power companies. Before proceeding to consider the future it is well to bear this fact in mind and also to review briefly the past history of electric supply.

There have recently been three reports, those of the Coal Conservation Sub-Committee, the Electrical Trades Committee and the Electric Power Supply Committee.

Each report refers to the causes which tended to restrict the full and natural development of the supply of electricity. It is shown that systems confining each undertaking within a municipal area are mistaken. The Electric Power Supply Committee's report states "that the present system under which a supply of electricity is provided in a large number of small areas by separate authorities, is the result of a policy adopted at a time when the applied science of electrical engineering was in its infancy, and is incompatible with anything that can be accepted now as a technically sound system."

The mistakes made in legislative enactments relating to the supply of electricity arose from the presumption that citizens, through their elected representatives, should provide their own electricity. In the days when legislation was first proposed, namely, about 1880, the business was in an experimental stage. Standard plant and cables did not exist; any person starting to provide a supply of electricity was forced to shoulder all the usual risks of a pioneer. Realising that a business involving such risks was an unsuitable one in which to invest public money, the Act of 1882 gave a reluctant consent to private companies to use the streets for the purpose of laying mains, but, in order to satisfy the view that municipal authorities should provide the electrical supply, three conditions were attached to the consent, viz., (1) that the supply should be confined to the area governed by the municipality; (2) that companies supplying in neighbouring areas should be denied the right of association; and (3) that the local authorities should have the right of purchasing the undertakings at the end of 21 years, paying for the land, buildings, plant and cables their value at the date of purchase without any allowance for goodwill.

The result was complete stagnation until the Act was amended in 1888 by extending the term of the lease from 21 to 42 years, the other restrictive conditions remaining.

Following on this revision, a number of companies were formed, and municipal authorities, led by the Vestry of St. Pancras, proceeded to set up electricity undertakings. In general, the latter have been carried on in an efficient manner, and have served the public well, their efforts, however, being with few and small exceptions, confined within municipal boundaries. Now, it was realised at a very early date that electricity would furnish means of transmitting power over far greater distances than were possible with older methods. In the earlier stages the commercial success of the low-pressure direct-current plants exceeded that of the high-pressure alternating, and naturally the low-pressure plants predominated. The foundations of knowledge of the subject were being laid, but there were many variables in the problem and little experience; and, although now it is common to complain of the great diversity of systems in this country, it should be remembered that there was a very good reason for their origin. The relative advantages of different systems was a matter of much discussion. Moreover, the Electric Lighting Acts, definitely preventing association between neighbouring companies, tended to encourage variations in systems. If it had been contemplated at first that neighbouring companies might work together, more effort would have been made to employ uniform systems. It is difficult to realise now how strong were the arguments put forward on each side by the advocates of direct current and alternating current respectively, and in view of this strong difference of technical opinion, there is no wonder that uniformity of systems was not immediately attained.

Soon after the original systems were started up, defects appeared. Owing to the difficulty of selling alternating current, because of its unsuitability for arc lighting and power in competition with direct current, whole systems supplied with alternating current were scrapped and changed over to direct current. Certain early types of plant, overhead wires and cables were found to be unreliable, and were scrapped. Great difficulty was experienced in coping with the demand, which was almost entirely for lighting. In the large towns the most violent changes occurred. A dark cloud coming over a city would cause the load to be more than doubled in a few minutes. Apart from the difficulties of dealing with these sudden loads, it was very difficult to predict 12 months beforehand what figure the next winter's demand was likely to reach, and many supply works found themselves overloaded and working under the gravest difficulty. In London, and to a lesser extent in other large towns, it became apparent that the initial works erected within the town boundaries were inadequate. The effect on the cost of changing over from inefficient small stations to larger ones is illustrated by the experience of the Metropolitan Electric Supply Company. Whereas in 1902 to generate 23,000,000 units cost £114,000, in 1905 to generate 26,000,000 cost £64,000. Other undertakings have effected similar improvement.

At the present time the public supply of electricity is provided by companies working under provisional orders from about the year 1888 and expiring about the year 1931. The large provincial towns are almost all supplied by their municipalities. In 1899 and 1900 a number of companies were formed for the purpose of supplying electricity over areas enclosed rather by county than by municipal boundaries. These companies met with strenuous opposition from the municipal authorities with the unfortunate result that the large towns were excluded from the companies' areas of operation. There are now operating in the country 21 such power companies which have made considerable progress, and during the war have performed most valuable work; many industries have been started which, without their assistance, could not have been put into operation. It is a great misfortune that municipalities treated the power companies as enemies. Had they, while reserving their distribution rights, encouraged the power companies by purchasing power in bulk, a large capital sum would have been saved by the avoidance of unsuitable sites, &c.

To co-ordinate the work of these different bodies the report of the Electric Power Supply Committee proposes to set up commissioners to delimit areas and generally control the expansion of the business; to leave existing suppliers to attend to distribution for the present and to form district boards which shall purchase all the power stations and main transmission lines and erect new power stations and transmissions lines to supplement and, where necessary, supersede the existing plants.

With the present cost of plant, fuel and labour, no startling reductions in price can be looked for. The term "cheap" electricity has been freely used in recent reports and articles. Unfortunately, there is no simple means of measuring the cost of supplying electricity to enable a ready comparison to be made between one method and another or between the costs of one station and another. The cost of a Board of Trade unit is far from being a satisfactory basis of comparison. Nor is the average selling price per unit a measure of the excellence or otherwise of an electrical undertaking. Without qualification, this method produces utterly misleading results.

Wide variations exist in the working cost per unit sold and the average price received for electricity, and in the original Paper this is illustrated in a table giving maximum load, cost per unit, average price per unit, and percentage of gross profit on capital for various concerns. An inexpert study of these figures would lead to many erroneous conclusions. It might be argued, for instance, that a small undertaking can supply at less than cost than a large undertaking, and that the former are more profitable than the latter. The reasons for the large variations in the costs and in the selling prices are to be sought in the existence, or otherwise, of competition, in differences in the price of coal, the number of consumers, their average load and the use made by each consumer of electricity.

The total cost of supplying electricity to a consumer is made up of the following items:—

A. *Power Station Charges.* (1) Capital charges, including interest, reserve, depreciation and sinking funds, say, 10 per cent. on the capital; (2) fuel and stores; (3) wages and salaries; (4) repairs, rates, rents, &c.

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* Abstract of a Paper read before the Royal Society of Arts.

B. *Distribution Charges.*—(1) Capital charges; (2) maintenance rates, wages, salaries, &c.

The incidence of the above charges varies with the class of load supplied, as follows:—

Total capital charges	From 30 to 60 per cent.
Coal	,, 55 to 10 ,,
Other working expenses	,, 15 to 30 ,,

The first figures represent approximately the ratio for undertakings supplying a small number of large consumers with a high load factor, and the latter figures undertakings supplying a large number of small consumers. Having regard to the fact that the distribution capital represents approximately 50 per cent. of the total capital employed, and that the cost of transformation, distribution and maintenance of meters represents some 20 per cent. of the total cost, it follows that no decrease in the price of bulk supply by super-stations or otherwise can possibly result in a very large reduction in price to the ordinary small consumer. The ordinary consumer can effect for himself a reduction in the price per unit of much larger magnitude by making a better use of the supply.

The high price of coal has encouraged the use of electricity for heating, and there has also been a great increase in the use of electricity for power; the load factor has increased, and, in spite of the fact that new plant, when installed, has cost more than 50 per cent. above pre-war prices, that the price of coal, having regard to quality, has doubled, that wages and other expenses have increased two or three times, the electricity supply undertakings have been able to carry on and to make ends meet with a relatively small increase in price generally not exceeding 50 per cent., and with a smaller increase in the average selling price.

The steam turbine, by making possible the use of very large plants of an economy far higher than can be attained by other means having regard to capital cost, revolutionised the means of generating electricity. Had plant remained at pre-war prices, there is no doubt that progress in replacing small stations by large turbine stations would have been rapid. The advance in the cost of plant and mains necessarily must result in delay in effecting a change. Under the best conditions the cost of transmission for distances exceeding 20 miles is a serious item.

The first overhead electric line under Board of Trade consent was erected at St. Helens, in Lancashire. Many miles of overhead lines have since been run. Their use reduces the cost, particularly of services to works, collieries, mines, farms and other scattered loads. For trunk lines carrying large power there is less advantage. The overhead lines are less reliable than underground lines. Lightning and wind may do much damage and alternative routes become advisable, where security of supply is a matter of the first importance. Great improvements are possible in means to increase the distance over which power can be economically transmitted.

It is not possible to lay down general rules for the supply of electricity. Much nonsense has been talked about the universal use of super-stations. Where a sufficient load can be collected within a moderate distance, accompanied by a site for the power station, with the ample water supply necessary to the running of a large turbine plant, a station of the largest size should be used. Where there is not adequate water, the super-station is not possible. One advantage of connecting up power stations over relatively wide areas so that they feed a common system of transmission lines, is that the large amounts of waste heat available in some parts of the country can be made full use of. Much has been written about the possibility of using the coal so as to obtain some or all of the by-products.

The difficulty is that either coke or gas must be burnt under boilers when turbines are used, and neither is a very satisfactory boiler fuel, and both coke and coal gas command a large general market at high prices. This method also involves the consumption of about 25 per cent. more fuel owing to the extraction of part of the coal and its consequent loss as a heating agent, and the double heat losses in the producers or retorts in addition to that in the boiler. If the gas could be used direct, without the agency of the boiler, then a solution of the difficult problem would become nearer. It is a problem calling for the most skilful research on a large scale. With present methods, about 18 per cent. of the heat energy in fuel can be converted into electricity.

The whole principle of public electricity supply depends on the fact that a large central plant can supply power with a less consumption of coal than individual small plants. There is no doubt that had the prices charged to the consumers been increased by even 1 per cent., and had the additional profits been applied to improving methods and apparatus, the cost to-day to the consumer would have been less. Whatever is ultimately decided upon for the future conduct of electricity supply, the finances of the industry should be arranged so that there will be such a margin over and above the cost of production, including the capital charges, as will provide an ample reserve not only for the replacement of plant as it becomes obsolete, but also for the conduct of large-scale experiments, directed to increasing efficiency and improving methods. The report of the Electric Power Supply Committee clearly contemplates probably large financial assistance from the State. Financial assistance from the State for industry may be, in certain cases, necessary and justifiable, but such assistance should be rendered only when absolutely necessary. So far as possible, the money should be laid out so as to bring in a proper return. From the data available there does not seem to me to be any strong case for State assistance so long as the development of electrical supply proceeds along well-trodden lines.

It is, however, undesirable that the undertakings in certain parts of the country, where large towns exist in close proximity to one another, should continue to develop their undertakings solely for each town. There are many districts where a large power-station should be erected in a suitable position to meet the increasing demand, not in one town only, but in several towns. Apart from the industrial areas, there are large areas in the country consisting of entirely rural districts with a few small towns. The supply to the whole of these districts from one or more stations, even with overhead mains, is not commercially practicable. Development should proceed outwards from the towns. With this object a uniform system should be adopted so that, when eventually the call for power increased in the intermediate districts, the supplies could be linked together so as to form a uniform and complete system. There is no doubt that the most satisfactory method of financing a power undertaking is for most of the consumers to have, at any rate, some direct financial interest in its success. The prices for power should be so fixed as to produce an ample return on the capital, so that sufficient amounts can be set aside to provide for the early scrapping of uneconomical plant, for the adoption of newest methods, for research in the methods of using fuel, and for the payment of, say, 8 to 10 per cent. on the ordinary capital. A company so situated would be able to raise money at the lowest market rate of interest; the fact that its consumers are interested in its prosperity will make them most excellent canvassers, so that the business should increase rapidly; with every increase in business its cost will tend to decrease, and, consequently, its profits will increase.

It is probable that in the near future further progress will be made in the electrification of railways. In my view, these stations should not be put down by the railway companies but by the electric supply authorities, and should form part of their main systems. Any general scheme for improving the supply of electricity in the country must of necessity take into account railway electrification.

In conclusion, it is important to recognise that electrical supply undertakings in this country constitute a business of very great magnitude. The capital invested is given in the report of the Electric Supply Committee approximately as £26,000,000 by companies working under provisional Orders, £55,000,000 by municipalities, and by the power companies over £10,000,000. These figures are exclusive of plants used for railways, tramways, and private firms. A business of this magnitude cannot be radically changed without loss, and the expenditure of much money and much time. It is almost certain that the plant available to-day will be, from the point of view of economy in coal consumption, obsolete within the next 15 years. There is less reason to plunge rashly into huge expenditure far ahead of requirements. One plain fact, I think, emerges from experience, namely, that when Government takes under its wing any enterprise, it should take care that in making laws for its conduct the ordinary principles of business should be observed. Finally, it is of the utmost importance that the present uncertainty should be removed as soon as possible; it is hampering the industry just at a time when confidence is of the greatest importance. Extensions of plant are called for in every direction, and delay will lead to breakdowns and shortage of supply. Naturally, in the present uncertain position, doubtful if their property is to be transferred to rather nebulous district boards yet to be set up, and, if so, at what price, both companies and municipalities hesitate to embark on new expenditure. Any long delay will do far more harm than the district boards can put right for years.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, of receipt of published price, plus postage.]

"Electric Mains and Distributing Systems." New and Enlarged Edition. By J. R. Dick, BSc., M.I.E.E., and F. Fernie, A.M.Inst.C.E. (London: Benn Bros., Ltd.). 15/- net.

"List of Members of the Institution of Civil Engineers (1919)." (London: Institution of Civil Engineers.) Pp. 272.

Thermophones or Hot-Wire Receivers.

The following notes on thermophones (of which we gave some particulars in The Electrician, Vol. LXXIV., p. 358) are based on a communication we have received, and they may be taken as supplementing what has already been published.

Thermophones, or hot-wire receivers, as the name implies, are actuated by heat instead of electromagnetism, and hence their characteristics are different from those of the usual electromagnetic receivers. For example, the diameter of the wire that is used is all important. It is therefore well to consider first, in an elementary way, the relationship between the watts in a wire and the diameter of the wire, for sensitiveness must depend upon the readiness with which the wire can vary its temperature with variation of current. If we assume, for the moment, that the current density is maintained constant as the diameter of the wire is varied, then it follows that the current varies as the square of the diameter. If C stands for current, R for resistance and d for diameter, then $C \propto d^2$. Thus, the watts (C^2R) for a given length may be expressed in the form,

$$\text{Watts} \propto d^4.$$

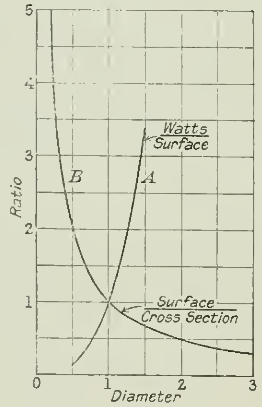
On the other hand, the surface of the same length is given by

$$\text{Surface} \propto d.$$

Hence.

$$\frac{\text{Watts}}{\text{Surface}} \propto d^3.$$

Taking the case when the diameter of the wire is greater than unity, if follows that the watts emitted per unit area rises very rapidly. For example, if the diameter is increased in the proportion of 2 to 3, the watts to be dissipated per unit area rise in the proportion of 8 to 27. Consequently, a limit may soon be reached when the permissible temperature-rise necessitates a lowering of the current density. For given temperature conditions, increased watts necessitate increased diameter of wire.



On the other hand, if we go to small wires the position becomes somewhat different. Suppose, for example, that the millimetre is taken as the unit of length and the diameter is reduced from 0·1 mm. to 0·01 mm. Then, for constant current density, the watts per unit area fall in the proportion $(1/10)^3$ to $(1/100)^3$; that is, to 1/1,000th of this previous value. Consequently, in order to maintain the temperature conditions, the watts may be increased enormously in the case of very small wires. It may, indeed, be found that the smaller of two wires may be able to carry more watts than the larger wire for the same temperature conditions. As an example, it has been found that a wire 0·001 mm. will carry 1·5 more micro watts than a wire of 0·003 mm. This is illustrated by curve A in the accompanying diagram.

The position may also be illustrated by considering the relation of surface to cross-section. We have

$$\text{Surface} \propto r.$$

$$\text{Cross-section} \propto r^2.$$

Hence

$$\frac{\text{Surface}}{\text{Cross-section}} \propto \frac{1}{r}.$$

From this it is seen at once that the ratio of surface to cross-section becomes smaller and smaller as r increases, provided r is above unity. On the other hand, if r is below unity the ratio of surface to cross-section increases rapidly. This is shown by curve B.

It will be easily understood that with very thin wires the great area of radiating surface as compared with the small cross-section allows the heat generated by the current to dissipate very rapidly. This property is made use of in the construction of thermophone receivers. A number of fine wires, 0·001 mm. or 0·0015 mm., are mounted in a semi-enclosed metal receptacle, and this in turn is enclosed in a similar case, but made of Erinoid or other insulating and hygienic material.

When the receiver is connected in series with a suitable transmitter and battery, and the transmitter is operated, the variations in the resistance of the transmitter cause the current flowing to vary. These variations affect the very thin wires, and as they dissipate their heat practically instantaneously, speech is reproduced by the motion of the small column of air caused by the heat variations.

The speech transmission is very faithful, articulation being perfect. There is no distortion, as there is no diaphragm; and while the column of air has a natural period of its own, it is in the region of 8,000 to 10,000, so that it is beyond the range of speech vibrations.

Having briefly described the operation, it may now be well to make a few comparisons.

It must be noted that the electromagnetic receiver is a very sensitive instrument, and responds to very minute currents circulating in the coils and to inductive effects which may be superimposed on the current flowing in the circuit, besides being subject to vibrations which affect its diaphragm mechanically. These qualities make it practically a series of instruments in one, of which one portion is wanted to reproduce speech, but as they cannot be split up, it proves very inefficient at times. It is a heavy instrument even in its lightest form.

The hot wire receiver is a telephone receiver pure and simple, and will only respond to the transmitter to which it is connected. When speaking it is necessary to speak close to, and into, the transmitter mouthpiece for the best transmission. Inductive effects are absent; and there being no diaphragm there is no inherent distortion. It has the great advantage of responding perfectly to low-spoken tones, or whispers; and if the voice is raised there is no clash or confusion of sounds. It is featherweight, weighing complete from 0·25 oz. to 0·5 oz., according to the model.

The type of transmitter most suitable for use with hot wire receivers does not prove very satisfactory for electromagnetic receivers, and as the instruments in the former case are connected in series without any induction coil this is easy to understand.

The hot wire receiver, as made for speech reproduction, is not the best form for wireless use, and special receivers are made up for that work, but there are none in use in England at present. Some experiments have been made with the ordinary form for wireless purposes in England, but they have not been very satisfactory for the above reason.

Heat-operated receivers have been referred to as "delicate" and "fragile," and further as "a scientific toy." These conceptions are quite erroneous. The receivers, as now made, will stand a considerable overload, and they are, mechanically, more robust than any other type of receiver on the market. They are machine made. They are manufactured in many forms, and vary in resistance from 20 to 3,000 ohms.

At present the hot-wire receiver is not so far develeped that it can be said to be ready to replace the electromagnetic receiver for all branches of telephony, but we understand that it has already filled conditions which the electromagnetic failed to do, and is available to replace its older rival in many important fields.

New Types of Arc Lamp Carbons.—We believe that the idea of using a solid carbon within a carbon tube, in order to avoid the shadow of the negative carbon, was suggested early in the history of the arc lamp, but the idea has been revived in a recent French patent, a feature of which is the use of a coil to cause the arc to revolve. It is further suggested that the annular space between the central carbon and the surrounding tube might be filled with suitable material to colour the arc.

A Heterodyning Wavemeter.

By Lieut. J. SCOTT-TAGGART, M.C., R.E.
(Membre de la Société Française des Electriciens, Assoc.I.R.E.)

The development of continuous-wave wireless telegraphy has necessitated a special instrument capable of measuring the waves used. The ordinary wavemeter used for measuring the damped waves, transmitted by spark wireless stations, consists of a single variable oscillatory circuit, shunted by a crystal detector and a pair of telephone receivers. The waves are sent out in groups or wave-trains from the transmitting station, and influence the wave-meter oscillatory circuit, provided the latter is tuned to the same frequency as the transmitted signals. The groups of oscillations which are set up in the wave-meter are rectified by the detector producing unidirectional pulses through the telephone receivers. These pulses, occurring rapidly and at regular intervals, produce in the 'phones a buzz having a note-frequency equal to the spark-frequency of the transmitting station. The wave-meter is generally tuned to the transmitted signals by means of a variable condenser graduated in wave-lengths or degrees, in which latter case a calibration chart is used. When the loudest signals are heard in the 'phones the reading given by the condenser indicates the length of the waves being transmitted. This method is necessarily somewhat crude, since it relies very largely on the personal element; it is always very difficult to decide the point where the signals are loudest, particularly when the peak of the transmitted wave is not very sharp and signals appear to be the same strength over a considerable range of the condenser scale. None of these difficulties are met with when measuring continuous waves by means of the heterodyning wave-meter described below. The greatest accuracy may be obtained, the only personal element consisting in differentiating between a high and a low note—a very simple matter.

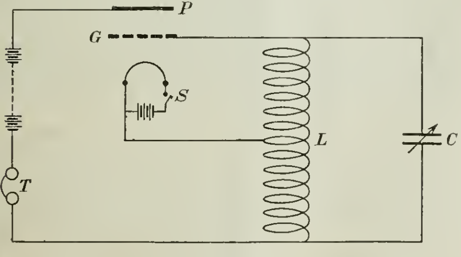


Fig. 1.

Although an ordinary spark wave-meter is not designed to measure continuous waves, yet it is not incapable of doing so. If such a wave-meter be brought near a continuous-wave transmitter the key of which is depressed, sustained oscillations of constant amplitude will be set up in the wave-meter circuits. These oscillations are not broken up into groups, as in the case of spark signals, and, therefore, when rectified by the detector, merely produce a steady flow of current through the telephones. Nothing will be heard except clicks at the commencement and end of the stream of oscillations. If, however, dots are sent on the transmitting key, clicks will be heard in the 'phones, and will be loudest when the wave-meter is tuned most accurately to the transmitted waves, the maximum energy being then received. Another method would be to break up mechanically, by means of an interrupter, the steady flow of current through the telephones. These methods, however, are unscientific and inaccurate and give only very rough results.

Fig. 1 shows an instrument sound and accurate both in theory and practice. It consists, in effect, of a simple valve circuit suitable for the reception of continuous waves. The plate *P* of a vacuum valve is connected to the positive of a battery of small dry cells having a total voltage of about 20 volts. The negative end of this battery is connected to one side of a pair of low-resistance 'phones, the other side of which is connected to the end of an inductance coil *L*. The other end of this coil is connected to the grid *G* of the valve. The filament of the valve is heated by means of a 4-volt accumulator, which may be switched on or off as desired. A half-way connection is taken from the coil *L* to the positive side of the filament. A variable condenser *C* is connected across the inductance *L*. When the circuit is connected up and the filament current switch closed, the whole system will commence to oscillate of its own accord at a frequency which may be varied by means of the condenser *C*. The range of wave-lengths it is desired to measure will determine the size of the inductance *L* and the capacity *C*. The lower half of the coil *L* may be considered a reaction coil coupled to the upper portion which forms the grid oscillatory circuit. The condenser *C* varies the wave-length of both plate and grid oscillatory circuits at the same time. This arrangement, together with auto-transformer coupling, greatly simplifies the design of the wave-meter without detracting from its efficiency.

In order to calibrate such a wave-meter, an ordinary spark wave-meter of known accuracy is brought near to the instrument and made to transmit waves of known length, which will produce buzzes in the telephones of the oscillating wave-meter when the latter is correctly tuned. The calibration chart of the heterodyning wave-meter is then marked with the readings given by the spark wave-meter. Once such a standard wave-meter has been calibrated, any number of similar wave-meters may be calibrated from it with very great accuracy.

Let us now consider the use of the instrument for measuring continuous waves. Suppose it be brought up to a set which is sending out waves of, say, 600 metres length, which is equivalent to a frequency of 500,000 per second. These waves will set up additional oscillations in the circuits of the wave-meter which will have an interference effect on those already taking place. If the wave-meter be adjusted to 550 metres the frequency of the local oscillations will be 545,545. The two sets of oscillations, superimposed on each other, will produce a resultant oscillating current which periodically increases to a maximum amplitude, these "beats" being produced when the two sets of oscillations are momentarily in phase, and therefore assisting each other. The beat-frequency will equal the difference of the two separate frequencies, and will in this case be 45,545.

The valve, in addition to generating oscillations, also acts as a rectifier and will, therefore, rectify any beats produced. The result will be a note in the telephones having a frequency equal to the beat frequency. If this is in excess of about 4,000 nothing will be heard, since the human ear cannot respond well to higher frequencies. If the wave-meter be set to 550 metres, the beat-frequency will be 45,545, which is much too high to be audible. As the wave-meter condenser is turned round to 595 metres, a very high note will be heard which will gradually get lower as the two frequencies approach each other. When the wave-meter is adjusted to 600 metres, both sets of oscillations will have the same frequency, and, since no beats will be formed, nothing will be heard in the 'phones. As the wave-meter condenser is gradually turned further round to higher wave-lengths this time than 600 metres, beats are once more formed and produce a low note, which gets higher and higher until it dies out at about 605 metres. From this it will be seen that if the wave-meter is more than 5 metres out of adjustment, nothing whatever will be heard, so that great accuracy is attainable. Moreover, the slightest variation of wave-length, such as would be caused by putting the hand near the transmitting set, will cause a change of note in the telephones of the wave-meter. On account of this abnormal sensitiveness, it will be found best to enclose the box containing the wave-meter circuits in an outer gauze covering connected to earth.

From the above it will be seen that, in order to measure waves of unknown lengths, it is only necessary to turn the wave-meter condenser round until the note resembling a "chirp" is heard. When the silent point of this "chirp" is obtained, the wave-meter will register the length of the waves being transmitted. Care should be taken to keep the wave-meter as far away from the transmitting station as possible, as otherwise misleading results may be obtained.

In addition to acting as a receiving wave-meter, it may also be used as a transmitter without any alteration to its circuits, since the valve is oscillating and therefore radiating feeble waves. If, therefore, it is desired to adjust a receiving circuit to a given wave-length, all that is necessary is to adjust the wave-meter to the required wave-length and to tune the set to it. The device is also of great use as an external heterodyning oscillator for use with a non-oscillating detector for the reception of continuous waves.

These devices were presented to the Inventions Department of the Ministry of Munitions early in 1917, and modifications have been described by the author in the *Wireless World*.

The Alternating Current Track-Circuit.

By DOUGLAS C. GALL.

The problem of the alternating-current track-circuit is one seldom dealt with in treatises, yet upon its reliable operation the lives of many railway passengers depend, for it is installed largely upon the tubes and other railways, and controls the traffic almost entirely.

The following is a description of methods used to determine the behaviour of a track-circuit, given apparatus of a certain type. This is, in fact, the problem most frequently encountered by the railway signal engineer. The designer, on the other hand, may use the same methods, starting from the opposite end, and arriving ultimately at the properties which must be possessed by the apparatus to fulfil the primary condition.

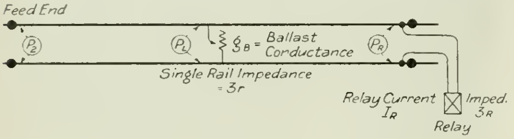


Fig. 1.—Diagrammatic Arrangement of Track-Circuit.

These primary conditions are the physical properties of the permanent way and the trains which run thereon. Electrically their properties are :—

1. The insulation resistance of the ballast.
2. The impedance of the rails.
3. The impedance of the circuit through the wheels in contact with the rails.

This latter property is one about which little appears to have been written, and it is hoped that its importance will be appreciated from the following and Fig. 6 in particular, for unless this wheel impedance is below a certain value, the track-circuit will not operate with a train in it. Further, the value of this impedance is largely influenced by the ratio of its ohmic resistance to its reactance—in other words, its phase angle.

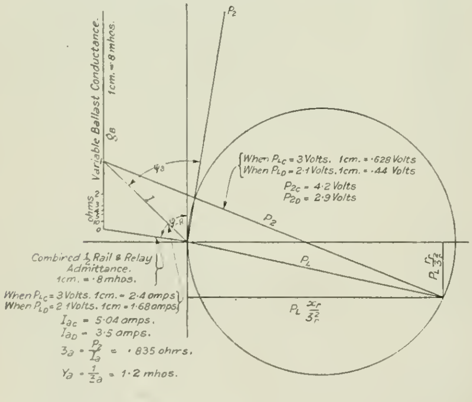

P_2
Variable Ballast Conductance. 1cm. = ·8 mhos.
g_B
ohms
φ_a
φ_R
When P_{LC} = 3 Volts. 1cm. = ·628 Volts
When P_{LD} = 2·1 Volts. 1cm. = ·44 Volts
P_{2C} = 4·2 Volts
P_{2D} = 2·9 Volts
P_2
P_L
$P_L \frac{r_r}{3_r^2}$
$P_L \frac{x_r}{3_r^2}$
Combined ½ Rail & Relay Admittance. 1cm. = ·8 mhos.
When P_{LC} = 3 Volts. 1cm. = 2·4 amps
When P_{LD} = 2·1 Volts. 1cm = 1·68 amps
I_{ac} = 5·04 amps.
I_{aD} = 3·5 amps.
$3_a = \frac{P_2}{I_a}$ = ·835 ohms.
$Y_a = \frac{1}{3_a}$ = 1·2 mhos.

Fig. 2.—Graphical Method of Obtaining Pressure at Feed-End.

Surely this is a matter too important not to be definitely investigated, and so far as the writer is aware, nothing has been published upon this point.

With the track-circuit the most variable factor is the ballast leakage, so that for the determination of operating conditions a means is convenient which covers all possible leaks.

In a simple alternating-current track-circuit there is one function to be fulfilled having two conditions. This requirement is a definite voltage at the relay. The two conditions arise when the relay is (1) energised, (2) de-energised. For the first, a voltage sufficiently high to ensure correct operation is necessary ; and for the second, one sufficiently low to ensure the dropping of the relay.

Distinct values for these two conditions obtain throughout the circuit, and the values of current, voltages, &c., necessary at various points to this effect are designated " Clear " and " Drop," shown by affixes " C " and " D " respectively.

Starting with the " Clear " relay voltage, in order to produce this value at the relay end of the track a higher voltage is required at the feed-end, depending upon the ballast leakage. This voltage then is the first quantity to be determined for all values of ballast insulation-resistance.

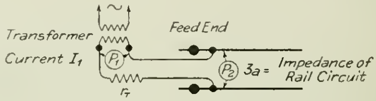


Fig. 3.—Diagrammatic Arrangement at Feed-End of Track-Circuit.

So that the presence of a pair of wheels in the track will reduce the relay voltage to its second value or " Drop " voltage, it is usual to insert a resistance between the source of supply and the feed-end of the track, which lowers the feed-end volts to their " Drop " value when an increased current is passing, caused by the presence of the wheels. The value of this inserted resistance becomes, therefore, the second quantity to be found, it being of such a value that the supply pressure is reduced to the " Clear " feed pressure when the " Clear " current is flowing.

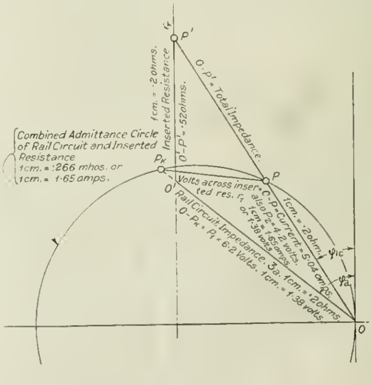


Fig. 4.—Graphical Method of Obtaining Value of Inserted Resistance.

Further, it is necessary to know what the value of " Train-shunt " or wheel resistance must be to increase the total current to such a value that the voltage drop on the inserted resistance reduces the feed pressure to its " Drop " value ; the relay pressure dropping in turn, and so completing the cycle of operations of the track-circuit.

Fig. 1 shows a simple double-rail track-circuit fed on the left-hand end, from some source of supply of pressure P_1, there producing a pressure P_2, which, in turn, produces a relay pressure P_R.

The insulation or ballast resistance between rails is converted into conductance g_B mhos or $1/g_B$ ohms.

There is no practical gain in the accuracy of the values obtained in taking the leak as distributed for any but very long tracks and the error in phase angle is seldom critical, in substituting a central leak, so this has been done in Fig. 1. Figs. 2, 4 and 6 are graphical methods of obtaining the three quantities above mentioned.

Fig. 2 finds the feed pressures required to produce relay voltages and currents for all values of leak.

Fig. 4 determines the value of the inserted resistance.

Fig. 6 determines the "train-shunt" necessary to de-energise relay.

In assuming the central leak it is convenient to extend the relay voltage P_R to the necessary value $P._L$ at the leak.

The following values have been taken in the diagrams, and are expressed symbolically in their component parts :—

Relay impedance............................	Z_R =0·07−j·57 ohms.
Single rail impedance.....................	Z_r =0·05−j·225ohms.
"Clear" voltage required for relay...	P_{RC}=2·3 volts.
"Clear" current required for relay...	I_{RC}=3·75 amperes.
"Drop" voltage not to be exceeded at relay................................	P_{RD} =1·6 volts.
"Drop" current not to be exceeded at relay................................	I_{RD} =2·62 amperes.
Voltage of supply	$P._1$ =6·2 volts.

Combined added impedance of Z_R and Z_r to centre point of track Z_{Rr}=0·12−j·795=0·803 ohm numerically.

Since $P_L=I_R Z_{Rr}$, then

$$P_{LC}=0{\cdot}803\ I_{RC}=3{\cdot}0 \text{ volts.}$$
$$P_{LD}=0{\cdot}803\ I_{RD}=2{\cdot}1 \text{ volts.}$$

Converting Z_{Rr} into admittance

$$Y_{Rr}=\frac{0{\cdot}12}{Z_{Rr}{}^2}+j\frac{0{\cdot}795}{Z_{Rr}{}^2}$$
$$=0{\cdot}186+j\ 1{\cdot}23 \text{ mho.}$$

To determine $P._2$ required to produce the two values of P_L for all values of leak, Fig. 2 is constructed as follows :—

Let 1 cm. =0·4 mho.

Then Y_{Rr} =0·465+j 3·08 cms.

Lay off Y_{Rr} from origin and add vertically the leak conductance g_B of indefinite value.

Then the total admittance between the two rails at the centre point for any value of ballast conductance is given by the line connecting that value on the vertical line and the origin to the scale

1 cm.=0·4 mhos.

Next, from the origin lay off the two components

$$P_L\frac{x_r}{Z_r{}^2} \text{ and } P_L\frac{r_r}{Z_r{}^2}$$

in the opposite quadrant.

When P_{LC}=3 volts, 1 cm.=3×0·4 ampere=1·2 amperes (since 0·4 mho=1 cm.).

$$\therefore\ P_L\frac{r_r}{Z_r{}^2}+jP_L\frac{x_r}{Z_r{}^2}=1{\cdot}2\times3(0{\cdot}835+j\ 3{\cdot}75)=2{\cdot}085+j9{\cdot}37 \text{ cm.}$$

Let this equal P_{LC} to a new scale. Then, since the length of this line representing P_{LC} is

$$\sqrt{2{\cdot}085^2+9{\cdot}37^2} \text{ cm.}=9{\cdot}55 \text{ cm.}$$

9·55 cm.=3 volts— *i.e.*, 1 cm.=0·314 volt.

When P_{LD}=2·1 volts

1 cm.=2·1×0·4=0·84 ampere.

9·55 cm.=2·1 volts—*i.e.*, 1 cm.=0·22 volts.

When g_B the ballast conductance=1 mho, or the ballast resistance=1 ohm.

From the diagram

$$P_{2C}=42 \text{ volts.}$$
$$I_a=5{\cdot}01 \text{ amperes.}$$

By describing a circle such that its centre lies on the horizontal axis and it passes through points 0 and 0_1. φ_a—the angle separating I_a and P_2 is given as shown in the diagram.

To drop the relay, P_{2C} must be reduced to the drop value P_{2D}, which produces only P_{LD}=2·1 volts at centre.

As above, since 1 cm.=0·22 volts in this case.

P_{2D}=2·9 volts.

And, similarly, I_{aD}=3·5 amperes.

Fig. 4 determines the inserted resistance required to produce P_{2C} at feed-end of track.

Rail circuit impedance between two feed points as shown in Fig. 3 is

$$Z_a=\frac{P_2}{I_a}=0{\cdot}835 \text{ ohm.} \quad \varphi_a=51°.$$

To construct this diagram, let 1 cm.=0·1 ohm. Lay off Z_a=8·35 cm.

Add inserted resistance r_T of indefinite value. Inverting this line geometrically with respect to the origin O gives the circle representing the admittance for all values of r_T.

Let 1 cm.=0·133 mho=0·825 amp. (since P_1=6·2 volts).

$$\text{Then, constant of inversion } I=\frac{1}{0{\cdot}1\times0{\cdot}133}=75.$$

Diameter of admittance circle$=\frac{75}{6{\cdot}5}$ (since resistance line is 6·5 cm. from origin)=11·5cm.

Letting $O-P_K$ equal the supply pressure P_1

i.e., 9 cm.=6·2 volts.

∴ 1 cm.=0·69 volt,

P_{2C}=4·2 volts=6·1 cm.

With centre O and radius P_{2C}=6·1 cm. cut admittance circle at P. This gives current I_a=5·04 amperes.

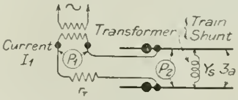


FIG. 5.—DIAGRAMMATIC ARRANGEMENT AT FEED-END WHEN TRACK-CIRCUIT SHUNTED BY Y_s.

The inverse point of P is P'. This gives the value of the inserted resistance required $O'-P'$, and as 1 cm.=0·1 ohm.

$$\therefore\ r_T=0{\cdot}52 \text{ ohm.}$$

Many track-circuits are equipped with a special type of resistance which has the property of rapidly increasing its resistance with increased heating due to current increase, thus helping the operation of the track-circuit greatly. These are known as thermal-regulators, and curves are made showing their resistance at varying currents. Fig. 7 is typical.

It is common to bring the resistance to its required value by putting more or less regulators in parallel, and the number of regulators required can be found from the curves of their behaviour.

A resistance of $r_T.N$ must be found at a current value of I_a/N, then N is the number of regulators required.

Since N must be integral, and is seldom more than six, it can be found in less than that number of trials, but may not give the exact requirement, a number must be chosen which will operate the relay—in other words, the resistance may be lower than required.

Suppose this number comes to 5. To determine the "train-shunt" necessary to reduce P_{2C} to P_{2D}, where thermal regulators are used, Fig. 6 is constructed. From previous diagrams, these values have been found :—

Rail admittance Y_a .=1·2 mhos φ_a=51°.

P_{2C}.=4·2 volts.

P_{2D}.=2·9 volts.

P_1 .=6·2 volts.

N .=5 regulators,

which are shown in Fig. 5 diagrammatically.

Let 1 cm.=0·1 mhos. Then, Y_a=12 cm.

Lay off Y_a and add the indefinite train-shunt admittance Y_s, having a fixed phase angle φ_s of, say, 40°. Invert this with respect to O.

Let 1 cm.=0·1 ohm; then constant of inversion I=100.

Diameter of circle=$\frac{100}{2\cdot3}$ cm.=43·5 cm. This gives the impedance circle for all values of train-shunt admittance.

From the supply transformer regulation curve determine an equivalent resistance which gives approximate pressure drop at working load (*see* Fig. 8).

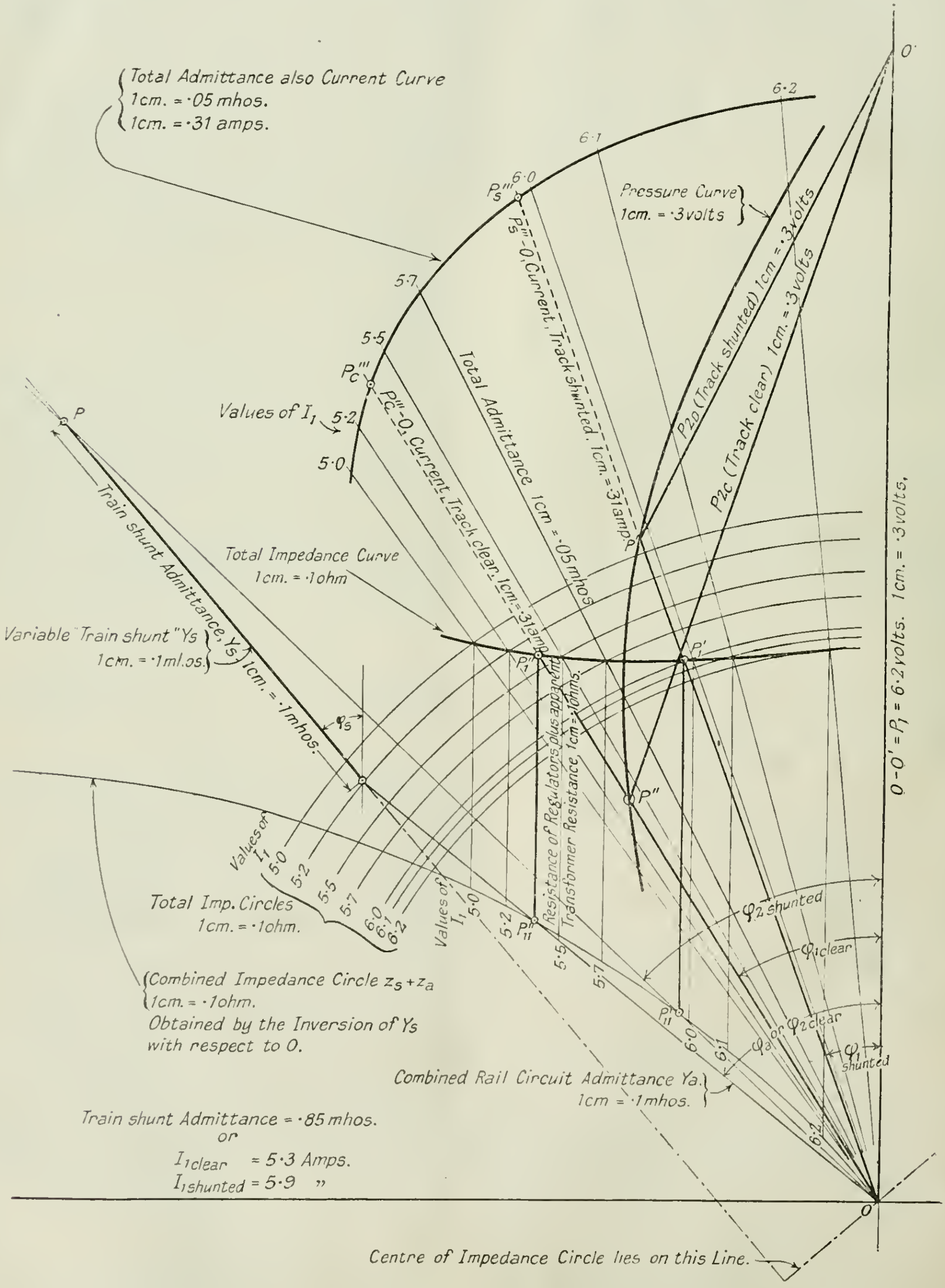

Total Admittance also Current Curve
1cm. = ·05 mhos.
1cm. = ·31 amps.
O'
6·2
6·1
6·0
P_s'''
Pressure Curve 1cm. = ·3 volts
5·7
5·5
P_c'''
Values of I_1
5·2
5·0
P
P_s'''-O, Current, Track shunted. 1cm. = ·31 amps.
P_c'''-O, Current, Track clear. 1cm. = ·31 amps.
Total Admittance 1cm = ·05 mhos
P2o (Track shunted) 1cm = ·3 volts
P2c (Track clear) 1cm. = ·3 volts
Train shunt Admittance, Ys 1cm. = ·1 mhos.
Total Impedance Curve 1cm. = ·1 ohm
Variable "Train shunt" Ys 1cm. = ·1 mhos.
P_1'
P_1'
P'
P''
φ_s
Resistance of Regulators plus apparatus Transformer Resistance 1cm = ·1 ohms.
O-O' = P_1 = 6·2 volts. 1cm. = ·3 volts.
Values of I_1
5·0
5·2
5·5
5·7
6·0
6·1
6·2
Total Imp. Circles 1cm. = ·1 ohm.
Values of I_1
P_{11}'
P_{11}''
φ_2 shunted
φ_1 clear
φ_a or φ_2 clear
φ_1 shunted
Combined Impedance Circle $z_s + z_a$ 1cm. = ·1 ohm.
Obtained by the Inversion of Ys with respect to O.
Combined Rail Circuit Admittance Ya. 1cm = ·1 mhos.
Train shunt Admittance = ·85 mhos.
or
I_{1clear} = 5·3 Amps.
$I_{1shunted}$ = 5·9 "
O
Centre of Impedance Circle lies on this Line.

Fig. 6.—Diagram for Determining Value of "Train-Shunt" for a Track-Circuit with Thermal-Regulators.

Equivalent resistance $r_\epsilon=0·14$ ohm.

Tabulate the values in Table I.

Total I_1.	Current through 1 regulator.	Resistance of 1 regulator.	Resistance of 5 regulators, r_5.	r_5+equivalent transformer res. r_ϵ (r_5+r_ϵ).	(r_5+r_ϵ) to scale, 1 cm.=0·1 ohm.	$I_1(r_5+r_\epsilon)$ volts.	$I_1(r_5+r_\epsilon)$ to scale, 1 cm. 0·3 volt.	Total impedance, $Z_1=\frac{P_1}{I_1}=\frac{6·2}{I}$	Z_1, to scale, 1 cm.=0·1 ohm.	Total admittance, $Y_1=\frac{1}{Z_1}$.	Y_1, 1 cm. 0·05 mho.
5·0	1·0	1·5	0·3	0·44	4·4	2·20	7·33	1·24	12·4	0·805	16·1
5·2	1·04	1·6	0·32	0·46	4·6	2·39	7·95	1·19	11·9	0·84	16·8
5·5	1·1	1·8	0·36	0·50	5·0	2·75	9·17	1·128	11·28	0·885	17·7
5·7	1·14	2·0	0·40	0·54	5·4	3·08	10·3	1·088	10·88	0·91	18·25
6·0	1·2	2·7	0·54	0·68	6·8	4·07	13·6	1·03	10·3	0·97	19·4
6·1	1·22	3·0	0·60	0·74	7·4	4·50	15·0	1·015	10·15	0·98	19·6
6·2	1·24	3·8	0·76	0·90	9·0	5·38	18·6	1·00	10·0	0·99	19·9

With radius Z_1 in Table I. and centre O describe arcs for varying values of I. With values (r_5+r_ϵ) for varying values of I determine the points on these arcs where the perpendicular distance between the impedance circle and the arcs is equal to the value of (r_5+r_ϵ) for similar values of I. These points give the total value of Z_1, corresponding to the current—*i.e.*, the total impedance curve, and the correct phase angles.

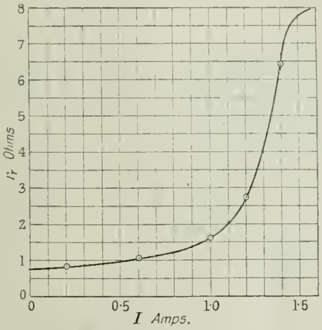


FIG. 7.—CURRENT RESISTANCE CURVE OF THERMAL-REGULATOR.

Project lines radially from O through these points. Upon these lines mark off corresponding values of $I(r_5+r_\epsilon)$ from Table I. These points give the voltage curve to scale 1 cm. =0·3 volt.

The inversion of the total impedance curve gives the total admittance curve to the scale 1 cm.=0·05 mho, or $0·05\times6·2$ =0·31 ampere. Mark off P_{2D} (to scale 1 cm.=0·3 volt) from centre O' cutting voltage curve at point P'. Projecting this point radially on to the impedance curve to point P_1' gives total impedance Z.

Dropping vertical from P_1' to P_{11}' on impedance circle gives external impedance Z_a and Z_s, and the corresponding point of this gives the train-shunt admittance Y_s required for this value of P_{2D}

$$Y_s=0·85 \text{ mho.}$$

By reversing the process the normal value of P_{2C} is found when $Y_s=0$, $P_{2C}=4·26$ volts.

as against 4·2 required.

The current is given on the current curve

$I_{1C}=5·3$, as against 5·04 required.

$I_{1D}=5·9$.

This shows a rise of only 11·3 per cent. in current, with an increase of 68 per cent. in the external admittance Y_{as}. This small rise in current is due to the action of the regulators.

It is obvious from the diagram that the value of Y_s is greatly affected by its inherent phase angle, and since this is the vital factor in safe operation upon which the lives of thousands of railway passengers depend, it is essential that a sure knowledge should exist of its probable and most adversely possible value. Little seems to have been done in this country with a view to determining it accurately, but measurements are shortly to be carried out at Messrs. Tinsley & Company's laboratories on this and other important points, which should be of considerable value to those interested in signalling design and safety.

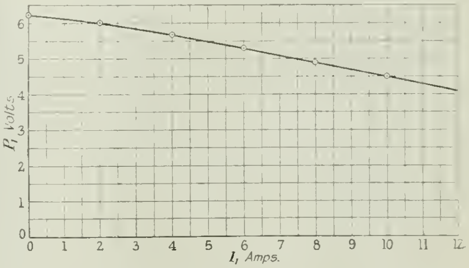


FIG. 8.—REGULATION CURVE OF TRACK-TRANSFORMER (0·9 Power Factor).

Conference of Research Organisations

(*Concluded from p. 230.*)

CONDITIONS OF EMPLOYMENT OF RESEARCH WORKERS.

Ald. **HINCHCLIFFE** (Chairman of Woollen and Worsted Research Association) pointed out that the success of their endeavours in the different fields of research would depend very largely on the generosity and fair-mindedness with which they treated their agreements with research workers. He was certain that unless they made those agreements absolutely fair as between the Association and their workers then they were doomed to failure. The Association had to make numerous agreements with professors and the heads of various educational institutions, and also with investigators. The first standard he would lay down was that they should pay such a salary as to put the investigator in such a position that he had no family anxiety; otherwise his mental effort was detracted from, and he could not give the best service to their work. In the textile industry they were out to tap all the best brains in the country, and they were sending out a notice to be put in every subscriber's factory to the effect that the Association was desirous of encouraging discoveries or inventions in the textile trade, and was prepared to assist financially and by expert advice the promotion of any such discovery or invention. Communications were considered by the director and the Research Control Committee and were treated as strictly confidential. Such an agreement required the most careful and the most generous consideration.

Sir **FRANK HEATH** said he had a letter from the director of the research laboratory of one of the largest engineering works in the country criticising the conditions of employment. The writer said: "One general criticism of this pamphlet is that it regards the research worker merely as an individual and not as one member of a team. The last paragraph of page 2 of the memorandum has in it the germs of a disastrous failure. (That is the paragraph beginning 'Although results must be the property of the Association.') The payment to people of special amounts on account of successful work creates the worst spirit on a research staff.

Firstly, a successful result is hardly ever the work of a single man; it nearly always arises as the result of conversations with and suggestions from others. One has known cases where the research man has received all the essence of an idea from a workman, and one can recall few cases in which much help has not come from colleagues or the director himself. The bestowal of special grants is liable to cause ill-feeling and tends to invite secrecy and exclusiveness. Secondly, the director is responsible for assessing pieces of work of different individuals, and it puts him in an unfair position when he has to give a man a piece of work which, in the nature of things cannot lead to anything for which a special grant could be obtained. I suggest that general individual merit should be rewarded by salary increase, and that successful research work should be rewarded, if thought desirable, by a grant to be divided amongst all members of the research staff, whether they have participated in the successful research or no. The existence and authority of the director of research in any association is ignored in the pamphlet. . . . " "It is important to ensure for the director his proper position and authority, and not to allow research men to feel that he is short-circuited in important matters by reference to the Council. . . . " "Whilst it may be undesirable to publish such things, the majority of the work done in a laboratory can be published, and every encouragement should be given to men to prepare papers for publication. When it is undesirable to publish the results of research there is usually no difficulty in giving an account of the research. It is right, however, that all publications by the staff should be supervised." Finally, the writer criticised the paragraph which states that "The ultimate aim of industrial research is mainly financial profit." "This paragraph is surely untrue. It makes it appear that the main object of industrial research is to make profits thereby. The main object of industrial research is to build up a strong and progressive industry."

Mr. Greenwood (Cotton Research Association) said, generally speaking, he should agree with the writer. The point about paying special bonuses for research was perfectly right, because there was great difficulty in deciding who really had found out or should have the real credit of any particular invention or discovery. Further, if research workers were to know that they would be paid for their services in a great measure by a bonus dependent on the success of their efforts with regard to discoveries, it would militate against getting the very best work from them. It might be that the very greatest discoveries might be made after a certain number of men had laboured in vain, and then, greatly as the result of their labours, someone else would come along and take advantage of their discoveries.

Sir George Beilby, F.R.S., also said he agreed substantially with what had been said in the letter. It was a very difficult and dangerous thing to begin apportioning the special share of credit to each member of a research staff that was to be recognised by a money payment. His own practice had always been rather to give all the able men who were doing their best to improve the manufacture that they were interested in, an interest in the whole of the profits—in the actual results. Giving special prizes, or even special bonuses on actual savings made in a given process, he had found to be dangerous, because the man immediately becomes narrow minded, and he thought of nothing but making his particular department successful and showing how much was saved.

Sir H. Jackson, F.R.S., said that when the idea of some kind of bonus being given to research workers came before him, he viewed it with consternation. It would be impossible for a director to carry out his work under those circumstances. He had already started a scheme which he hoped would be most helpful. On any research being done by any one man, they all met together and discussed it, so that each man who had a little bit of knowledge could add it for the benefit of the one who was carrying it out. The only way was to remember that when you got a good man you should pay him well, and when you had got your good man, give him a feeling of security of tenure by increasing his salary.

Mr. Williamson (Scientific Instrument Research Association) raised a point as to keeping accounts showing the cost of researches. He hoped and believed that most agreements with research workers would be submitted to the department for approval, and he suggested that the department should not interpret that clause narrowly, otherwise it would be almost impossible to arrive at a just estimate of the cost of each research if the work was being done in a Research Institute.

Sir Frank Heath said it was not intended to mean an attempt to put a price against each particular research. The paragraph was only drafted as a very summary sketch of the kind of thing that the Research Associations had to keep in mind. They would value an expression of opinion as to the treatment of the results obtained. It had been suggested to the department rather strongly from one quarter that, supposing a discovery was made by a worker under a Research Association and the discoverer thought it ought to be patented and the Association disagreed with him and said, "Well, we are not specially interested in this, and we are not going to secure this by a patent," it ought to be open to the discoverer to go and patent that discovery himself and to take any benefits that might result from such patent.

Col. O'Gorman (Adhesives Committee of Conjoint Board of Scientific Societies) said he had been concerned with trying to persuade the Institutions of Civil Engineers and Mechanical Engineers, the Institute of Automobile Engineers and another small society, to come together with a view to forming on behalf of the professions which they represented, a common basis of agreement. Of the three Institutions, the only one which had taken any active interest in the matter was the Institution of Automobile Engineers. The cost of world-patenting was represented by £350 to £400, and the number of inventions which 4,000 employees could think of in a year was phenomenal. Firms very often had not got the £400 to waste, for wasted it nearly always would be. Still, the position was a very difficult one indeed. Broadly speaking, he did not think firms attempted to touch the inventions of their workmen, that was to say, the workmen came in without agreement. Designers and draughtsmen, the higher skilled men, were, on the other hand, generally bound by agreement to assign their devices and inventions to the firm, and it was left to the generosity of the firm to reward them. That was a perfectly good arrangement because the firm had considerable inducements to reward them, but what the employee considered obnoxious was the fact that he was prevented from patenting on his own behalf something against the firm by signing a form of agreement. That was such a very big question that, if it were possible for the Research Associations to go to the various Institutions and get some common agreement for the form of an agreement for inventors it would be a very great advantage to all industries and would remove the odiousness of the position into which a firm was put by adopting what appealed to him as a correct solution, namely, that the individual inventor should not be rewarded *ad hoc* for his invention when he was a whole-time employee of a firm. He had found that the proof of good organisation was team work, and the death of team work was individuals pulling against one another, working up secrets and then crystallising them into a patent.

Sir Charles Parsons, F.R.S., said there were many cases in the Law Courts where a man had patented work on which he had been employed and paid by his employer, and he had taken that patent away with him. The decision was always against the man. The man was quite at liberty to patent things done in his own time which he was not employed upon and which had no connection with his employer's business.

Mr. Blakeman (Boot and Shoe Research Association) suggested that in drafting the agreement a definite distinction should be drawn between a worker set on a particular problem by the Association, and a worker who might discover an invention which did not arise in any way from the suggestion of the Association.

Sir Frank Heath replied on the discussion, and said what they had done was to take power to approve of agreements. It would be a long time before there was any attempt to standardise agreements. It was the sort of subject which he would like to suggest might come up again at a further conference.

Co-operation of Research Associations.

Col. O'Gorman gave an address on "Co-operation amongst Research Associations for the Study of Accessory Materials or Equipment." Co-operation, which was the chief keystone in the house of each research association, was also what might be termed the quarry material which must be used to build up the greater edifice in which all research associations took part. Co-operation was, of course, directed in industrial organisations to securing industrial advantage, but for all that co-operation was dependent on the continued exercise of self-denial for its cohesive quality. The research associations were concerned with the study of materials and methods, some of which were found to be equally interesting to many of the neigbouring industries. He could not take a better example than glue and its analogues, adhesives and cements. Scientific progress made at the instance of aircraft workers proved to be interesting and profitable to furniture makers, piano builders, manufacturers of ply-wood, shipbuilders, makers of felt hats, the woollen textile industries, papermakers, and many others. It was clear that a body could with difficulty be elected to voice with a nice balance of proportional representation such diverse interests, even within the limited sphere which they had in common. Where the industries did not compete with one another co-operation for the common end could more easily be initiated than where there was competition. It was precisely for the study of accessory materials that one might hope to get more easily joint support, than co-operation, for research. As regards adhesives, there had been conducted, for an expenditure of about £1,000 (spent in one year), an astonishingly successful exploration of what in itself appeared to be a dull and unpromising territory. As soon as legitimately possible the results would be made public, and when they were made available no less than 12 significant industries would owe a very considerable debt of thanks to the aircraft people. In conclusion, he put it to the meeting to suggest the names of other subjects than adhesives, where the associations might associate for their mutual good by forming committees like the Adhesive Committee.

Sir Frank Heath said it had been suggested that the best procedure would be the appointment of joint committees which might include representatives of a number of associations, and that these joint committees should have specific problems referred to them, and that by agreement between the various associations contributions from those associations should be made by which the researches could be financed. Refractories was a subject which was of very great interest to a large number of industries. It had been suggested that the best way of dealing with refractories for glass was to have a joint committee of the Glass Research Association and the Refractories Research Association working out refractories specifically from the point of view of the different industries. Refractories happened to be a subject which would force the new association into very close relationship with a whole ring of other associations, but there must be a number of subjects similar to the one referred to by Col. O'Gorman, where two or more research associations were directly interested.

Ald. Hinchcliffe said his association had come to the conclusion that when the other kindred associations were properly formed it might be desirable for the associations to have an interchange of members. When the associations were formed there might be a conference of those associations to discuss the problem. The voluntary system had objections, because it tended to encourage applications to firms outside the industry itself.

Note on a Universal Switch for Delicate Potential Measurements.*

By WALTER P. WHITE.

In 1916 a description was published of a universal switch for thermo-electric and other delicate work.† The instrument combined two features, a contact between thin leaves of copper with sheet celluloid insulation and a mechanical arrangement for making the contacts simply and for changing the combination quickly. The actual instrument has now had over a year of trial and has proved satisfactory, but two modifications have been found advantageous, which deserve publication. The two diagrams are reproduced from the original article. One modification concerns the contacts between the "auxiliary-connecting frames" and their bus bars. In the earlier apparatus the only contacts were like the contacts between the thermo-electric leads and their bus-bar in the present one, and the making of these contacts evidently involves a slight amount of rubbing, which promoted satisfactory performance. The similar contacts in the present one are equally satisfactory, but the auxiliary-connecting contacts, which occurred between two bodies moving in the same straight line, required frequent cleaning. It therefore seemed best to introduce a little rubbing here. This at once made these contacts as satisfactory as the others, and is by all means to be recommended. It was done by making the farther end of the auxiliary-connecting bus-bar travel on an inclined plane (laid under each end of the rod, *R*), while the sliding frames still move horizontally. Friction against the "*fixed auxiliary-connecting frame*," against which the bus-bar returns, could be provided by giving this frame a little horizontal travel, with a spring to press it towards the bus-bar. The total travel of the operating rod is increased by the same amount.

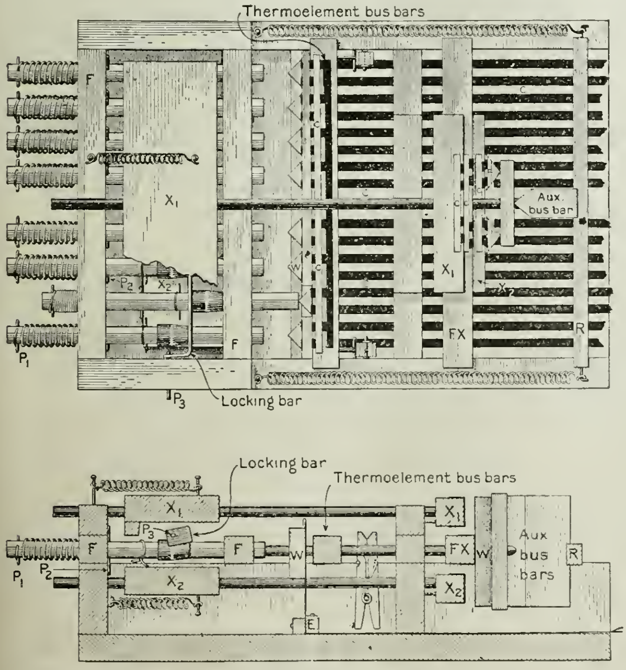


Fig. 1.—Top View and Section of the Universal Switch, ¼ Full Size.

Full black shows copper; clear white, C, celluloid insulation; shaded, wood or metal. Each of the eight rods, when pushed forward like the second one above, presses one of the wooden wedges, *w*, and with it two flexible flat copper thermo-element leads (or leads from some other unknown E.M.F.), against the *thermo-element bus-bars*, which are copper strips connected to the measuring apparatus. At the same time the pin P_2 in the rod may push one of the *movable auxiliary-connecting frames* X_1, X_2 against the *auxiliary bus bars*, thus connecting in the set of potentiometer dials, or other auxiliary, which it is desired to use with that particular thermo-element. When P_2 is horizontal, the *fixed frame* FX makes the connection. Change of combination is instantly made by rotating the rod.

The method adopted involved less change in an instrument already constructed, and is perhaps as good in any case. The bus-bar, raised by the inclined plane in its backward travel, remains up as it returns to the fixed frame (to secure this the spring was shifted so as to exert a lifting action), and is then pulled down by a bell crank, operated by the further return of the sliding frame. This pulling down gives the rubbing. Motion is transmitted to the crank by a whiffletree attached to the two sliding frames, so that the return of either pulls down the bus-bar. The arrangement was constructed in about 2 hours, mainly from strips of sheet brass. Rather thin bakelite of good insulating quality can now be bought ready cut into strips, so that instead of fastening copper strips on the wooden bars by means of sheet celluloid, it may be more advantageous to pin them to bakelite which is fastened to the wood, provided that there is no machining of the edges of the strips. This construction is somewhat more robust.

The Prospects of Automatic Telephony in the United States.

Telephone companies are finding rapidly increasing difficulty in maintaining the efficiency of their operating organisations, especially in the larger cities. To train an operator completely usually requires special instruction for several weeks or even months, and the large telephone companies have for years been compelled to maintain schools for training the large number of beginners continually needed to replace gaps. In the United States, according to the "Electrical Review" (U.S.A.), the percentage of marriages among telephone operators is extremely high, although in some European countries spinsters and widows continue the work until they reach ages even as advanced as 70. Another reason for the gaps among operators is that most companies have not been able to pay very high salaries so that operators are attracted to other more remunerative occupations. Some girls also find the work too strenuous. In short, the gaps are no sooner filled than they open again, so that there is a continual procession of girls training, working a short time and quitting. This high labour turnover is expensive, and incidentally accounts very largely for justifiable complaints of poor service.

It is not surprising, therefore, that the largest telephone companies have at last turned to automatic telephony. The new policy of the large Bell companies is to change over to automatic equipment those exchanges that have the heaviest traffic, incidentally making other rearrangements of offices, cables, &c., as would promote economy. The advantages of automatic telephony was recognised many years ago, but as many millions of dollars of investment were tied up in manual switchboards, any sudden change to automatic would mean losing much capital through discarding of equipment, and the raising of new capital to purchase the automatic apparatus.

Now, however, it becomes financially expedient to change over, and in the larger cities automatic telephony will make rapid headway.

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* Abstract of a communication to the "American Journal of Science."

† "Am. Jour. of Science," 41 307, 1,916.

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Electricity for Agriculture.

In view of so much that has been said on the question of electricity for agriculture, and the facile and somewhat irresponsible foreshadowings indulged in by various statesmen and others as to the benefits our country friends in rural districts would have showered on them in the near future, it is gratifying to note that the Government have given an earnest of their promises in a practical form. We refer to the grant and loans which have been approved for the Hereford electric supply department. The Ministry of Reconstruction and the other Government Departments interested are arranging for a considerable loan in order to extend the electric supply to the rural district round Hereford, and a grant has also been given of £9,770 per annum under the Development and Road improvement Funds Act, 1909. The application of this Act in connection with electricity supply is of particular interest to all undertakers in agricultural districts. Such grants could not, of course, be given to a company, since the grant is allowed only to bodies which are not trading for profit. At the same time, it is obviously open for a grant to be given to the Urban or Rural Council where the company is operating, which practically amounts to the same thing. It may be of interest to quote the actual text of the section in Part I. of the Act relating to "Development." It runs as follows:

> The Treasury may, upon the recommendation of the Development Commissioners appointed under this Act, make advances to a Government department, or through a Government department to a public authority, university, college, school or institution, or an association of persons or company not trading for profit, either by way of grant or by way of loan, or partly in one way and partly in the other, and upon such terms and subject to such conditions as they may think fit, for any of the following purposes.

The "purpose" which affects the subject we refer to is as follows:—

> Aiding and developing agriculture and rural industries by promoting scientific research, instruction and experiments in the science, methods and practice of agriculture (including the provision of farm institutes) . . . . and by the adoption of any other means which appear calculated to develop agriculture and rural industries.

This instance at Hereford of a practical encouragement being given to electric supply for agriculture (which, of course, demands outside financial assistance, seeing that it is impossible to make it immediately remunerative) is particularly welcome in view of the somewhat equivocal position which it has occupied in the debates of Committee B during the progress of the Electricity Bill. The only time, indeed, when any strong views on this point were expressed was when Sir A. Williamson urged the matter on the second reading. He said:—

> With regard to agricultural development, we had evidence that we are on the eve of great changes, and if cheap power were available there is no saying how far development might go in rural as well as in urban districts. People rather shake their heads at that, but the evidence we had before us distinctly declared that the development of cheaper electricity in agricultural districts would prove to be a very important factor.

Generally speaking, the results of the Hereford scheme will be, presumably, of a certain amount of importance in affording the Government some grounds for further extending their salutory assistance in this direction. The matter, we are glad to say, is in good hands, since Mr. Kerr, the Hereford electrical engineer, has already earned commendation from the Ministry of Reconstruction, as will be seen by reference to their brochure on "Electrical Development," where the work done by Mr. Kerr in adapting electricity to the purposes of agriculture is quoted in detail.

It is to be noted that the Development Act above quoted covers the furtherance of rural industries as well as agriculture, and the Ministry of Reconstruction is also urging the national benefits of such industrial reconstruction. Sir A. Williamson spoke on this point in the House with conviction: "If cheap power," he said, "were available in rural districts, there would no longer be any reason why manufactories should be put up in crowded centres, and if we can have those manufactories in rural districts there will be more space, more light, more air and more sunshine for the people who work in them."

As to a practical point for our readers, a good deal of pioneer work can be done by electric supply undertakers in country areas, whether municipal or company. An indispensable condition to any scheme, either for agricultural development or for the reintroduction of rural industries, is outside support, and it is therefore up to the undertakers to stimulate the interest of their Urban and Rural Councils and urge them to local activity, with a view to their obtaining Government support financially where required. There is usually a very considerable amount of latent enthusiasm and goodwill in these local districts, and this only needs some practical proposition, such as might be put forward by the supply undertaking, to crystallise into definite and beneficial action, beneficial to the district and also to the electric supply undertaking.

Review.

Multiplex Telephony and Telegraphy by Means of Electric Waves Guided by Wires. By Major-General George O. Squier, Ph.D. (Washington: Government Printing Office.) Pp. 102.

This is a convenient-size little book, 9 in. by 6 in. by 0·3 in., bound in dark-green stiff cloth. The work proper covers about 60 pages, the remainder being a reprint of four U.S.A. patent specifications relating to General Squier's inventions in multiplex telephony and telegraphy. The first portion of the book is a January, 1919, reprint of investigational records by the author in 1911, issued from the U.S. Signal Corps Research Laboratory, Bureau of Standards, Washington. The book, therefore, replete though it is with important original matter clearly and tersely explained, lays no claim to include later research results obtained in the U.S. Service by the author himself, and by others, as also in the British and French scientific Services during the imperatively inventive period covered by the recent war. Incidentally, regarding the same limitation, it is from pure regard and respect for the author that one ventures to express regret that in this 1919 edition of his work, he did not strain a point in favour of inclusion of some reference to his valuable work of 1917 dealing with *multiplex* in long submarine-cable telegraphy, based on simultaneous use of three or more alternating-current sine-wave series severally of different frequencies. Although this matter has no direct bearing on telephony, it may be sufficiently cognate for inclusion in General Squier's useful book.

The earlier portion of the present book is illustrated by two nearly full-page photographs. The first shows an U.S. Service alternating generator of the inductor type, driven by a shunt-wound 10 H.P. motor, and a De Laval turbine gearing—ratio 10 to 1—at 20,000 revs. per min., and giving 2 kw. at 100,000 cycles per second—practically pure sine waves. The second photograph affords another view of the alternator, including, also, a switchboard.

Further illustrations include 10 diagrams of multiplex telephony and telegraphy circuit connections, and 13 sheets of curves. There are also 12 tables covering all ranges of working requirements.

The second portion of the book, namely, the four U.S.

patents Nos. 980,356, 980,357, 980,358 and 980,359, include 20 diagrams of multiplex telephony and telegraphy working connections.

General Squier's book, apart from his patent specifications—which, by the way, are inscribed, "Dedicated to the public"—is divided into five sections, including an "Introduction" and a "Summary." The first deals with apparatus and equipment, the 100,000 cycle generator, and constants of a telephone line. The second covers duplex telephony using (*a*) one earthed circuit, and (*b*) metallic circuit: silent-earth circuits and resonance phenomena. The third deals with duplex-diplex telegraphy. The fourth concerns measurements on a standard telephone cable line, of wave frequencies from 20,000 to 100,000 ~ per second. This matter includes resonance curves; coefficient of coupling; function of stiffness L/C; selectivity curves; electrical dimensions of tuning elements; transmitting impedance at resonance by voltmeter-ammeter method; and the plotting of an attenuation-frequency curve at the receiving end of a telephone cable.

The general trend of the author's work as portrayed in his book indicates how, by means of electromagnetic waves or oscillations of high frequency propagated by means of wires, simultaneous transmission of a plurality of telephonic and telegraphic messages may be effected over (1) a single circuit, or (2) over a combination of earthed and of metallic circuits; with (3) a further object of rendering such a system silent to external disturbances, and immune from cross-talk. An interesting point is that the author, in accomplishing his scheme, has combined the engineering practice of wireless telegraphy and telephony with that of wire telegraphy and telephony, making use of such detectors as are commonly used in wireless telegraphy.

The necessary experimental work detailed in this book was carried out under the direction of the author over a seven-mile standard telephone cable between a research laboratory outside Washington and a construction laboratory of the U.S. Signal Corps in the same city. At each of these stations were also wireless telephone and telegraph installations with suitable antennæ.

All this quite aptly illustrates the contention long since urged by General Squier, namely, that radio engineering is merely an extention of the much older wire telegraphy. This thesis was cogently sustained by him in his contribution (January 20, 1916) to the discussion of Mr. H. H. Harrison's I.E.E. Paper, "The Principles of Modern Printing Telegraphy." In fact, to quote General Squier: "It seems possible that some day we may be able to have a perfectly general telegraph equation which will contain sufficient terms to apply to any case, from pure radio transmission, through wire practice, down to ocean cable telegraphy, by substituting the proper value of *n*, the frequency."

E. RAYMOND-BARKER.

A Simple Derivation of the Formulae for the Resonance Curves of a Damped Vibration and Some Properties Thereof.

By BALTH. VAN DER POL, Jun., D.Sc. (Utrecht).

(Concluded from p. 228.)

With these approximations the equations (14) and (15) obtain the very simple form

$$\left.\begin{aligned}(a_1+a_2)\int_0^\infty i_2sdt+(\omega_2-\omega_1)\int_0^\infty i_2cdt&=\frac{E}{2L}\int_0^\infty s^2dt\\-(\omega_2-\omega_1)\int_0^\infty i_2sdt+(a_1+a_2)\int_0^\infty i_2cdt&=\frac{E}{2L}\int_0^\infty scdt\end{aligned}\right\}\quad .\quad .\quad (15)$$

The next thing to be done is the evaluation of the integrals in the right-hand members of (15). Now the function under the integral sign of $\int_0^\infty s^2dt$ is over the whole range positive, but the same of $\int_0^\infty scdt$ is an alternating function. This at once suggests that these two integrals are of different order of magnitude. In fact, we have

$$\int_0^\infty s^2dt=\int_0^\infty e^{-2a_1t}\sin^2(\omega_1t+\varphi)=\tfrac{1}{2}\int_0^\infty e^{-2a_1t}\,dt-\tfrac{1}{2}\int_0^\infty e^{-2a_1t}\cos(2\omega_1t+2\varphi)dt.$$

Of the latter two integrals, the first only is of importance, being equal to $\frac{1}{4a_1}$, while the second is very approximately zero as the damping factor a_1 being small, the successive half cycles above and beneath the axis of abscissæ practically annul each other. We therefore obtain

$$\int_0^\infty s^2dt \cong \frac{1}{4a_1}.$$

The other integral, $\int_0^\infty scdt=\frac{1}{2}\int_0^\infty e^{-2a_1t}\sin(2\omega_1t+2\varphi)dt$, containing only an oscillating part, vanishes for the same reason why the second part of the former integral was zero; hence

$$\int_0^\infty scdt \cong 0.$$

The application of these legitimate approximations shows the relative unimportant part played by the quite arbitrarily introduced initial phase φ, for here the latter completely drops out, and this fact proves in a general way that if the damping factors are small the influence of the initial phase φ on the form of the resonance curves is negligible.

The equations (15) therefore reduce to

$$(a_1+a_2)\int_0^\infty i_2sdt+(\omega_2-\omega_1)\int_0^\infty i_2cdt=\frac{E}{L}\cdot\frac{1}{8a_1}\quad .\quad .\quad (16a)$$

$$-(\omega_2-\omega_1)\int_0^\infty i_2sdt+(a_1+a_2)\int_0^\infty i_2cdt=0\quad .\quad .\quad .\quad .\quad (16b)$$

Solving these two equations for $\int_0^\infty i_2sdt$ and $\int_0^\infty i_2cdt$, we have

$$\int_0^\infty i_2sdt=\frac{E}{8La_1}\cdot\frac{a_1+a_2}{(\omega_2-\omega_1)^2+(a_1+a_2)^2}$$

and

$$\int_0^\infty i_2cdt=\frac{E}{8La_1}\cdot\frac{-(\omega_2-\omega_1)}{(\omega_2-\omega_1)^2+(a_1+a_2)^2}.$$

The definitions (4) and (5) finally give:—

The mean square current in the secondary is

$$B=\frac{NE^2}{L^2}\,\frac{a_1+a_2}{16a_1a_2\,\{(\omega_2-\omega_1)^2+(a_1+a_2)^2\}}.$$

which is the well-known Bjerknes formula, and the deflection of the dynamometer is

$$P=\frac{NE^2}{ML}\,\frac{\omega_2-\omega_1}{8\omega_1a_1\,\{(\omega_2-\omega_1)^2+(a_1+a_2)^2\}}.$$

This latter expression agrees with the formula obtained by Mandelstam and Papalexi if in their more general result our conditions *a*—*d* are introduced.

Before indicating some of the many properties these curves possess we will first consider in more detail their physical meaning. The curve B (of the first type) represents the total amount of energy absorbed by the secondary from the primary at different natural frequencies of the secondary. That with the conditions imposed on the system this energy distraction is a maximum when the two circuits are in tune follows at once from the general definition of "resonance." The second curve (P), on the other hand, being proportional to $2M\int_0^\infty i_1 i_2 dt$, represents the arithmetic mean value of another form of energy, viz., the mutual magnetic energy of the two coupled circuits. This latter form of energy changes its sign when *only one* of the two currents i_1 and i_2 passes through zero. It will, therefore, occasionally have the property unusual for energies of being negative. This difficulty can, of course, at once be removed by transferring its mathematical expression to the other member of the equation where it occurs, it there having the proper positive value. That the arithmetic mean value of this energy when a series of damped oscillations are present is zero for resonance is difficult to predict. The more extensive investigation by Mandelstam and Papalexi is fully confirmed by our simpler, less general analysis.

The curves B and P (*see* Fig. 2) show a striking resemblance with the variation of absorption and the square of the refractive index of a dispersing medium near an absorption line. This is not to be wondered at when it is remembered that similar phenomena take place in the optical analogy in so far as energy is absorbed from light waves travelling through a medium having one or more natural frequencies. In fact, the above analysis shows that, keeping the amplitude of the impressed E.M.F. constant, similar curves will be obtained when the frequency of the primary is varied instead of the frequency of the secondary.

Another interesting analogy is to be found in the change with frequency of the motional resistance and reactance of a telephone receiver as found, *e.g.*, by M. Wien, and lately investigated in more detail by Kennely.[*]

Here, again, a system is present having its own natural time period or periods—viz., the diaphragm of the receiver. This diaphragm shall in general extract the more energy from an alternating potential source the nearer its natural frequency is again to the frequency of the impressed E.M.F. A detailed theoretical investigation by Poincaré on the influence of the motion of the diaphragm on the currents in a telephone receiver, based on Lagrange's equations, shows that, when the losses due to hysteresis and eddy currents are neglected, and when the diaphragm is considered as having one degree of freedom only, somewhat similar functions are obtained for the motional resistance and motional reactance for undamped sinusoidal currents as the B and P functions respectively.

The simple form in which the B and P functions were found above, enables one to obtain a series of interesting properties of and relations between these functions. So far as I am aware, these relations have nowhere been stated explicitly. This may be due to the more complicated form in which at least the P function was obtained.

Both functions contain a constant factor that is immaterial as far as the functional relation is concerned with regard to the amount of detuning $(\omega_2 - \omega_1)$. If we drop these factors and only consider the functions,

$$B_1 = \frac{a_1 + a_2}{(\omega_1 - \omega_2)^2 + (a_1 + a_2)^2},$$

and

$$P_1 = \frac{\omega_1 - \omega_2}{(\omega_1 - \omega_2)^2 + (a_1 + a_2)^2},$$

we still retain all their peculiar properties. They can further be combined as follows :—

$$P_1 + iB_1 = \frac{1}{(\omega_1 - \omega_2) - i(a_1 + a_2)},$$

subject to the condition that both P_1 and B_1 are real. The well-known and valuable peculiarity of B_1 that the breadth of this curve at a point half way up the height of its maximum is equal to twice the sum of the damping factors $[2(a_1 + a_2)]$ is too well known to be discussed here in any detail. [*See* Fig. 2 where $AD = 2(a_1 + a_2)$]. Again the distance of the abscissae of the maximum and minimum of the curve P_1 is equal to the same quantity. [Fig. 2 where $FG = 2(a_1 + a_2)$]. When, further, the two curves are superposed on the same system of co-ordinates they cut at a point A half-way up the height of the maximum of B_1. This point of intersection is at the same time the maximum of P_1. It is further a point of inflection of B_1 where the latter changes from convex to concave. All these relations follow directly from the simple expressions for B_1 and P_1 and it is, therefore, not necessary to give here any proof.

If, further, the square of the mean square current in the secondary (B_1^2) is added to the square of the indications of the dynamometer, again a curve is obtained of the form of the mean square current in the secondary—*i.e.*, of the form of B.

Another relation between these functions can at once be obtained from our equation (16*a*). It can be expressed as follows : If the deflection of the dynamometer for every frequency is multiplied by the amount of detuning for each corresponding frequency $(\omega_1 - \omega_2)$, a resonance curve of the first type (B) is obtained, but upside down. In Fig. 3, *e.g.*, AD is multiplied with DF, and the quantity thus obtained set off vertically (AE). If this is done for all points of P_1 the curve G is obtained, which is a reversed resonance curve of the ordinary type.

Again, (16*b*) furnishes the relation that if every ordinate of a resonance curve of the first type (B) is multiplied with the amount of detuning corresponding to that ordinate, a resonance curve of the second type (P) is obtained (*see* Fig. 2).

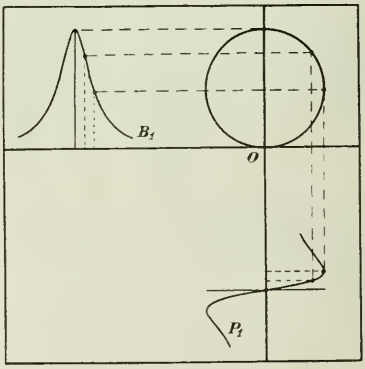

Fig. 4.

Another peculiarity of these curves has first been found experimentally for the motional reactance and resistance of telephone receivers. When, namely, in a system of rectangular co-ordinates abscissæ are set off equal to the deflection of the dynamometer (P), and the corresponding ordinates are given a length proportional to the mean square current in the secondary (B), an ellipse will be obtained. If a suitable constant be chosen, the ellipse becomes a circle (*see* Fig. 4, which explains itself). In our case the centre of the circle lies on the axis of ordinates, while in the telephone experiments[*] the centre is shifted. This may possibly be due to hysteresis or eddy current effects.[*]

Obviously, many other relations between the functions B and P can easily be found. Some of the properties of these functions expounded above can be obtained directly from the differential equations without actually solving them. They all apply equally well when, instead of a damped sinusoidal E.M.F., a simple harmonic voltage is impressed. In this case the analysis is, of course, still simpler.

In conclusion, we wish to point out again that the expressions obtained for the functions B and P are only correct subject to the four conditins a—d set out at the beginning, these being the usual conditions that have to be fulfilled in nearly all experimental work on resonance.

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[*] *See, e.g.*, Taylor, "Proc." Inst. of Radio Engineers. Vol. VI. (1918), p. 37.

[*] *See* Paper cited.

[†] *See* also Eccles, "Handbook of Wireless Telegr. and Teleph.," second edition, p. 350.

Large Power Transformers.*

By A. G. ELLIS and J. L. THOMPSON.

Summary.—The authors first refer to the progress towards increased size of modern stations, generating units and transformers, and the tendency to higher pressures. Limiting sizes of transformers as effected by handling and cooling are discussed, and prices per kilovolt-ampere in relation to output, voltage and cooling are presented. The condition affecting choice of types and relative advantages of shell and core transformers are next dealt with. Subsequently safety factors, transformers for interlinking and the operation and care of transformers (switching in and out, drying out, &c.) receive attention. The final section of the Paper discusses the influence of war conditions.

1. Development.

Modern developments and future progress in electrical power generation and distribution tend towards centralisation of power and an increase in the sizes of power stations and of generating and transforming units. Within the last decade the average and practicable sizes of generating and transforming units have increased practically tenfold; to-day the size of unit for large stations is from 15,000 kw. to 50,000 kw. Generation voltages up to 11,000 volts, and transmission voltages up to 150,000 volts have been used in America and on the Continent. In this country the transmission voltage has hitherto not exceeded 30,000 volts, but schemes for 60,000-volt transmission are under consideration. The home demand for large and high-voltage transformers will in the near future thus be much extended. It is now proposed, first, to examine the possibilities and limitations of large and high-voltage transformers, as regards conditions of manufacture, transport, handling, installation and operation; and, secondly, to inquire into various questions regarding transformers which present themselves to engineers engaged in the design of large installations.

2. Limiting Sizes of Transformers.

For home service it is usually desirable to transport transformers complete in their tanks, thus minimising erection work and cost; also to ship the transformer complete in oil, generally obviating drying out on site. The size of transformer which can be transported and handled complete is limited by the loading gauge restriction and maximum truck size and loading, and by the handling facilities and crane capacity on the customer's premises. Crocodile trucks up to 50 tons loading weight are available in this country, with maximum loading dimensions of 30 ft. in length, 8 ft. 5 in. in breadth, and 11 ft. 8 in. in height. From these data the maximum rating of single and three-phase transformers of the self-cooled and artificially cooled types which can be shipped complete (with terminals removed) can be determined.

Transformers Shipped Complete in Oil.

(*a*) *Oil-immersed Self-cooled Transformers.*—The maximum rating is limited by the radiating surface of a tank of overall dimensions within the above limits. Such a tank could be constructed to radiate a total loss of about 50 kw. with a temperature rise of 50 deg. C. This would be practically the total loss of a three-phase 50-cycle transformer of about 5,000 k.v.a. whose efficiency would be practically 99 per cent. at full load. For a single-phase transformer the maximum rating is further determined by the shape of the carcase, limiting the rating for shipment complete to about 3,000 k.v.a. at 50 cycles.

The above approximate limits are for voltages up to 50,000, but are not much influenced by voltage or type of construction for fairly large outputs. For 23-cycle transformers the limiting ratings are about 70 per cent. of the 50-cycle limits—*i.e.*, about 3,500 k.v.a. three-phase, and 2,000 k.v.a. single-phase.

(*b*) *Oil-immersed Water-cooled Transformers.*—The maximum rating of water-cooled transformers with internal cooling coils is limited by the space required for these coils in the tank. This consideration limits the practicable sizes to about 15,000 k.v.a. three-phase, and 10,000 k.v.a. single-phase at 50 cycles. Such transformers come well within the limits given in the next section for forced cooling.

(*c*) *Oil-immersed Forced-cooled Transformers.*—For water-cooled transformers the rating is limited only by the internal dimensions of the tank and the necessary clearance between windings or carcase and tank sides. A three-phase transformer filling out such a tank would have a rated output of approximately 40,000 k.v.a. for voltages up to 50,000. Its weight, excluding tank and oil, would be about 37 tons. The tank would weigh about 8 tons and contain about 13 tons of oil, making the total weight 58 tons. In a factory or a power station handling such large transformers a crane would be installed for at least 50 tons.† A transformer could be withdrawn from its oil on site, the tank with oil lifted off the track and placed in position, and the transformer then lifted back into the oil during a few hours. Thus, the transformer windings would not absorb any appreciable moisture, and full advantage would thus be taken of drying out in the factory before shipment. The use of such large units is only possible in a well-designed station with a properly laid-out transformer house having sufficient headroom. The overall height of a 40,000 k.v.a. three-phase transformer would be about 11 ft. 6 in. (excluding terminals), and thus about 28 ft. total headroom from crane hook to floor would be required.

Where sufficient handling facilities are not available, smaller three-phase units would have to be used, or a group of three single-phase units each of one-third the group capacity. The largest single-phase transformer that could be shipped complete in oil within the prescribed dimensions is also limited by the shape of the transformer carcase. Actually the limiting single-phase rating is about 25,000 k.v.a. at 50 cycles and 50,000 volts. The weights of such a transformer would be approximately: Transformer, 23 tons; tank, 6 tons; oil, 8 tons; complete with oil, 37 tons.

Transformers Shipped Dismantled.

For transformers shipped dismantled and erected on site the limiting ratings can be further increased.

(*a*) *Oil-immersed Self-cooled Type.*—For three-phase transformers the limits are the same as when shipped complete, but large self-cooling tanks for single-phase transformers can be transported laid on their side. The limiting ratings may thus be increased by about 25 per cent.—*i.e.*, to about 3,750 k.v.a. at 50 cycles, and 2,500 k.v.a. at 25 cycles up to 50,000 volts. These can be still further increased by resorting to a construction of self-cooling tank with detachable radiating pockets. This type of tank is widely used in America. The tank is shipped with the external radiators dismantled and subsequently attached to the tank on site.

The limiting single-phase rating would thus be increased to about 6,000 k.v.a. at 50 cycles, and 4,000 k.v.a. at 25 cycles. For three-phase transformers the limits would be approximately 7,000 k.v.a. at 50 periods and 5,000 k.v.a. at 25 periods.

(*b*) *Oil-immersed Water-cooled Type.*—Here there is no gain in the three-phase limiting rating in shipping dismantled, as the output is restricted to about 15,000 k.v.a. 50 periods by the size of the cooling coil. The single-phase limit may be increased 50 per cent.—*i.e.*, to 15,000 k.v.a. 50 periods if the tank is transported on its side or constructed in two sections built up together on site.

(*c*) *Oil-immersed Forced-cooled Type.*—By shipping the transformer dismantled and the tank in two or more sections the possible output is limited only by the crane capacity. From the manufacturing standpoint any size of transformer can be constructed that is likely to be called for with the largest generating units. Assuming a 50-ton crane, the limiting rating for a three-phase 50,000-volt transformer would be about 50,000 k.v.a. at 50 cycles, and 25,000 k.v.a. at 25 cycles.

3. Price and Weight.

The principal factors which influence the price and weight of transformer units are: (*a*) Whether single or three-phase, (*b*) frequency, (*c*) voltage, (*d*) method of cooling. Other considerations are questions of temperature rise, overload capacity, and special structural requirements.

In Figs. 1a and 1b we have typical representative curves of price and weight per kilovolt-ampere, showing the influence of the four variables, (*a*), (*b*), (*c*) and (*d*) above. These curves are all based on the British standard rating—*viz.*, 50°C. temperature rise in oil, with 40°C. air temperature and no overload capacity at this air temperature. A few general explanatory observations may be helpful:—

(*a*) *Single v. Three-phase.*—In general a large single-phase transformer is about 7 to 10 per cent. cheaper and about 12 to 15 per cent. lighter than a three-phase transformer of the same rating. A large three-phase transformer is, however, about 5 to 8 per cent. cheaper and 10 to 15 per cent. lighter than a group of three single-phase transformers of the same three-phase group capacity.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

† A turbo-generator set for 40,000 kw. 1,000 r.p.m. would require a crane of 100 tons to handle the heaviest parts of the plant.

(*b*) *Frequency.*—On the average, large 25-cycle transformers are some 35 per cent. dearer and 40 per cent. heavier than 50-cycle transformers of the same rating.

(*c*) *Voltage.*—The curves are shown for two high-tension voltages—viz., 11,000 and 55,000 volts, and for a maximum low-tension voltage of 6,000 volts. As a rough guide it may be taken that the price and weight increase by 1 per cent. for the smaller ratings, down to 0·6 per cent. for the largest ratings, per 1,000 volts normal pressure above 11,000 volts. The influence of the voltage is greater the lower the rated output, as the frames are smaller and the copper factor of the windings decreases more rapidly with increasing voltage.

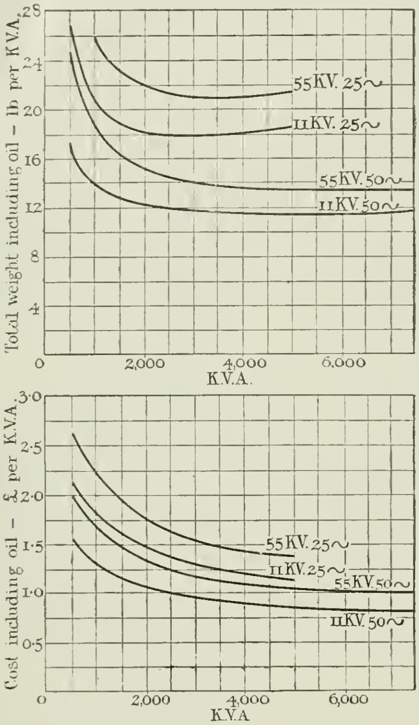

Fig. 1a.—Curves of Approximate Weight and Price per Kilovolt-ampere Rated Output for Three-phase Oil-immersed Self-cooled Transformers.

(*d*) *System of Cooling.*—The curves shown all refer to oil-immersed transformers, self-cooled up to the practicable limits of rated output, and water-cooled or forced-cooled (with external oil circulation) for all rated outputs up to the maximum figures given in sec. (2). At 1,000 k.v.a., 50 periods, the present-day prices of the self-cooled and water-cooled types are not appreciably different; the larger self-cooled units are, however, appreciably dearer than water cooled, up to a difference of 15 to 20 per cent. This may be to some extent offset in certain cases by the cost of water, pumping storage, &c.

4. Choice of Type.

(*a*) *Cooling.*—The system of cooling adopted is determined largely by the size of unit involved and the situation and cooling facilities available. For units of capacity up to the limiting sizes of self-cooled transformers given in sec. (2), the following broad lines may be laid down.

For isolated sub-stations where continual attendance is not available, self-cooled units are to be recommended up to 5,000 k.v.a. three-phase and 3,000 k.v.a. single-phase at 50 cycles. The same applies to sub-stations with continual attendance and power stations where cooling water is dear.

There is a decided tendency nowadays towards large self-cooled units for sub-stations. The air temperature should not exceed 25°C. if possible. Ample headroom should be provided, and good clearances between the tank and adjacent wall or cubicle. The latter should not be less than 1 ft. to 2 ft. up to 1,000 k.v.a., and 2 ft. to 3 ft. for larger sizes. The sub-station or cubicles should be provided with ample air ingress and egress to ensure circulation—*i.e.*, 200 cubic ft. per minute per kilowatt loss for a temperature rise of air of about 10°C. With fireproof cubicles the ventilating apertures might be fitted with automatic dampers to close at a set maximum temperature such as would be attained in case of fire; a figure of 150°C. would suffice.

In power stations or sub-stations with attendance, where a plentiful and cheap water supply is available, water-cooled units are recommended for outputs above the following: 2,500 k.v.a. three-phase 50 cycles, 1,700 k.v.a. three-phase 25 cycles, 1,500 k.v.a. single-phase 50 cycles, 1,000 k.v.a. single-phase 25 cycles. Forced cooling with external oil circulation is to be recommended above the following limits: 5,000 k.v.a. three-phase 50 cycles, 3,500 k.v.a. three-phase 25 cycles, 3,500 k.v.a. single-phase 50 cycles, 2,500 k.v.a. single-phase 25 cycles. This system of cooling has several advantages—viz., better oil circulation is obtained in the transformer and a more uniform cooling of the windings; smaller headroom is required, which may be of importance in large units; several transformers may be cooled by a common cooler; less risk of water getting into the oil as the pressure of the oil in the cooler is maintained higher than that of the water. The oil circulation required is 0·66 gallon per minute per kilowatt loss for 15°C. fall in temperature of the oil, or 1 gallon per minute per kilowatt for 10°C. fall.

The water-cooled type is generally cheaper than the self-cooled, but the interest on the saving in capital outlay must be set off against the annual cost of cooling water. In large installations where water is scarce and dear a reservoir and water-cooling plant may profitably be installed. Water-cooled or forced-cooled units offer the advantage of better space economy. If water is not available or is dear, recourse must be had to air-blast cooling with either oil-immersed or dry-type transformers. The latter type (dry type) is preferably not used for voltages above 20,000 volts on account of the insulation question. Where air-blast transformers of either type are installed, continual attendance is necessary, as the ventilating fans must be kept running.

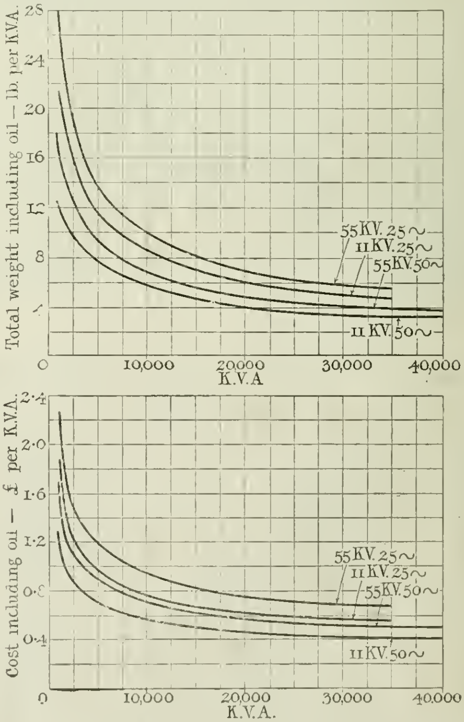

Fig. 1b.—Curves of Approximate Weight and Price per Kilovolt-ampere Rated Output for Three-phase Oil-immersed Forced-cooled Transformers.

(*b*) *Single v. Three-phase.*—The principal factors affecting the choice of single-phase or three-phase units are capital cost, floor space, spares, and continuity of supply. Where a number of groups are installed three-phase units are more suitable; where few groups are installed single-phase. The latter units ensure greater reliability of supply, as a group of three single-phase transformers operating in delta-delta can still run at about 58 per cent. of the group output with two of the transformers in open delta, should one transformer fail and be cut out.

Central Stations and Large Sub-stations.—In large stations with three or more units installed, three-phase will in general be preferable. Where the rated output of the generating units is 30,000 k.v.a. to 40,000 k.v.a., although three-phase transformers would be practicable, the question will often be determined by considerations of handling, which may necessitate the use of single-phase units. The floor space occupied by three-phase transformers is appreciably less than for single-phase groups. A three-phase unit has also a slightly higher efficiency than a group of single three-phase transformers of the same group output.

In illustration of the above considerations the authors present, in the original Paper, a comparison of a single-phase and three-phase group for 23,400 k.v.a. 25-cycle 6,600/20,000 volts. Thirteen of these 7,800 k.v.a. (British Standard Rating) single-phase transformers, designed by one of the authors, were recently built for the Glasgow Corporation's Dalmarnock power station.

The maximum lifting weight of transformer and tank complete for the three-phase units is 55 tons, and a crane capacity to meet this would be required if three-phase units were installed. At 50 cycles the above transformers would be capable of a rated output of about 45,000 k.v.a. per group.

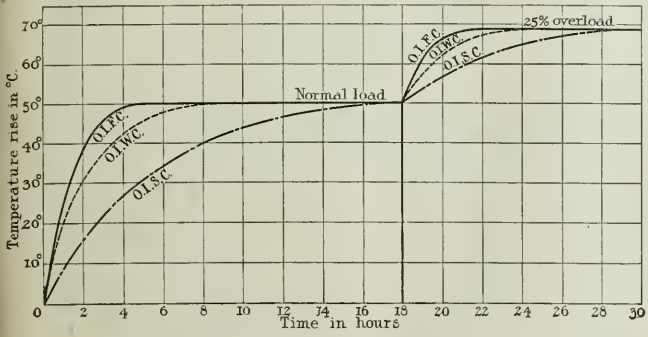

FIG. 2.—TYPICAL TEMPERATURE CURVES FOR 4,000 K.V.A. TRANSFORMERS.

O.I.S.C. = Oil-immersed self-cooled; O.I.W.C. = Oil-immersed water-cooled; O.I.F.C. = Oil-immersed forced-cooled; Ratio of copper loss to iron loss = 2 : 1.

Data for the losses, efficiencies and cooling for such a 50-period group are also given in the original Paper.

In such a station with, say, 10 generating units for a total plant capacity of about 250,000 k.v.a. at 25 periods, or 450,000 k.v.a. at 50 periods, the total cost of transformers required, excluding spares, would be approximately 30 × £6,500 = £195,000 for single-phase, or 10 × £18,500 = £185,000 for three-phase. If single-phase groups were employed, one single-phase transformer per six transformers installed (*i.e.*, for every two three-phase groups) would suffice as spare. The total cost of spares would be thus: 5 × £6,500 = £32,500. If three-phase units were used, one complete three-phase transformer for every five or six transformers installed would meet the case. The cost of spares in this case would be 2 × £18,500 = £37,000. The advantage of single-phase units lies in the flexibility of the spares.

Medium and Small Sub-stations.—In sub-stations of small and medium plant capacity up to 5,000 k.v.a. it will not generally be economical to install more than two or three groups. In such cases, the choice tends towards single-phase units of medium capacity, forming one or two three-phase groups, with one single-phase transformer as spare for the sub-station. Taking a typical case of a 3,000 k.v.a. 20,000-volt 50 ∼ station, the authors show that the most satisfactory proposition is three single-phase 1,000 k.v.a. units with one spare.

5. PROPORTION OF LOSSES AND OVERLOAD CAPACITY.

(*a*) *Power Station Transformers.*—In large step-up transformers for power stations, which are practically always working near or at full load, the actual ratio of iron to copper loss is itself unimportant. The average continuous load on such transformers in an economically run station is from three-quarter load to full-load on any sets in commission. A transformer designed for maximum efficiency has the iron loss about equal to the copper loss, which condition should be fulfilled at three-quarter load to full-load. In 40 to 60 period transformers the most economical and sound design usually fulfils this condition. In 25-period transformers, as the loss in iron decreases practically in proportion to the frequency, the iron loss is usually lower—*i.e.*, one-half to one-third of the copper loss.

The overload capacity of large power-station transformers should correspond to the generator overloads.

Table I.—*Annual Charges for Losses for Different Ratios of Iron to Copper Loss for Average Load 1,400 k.v.a., Peak Load 2,000 k.v.a., Normal Rating, 1,500 k.v.a.*

Ratio of iron to copper loss	1 : 1	1 : 1·15	1 : 1·5	1 : 2
Efficiency at 1,400 k.v.a.	99·0	99·0	99·01	99·02
Efficiency at 1,500 k.v.a.	99·0	99·0	99·0	99·0
Iron loss, watts	7,500	7,000	6,000	5,000
Copper loss, watts at 1,400 k.v.a.	6,500	7,000	7,800	8,700
Copper loss, watts at 1,500 k.v.a.	7,500	8,000	9,000	10,000
Annual charge for losses at ⅜d. per unit	£193	£193	£189·5	£188·5

If the generators are specified to withstand, say, 25 per cent. overload for two hours or more, transformers of the water-cooled and forced-cooled type would require to be designed to stand this overload continuously, since such transformers rapidly reach their final steady temperature. This is shown in the comparative curves in Fig. 2. On such artificially cooled plant it is inconsistent to specify short time overloads. The plant will generally have to be designed to stand the overload continuously, and should be rated on the maximum continuous rating, as specified in the B.E.A.S. Report, so that both generators and transformers are capable of the same duty.

(*b*) *Sub-station Transformers.*—In sub-stations the most economical proportion of iron to copper loss depends on the load factor of the individual sub-station and no specific rule can be laid down. The load curves on loads of different natures are very divergent. If the load diagram is known to a fair degree of accuracy, the ratio of iron to copper loss should be so chosen as to give a maximum all-year efficiency. Obviously the lower the load factor the lower should be the iron losses compared with the copper losses and vice versa.

An illustration of the method of arriving at the best proportion for the case of a certain load diagram is set forth in Table I.

Overload Capacity in Relation to Proportionate Losses.—In cases where specified overloads are required, these conditions must be taken into account in settling the most suitable proportions of iron and copper loss. On the basis of the British Standard Rating, now becoming widely adopted, no overloads are permitted, the rating being the maximum for 50°C. temperature rise in oil, at 40°C. air temperature, giving a maximum oil temperature of 90°C., which is the safe working limit. A transformer rated on this basis can, however, withstand overloads for short periods. Where the load factor is low the copper loss should be decreased relatively to the iron loss, so that the copper will not be unduly heated and the total temperature tise not excessive on the heavy overload.

Consider a sub-station with two 1,000 k.v.a. groups installed running at an average load factor of 70 per cent. It is sometimes specified that either group should be able to supply the average load of the two groups in the event of failure of one of them. The load on the one group would then be 1,400 k.v.a., equivalent to a continuous overload of 40 per cent. If a temperature rise of 40°C. in oil at normal load and 60°C. in oil at 40 per cent. continuous overload were specified, the ratio of iron to copper loss at normal load to meet these requirements must be 1 : 1, or on an average load of 70 per cent., 1 : 0·49. Thus, the transformers would have a relatively high iron loss. Such an overload will only occur rarely, as an emergency measure, and it would be more economical to install transformers with a better ratio of losses, say, iron to copper loss 1 : 1·4. With this ratio, for 60°C. temperature rise in oil on 40 per cent. overload, the temperature rise at normal load would only be about 38°C.

(*To be continued.*)

Application of Electrical Energy to the Melting of Metals.*

By H. A. GREAVES.

The conversion of electrical energy into heat presents a number of problems differing completely from those connected with the production of heat by the usual combustion processes. Owing to the almost unlimited temperatures obtainable electrically, and the absence of combustion products, a new field of development has been opened up to engineers and metallurgists. Owing to the comparatively low electrical resistance of most metals, it is not feasible, when melting metal in bulk, to increase the current to such a value that the metal reaches a melting temperature by its resistance loss only, except in furnaces of the induction type. The induction furnace melts the metal by resistance of the charge, and the enormous currents necessary are obtained by arranging the charge in the form of a ring round the iron core of a transformer. This type of furnace is not commercially satisfactory, owing to—

(1) The loss in efficiency caused by the metal being in the form of a ring, and therefore extremely high heat losses occur.

(2) The "Pinch" effect, or the breaking of the circuit if the current exceeds a certain value, this effect being due to the mutual attraction of parallel conductors.

(3) The electrical conditions of the induction furnace are unsuited to normal power-supply circuits; a bad power factor is obtained, very low frequency is required, and the furnaces are usually designed to operate on single-phase supply only.

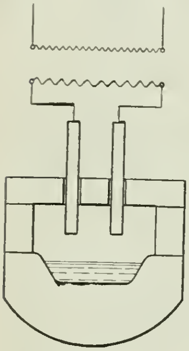
FIG. 1.

It is necessary, therefore, to use for the generation of heat a resistant material other than the metal to be melted, and the electric arc provides a ready and efficient method of generating a very intense heat in a small space. The most efficient method of utilising the heat of the electric arc is obviously to make the material to be melted one pole of, or part of, the circuit. The first furnace using the electric arc was designed with the container as one pole of the circuit, and a carbon electrode over the metal as the other pole. In order to use a higher voltage and obtain a better distribution of heat, a furnace was designed with two carbon electrodes over the charge, the current passing from one electrode to the charge, and from the charge to the other electrode, single-phase current being used, as shown diagrammatically in Fig. 1. In order to utilise three-phase currents, a third electrode was arranged over the charge, as in Fig. 2; furnaces of this kind have been largely adopted in connection with steel furnace practice. There are several inherent disadvantages in furnaces of this type, viz.

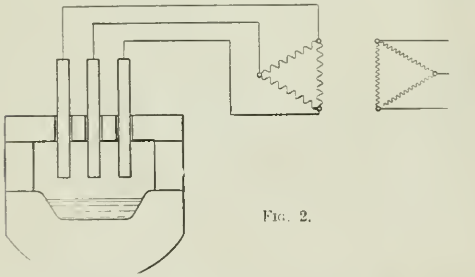
FIG. 2.

(1) The electrode currents are not independent of each other.

(2) The heat is applied to the surface of the charge only, and very little circulation of metal is caused.

If one electrode dips into the charge, or is being driven down into the charge by automatic regulation, while the other electrodes are clear, no current passes and the electrode or electrode-operating gear is liable to be broken while a molten charge of steel takes up carbon from the electrode and upsets the analysis. Many devices have been introduced to overcome these objections, but most users experience difficulties, particularly when the furnace has an acid or non-conductive lining. Moreover, in an electric furnace it is a great advantage to introduce a method of causing the metal to circulate freely. This circulation can be effected by making the hearth of the furnace fairly thick and passing a considerable current through it by using it as one electrode; it is possible in practice to apply from 8 to 10 per cent. of the total energy supplied to the furnace in the hearth alone, by using a mixture of magnesite and dolomite and grading it to give the highest resistances near the charge and a negligible resistance towards the outside. Such a hearth is as strong and permanent as any basic hearth that can be made.

Some years ago, in collaboration with Mr. Etchells, the author developed a method which enables three-phase or two-phase current to be applied to a furnace with an unequal resistance in one of the phases and still maintain a truly balanced load as regards both power and power factor on the primary phases. The connections of such a furnace are shown for three-phase and two-phase working in Figs. 3 and 4 respectively, the length of O C being determined by the resistance of the furnace hearth. With the systems shown in Figs. 3, 4 and 5, each electrode is independent and regulation of the electrodes, either automatically or by hand, is simple, while the heat generated in the hearth of the furnace maintains the metal in constant circulation. These systems also give a very steady load on the primary phases, due to the buffer effect of the resistance hearth and the phase displacement caused by short-circuit currents.

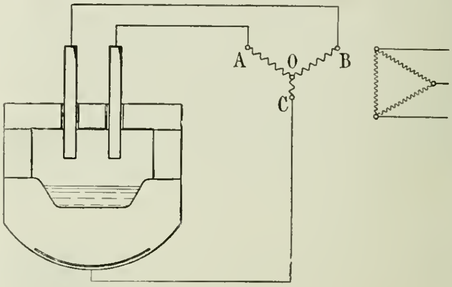

FIG. 3.

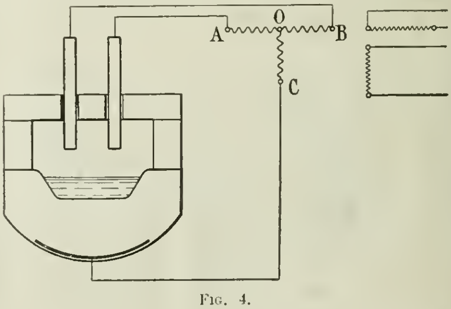

FIG. 4.

Up till recently furnaces of the bottom-connection type have not been operated with an acid lining, as such a lining is considered to be non-conductive, although one furnace is made with a water-cooled stud in the hearth to maintain contact with the charge. Water-cooling in the hearth of an electric furnace is a dangerous and inefficient makeshift. Fortunately a conductive acid lining has been discovered which has operated satisfactorily for some months; but of which full particulars cannot be given at present.

A number of furnaces have been built where the full load of the transformers cannot be obtained owing to the drop in power factor with an increase of current, and it has been found in practice that the full-load current per electrode on a 50-period circuit should not exceed 8,000 to 9,000 amperes For furnaces of 5 tons capacity transformers of 1,300 k.v.a., two-electrode furnaces are satisfactory, but above that size three or, preferably, four electrodes should be used. In the original Paper the author shows three combinations of the transformer system illustrated in Fig. 3 for use in such cases. It is general practice to provide tappings on the primary windings of the transformers in order to vary the voltage, usually one voltage for melting, one for refining, and one for holding the metal at a constant temperature in the furnace; by suitably connecting the voltage-changing switch one can arrange for different degrees of bottom heating effect for the different stages of each heat, the best circulating effect being necessary when the metal is molten and alloy additions are being made to the bath.

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* Abstract of Paper read before the Institute of Electrical Engineers.

There are several types of electric furnace which operate with an independent arc, *i.e.*, an arc is formed between the carbon electrodes, and the charge does not form part of the circuit. These types are not efficient for steel melting, the output, energy and electrode consumptions and lining repairs comparing very unfavourably with the direct-arc furnaces. For melting certain metals, however, such as bronze or copper, the indirect-arc furnace has certain advantages, particularly when melting metals which are volatile at comparatively low temperatures. In such a case to employ a direct-arc furnace would result in a very high loss due to volatilisation on account of the very hot region of the arc being actually in contact with the metal. By employing an indirect-arc furnace this effect is somewhat reduced, but special means for cooling the walls of the furnace must be resorted to in order to prevent the refractories from fusing at too high a rate and thus render the cost of running prohibitive.

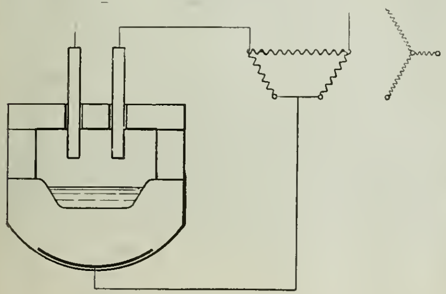

FIG. 5.

The reason for this is that the rays of intense heat from the arc strike directly on the walls, whereas in the direct-arc furnace the intense heat is more or less shielded by being partly buried in a crater of slag or metal, which material, in addition to acting as a shutter, also repidly conveys the heat away. To render the indirect-arc furnace a more commercial proposition, the U.S.A. Bureau of Mines have adopted a method of rocking the furnace in such a manner that the molten charge is constantly washing the walls of the furnace, and thus the lining is kept comparatively cool. In addition to this cooling effect, the washing of the metal has a tendency to absorb some of the metal which may have been driven off as a vapour; also the charge is kept well stirred, which results in a very uniform product.

For many kinds of work the arc furnace is quite unsuitable, such as reheating, annealing or melting of metals which have low melting temperature, and even with high melting temperature, when the quantity is small. For such work the resistance furnace is the best type that can be employed; but where the temperature to be attained is above 1,000°C., the difficulties to be met with are very numerous. For temperatures below this figure, probably the best element is that made from an alloy of nickel chromium; but for temperatures above 1,000°C., it is necessary to resort to other materials. In the Baily furnace a trough constructed of a highly refractory material, such as silicon-carbide, is built on the inside wall of the furnace. The trough is filled with a carbonaceous material which forms the resistor. The heat from the material usually travels in an upward direction and impinges on the roof of the furnace, which acts as a reflector and reflects the heat down on to the charge. A method of construction has been brought out to overcome some of the difficulties of the resistor furnace. The method consists in forming a hearth or crucible, which acts as the container for the bath of metal, the depth of the bath being relatively small compared with the surface area of the bath. The resistor element, or elements are suspended above the bath as close to the metal as possible, only sufficient distance as may be required for stirring or charging being allowed. The heat generated is transmitted to the charge mainly by direct radiation. The heating element is made of a highly refractory material, and yet not readily oxidisable at high temperatures, nor does the material disassociate until an exceedingly high temperature has been attained. The element itself is built up of a number of sections dovetailed into one another and held in suspension by pressure exercised at the ends of the resistor, the amount of pressure used actually being greater than that necessary to support the element; but as the resistance of the element to a certain extent depends upon the pressure, a margin of variation is allowed for. This type of element requires no booster transformer or any expensive voltage-changing device, such as is employed in most resistive types of furnace, the amount of energy being readily varied by pressure applied to the heater unit in a manner external to the furnace. Another feature of the furnace is that the elements are renewable even while the furnace is hot. The construction is such as to make the furnace gastight, which results in an absolute minimum of zinc loss when employed on brass melting.

Department of Scientific and Industrial Research.

The fourth annual report of the Department of Scientific and Industrial Research has been issued, and contains an account of the work of the department during the year ended July 31 last. The work of the department as described in the report, falls into three main divisions (*a*) the progress made in the establishment of research associations, (*b*) the organisation of research for national purposes, and (*c*) the developments that have taken place in the conduct of researches initiated either by other bodies or by individual workers.

As regards the formation of research associations, it is estimated that the number of these will ultimately be about 40; of these, 17 have been "approved" by the Department, though the necessary legal formalities have been completed in the case of nine only. With the signing of the Armistice in November last, it became possible to modify the necessarily stringent conditions relating to the availability of the results of research which had been laid down during the war; accordingly, the conditions of grant were revised in January last to make it clear that, subject to certain conditions, the ownership of the results of investigations conducted by research associations is vested in the associations themselves. The successful establishment of research associations has brought into prominence a number of new administrative problems, for whose solution the department has sought the help of the associations by calling the first of what is hoped will be a series of periodical conferences with representatives of research organisations. At this conference such matters as the best methods of dealing with problems common to two or more associations, the terms on which research workers should be employed and the scope and organisation of a "Records Bureau" by the department were considered.

Part II. of the report deals with the increasing amount of research for national purposes. At the National Physical Laboratory the work undertaken for the War departments has naturally diminished but the other Government work has grown. The testing of clinical thermometers is being carried out on a large scale, and the Electrical Standards Laboratory hitherto attached to the Board of Trade, has been transferred to the National Physical Laboratory. Important researches on thermal questions having a bearing on industry, on methods of calculating lens systems, on lubricating oils, on ternary alloys, and on the form of standard ships have been conducted. The main buildings of the Fuel Research Station at East Greenwich are now approaching completion, and the Fuel Research Board of the Department are reconsidering the whole question of research on the more economical use of fuel.

The Mine Rescue Apparatus Committee has continued its inquiries, and has acquired much valuable knowledge. The search for the means of recovering a greater proportion of tin from the ores of this metal has been continued by the Tin and Tungsten Research Board; researches on oxygen and on gas cyliners have gone on steadily; and the committee on lubricants and lubrication has carried its investigations to a further stage.

Considerable attention has been devoted to matters connected with the housing question, work having been done on the testing and artificial seasoning of timber and on building materials. Research has also been conducted for the authorities of the British Museum on technical problems connected with the preservation and restoration of objects in its keeping; the use of metal struts for aircraft, and the best methods of making sound castings of brass and copper have also been the subjects of investigation.

The Industrial Fatigue Research Board has had increased demands made upon it as a result of the pressing need for knowledge to be made available for the State and for industry, of the optimum conditions of physical labour of all kinds.

When it is taken into consideration that the whole of the work described in this part of the report is being carried on for the purposes of the State, it is obvious that the time for the establishment of a definite scheme of scientific investigation for the ends of peace was quite ripe; indeed, it is quite safe to say that the nation has suffered incalculable losses through its omission to provide at an earlier date for the systematic collection of scientific knowledge on which to base its actions.

Part III. of the report is concerned with work undertaken by independent institutions aided by the department or by individual workers or research students to whom grants are made. It is probable that this work has not become so well known generally as that done in the establishment of research associations or in the carrying out of scientific investigations for State purposes, the reason for this being that it is in the main connected with what is often called "pure science."

There is no more pressing problem before the department than that of increasing the supply of trained, efficient research workers; if these are not speedily found the opportunity of placing British industry on a sound scientific basis will pass—with results whose evils cannot be foreseen.

During the last year the total number of grants made to research workers and students was 103, as compared with 67 in the previous year. Certain difficult questions relating to the availability of the results of research have been advanced towards solution, but that of patents for inventions made with State assistance and especially of patents in countries overseas, is not yet settled, though progress is being made. One provisional decision has been reached—that patents shall in no case be taken out for (*a*) inventions for the preservation of health or of life, or (*b*) inventions whose use can be enforced by a Government department.

Residual Gases and Vapours in Highly Exhausted Glass Bulbs.*

By J. E. SHRADER.

By the use of the mercury diffusion pump and the Knudsen absolute gauge pressures of the order of $1 \cdot 10^{-8}$ mm. Hg have been produced and measured; but there are few data showing what pressures can be maintained in bulbs which have been pumped to this degree of exhaustion and sealed off. Accordingly four glass vessels were exhausted to a high vacuum, and sealed off, and their change in pressure with time was observed. A mercury diffusion pump with liquid air trap and a sensitive Knudsen absolute gauge of about 500 c.c. capacity was used, and the bulb to be tested was of about 1,500 c.c. capacity. The vacuum obtainable with the diffusion pump is limited practically by the heat treatment of the glass, though the greater the speed of the pump the lower the pressure attained. Equilibrium will be established when the speed of the pump is equal to the rate at which gases and vapours are given off from the glass. The effect of heat treatment on the vacuum obtainable after pumping until equilibrium was reached at that temperature is shown by the following results:—

Temperature	20	100	200	300	300	500
Pressure in mm. Hg.	1×10^{-5}	$1{\cdot}9 \times 10^{-6}$	$1{\cdot}7 \times 10^{-7}$	$1{\cdot}2 \times 10^{-7}$	2×10^{-7}	$2{\cdot}4 \times 10^{-8}$

The cleaning of the glass is important, and the removal of grease by potassium bichromate solution followed by a prolonged washing with boiling water to remove soluble salts proved most effective. The electric oven in which the gauges and bulbs were placed was kept at a temperature of 500 C. while the system was pumped for two hours, and then the electric oven was removed and the bulbs and gauges were allowed to cool. After the pressure had been observed, the sealing-off process was accomplished by heating the constriction with the pointed flame of a blowpipe. When the glass was near the melting point the gauge indicated a considerable increase in pressure. The glass was kept heated near the melting point for about 10 minutes while the pump continued to operate. The pressures before and immediately after sealing, for four bulbs and gauges which had been given identical treatment, were as follows:—

	No. 3 (702-P).	No. 5 (702-E.J.).	No. 6 (702-P.).	No. 7 (702-E.J.).
Pressure before sealing off	$2{\cdot}7 \times 10^{-7}$	$3{\cdot}0 \times 10^{-7}$	$8{\cdot}5 \times 10^{-8}$	$9{\cdot}7 \times 10^{-8}$
Pressure after sealing off...	$1{\cdot}1 \times 10^{-6}$	$1{\cdot}5 \times 10^{-7}$	$3{\cdot}1 \times 10^{-7}$	$8{\cdot}6 \times 10^{-7}$

These bulbs and gauges were securely mounted and the changes in pressure with time were observed. In all cases there was a rapid initial rise of pressure with time, followed by a slower and more uniform change. No conclusions can be drawn from these data on the different grades of glass as to its suitability for vacuum work. Bulbs 5 and 6 and 3 and 7 gave almost identical results. Although bulbs 6 and 7 were pumped to the highest degree of exhaustion, yet the pressure in No. 7 was the highest of all after a few days. Yet 5 and 6, which had the lowest pressure after sealing off, still had the lowest pressure after 60 days.

To determine the effect of subsequent heating, two of the bulbs and gauges were replaced in the oven and heated for one hour at increasing successive temperatures, and the increased pressure resulting from each heating was determined. Heating 7 to 250 deg. did not change the pressure, but for 3 the pressure increased with all increases of temperature. The changes of pressure at the lower temperatures have always been observed to be less rapid than at the higher temperatures. This investigation shows that the vacuum in sealed vessels deteriorates with time, rapidly at first, and then more slowly, and that subsequent heating even at temperatures lower than the heat-treating temperature results in increase of pressure due to further liberation of gases and vapours from the glass. No connection between different samples of the same glass or different glass can be established. It is quite probable that there are variations in the properties of different samples of the same glass quite as great as the variations between different glasses of about the same grade.

The Lighting of an Aeroplane Factory.

The importance of good lighting in factories is universally recognised in theory, but is often ignored in practice. A brief summary of the basic facts underlying this question of industrial lighting may be of interest at the present time when higher production and greater economy are the most urgent of our national needs. It is possible by improvements in artificial lighting to increase production by 11 per cent., to decrease spoilage by 25 per cent., to reduce accidents by 25 per cent., to achieve a higher standard of workmanship, to maintain daylight efficiency throughout the night shift, and generally to increase the efficiency, comfort and satisfaction of employees. These statements merely represent the considered opinion, not only of the majority of progressive factory owners, but also of the British, French and American Governments. Moreover, the total operating cost of an artificial lighting installation on the most up-to-date lines, including interest, depreciation, maintenance and power cost, is roughly one-half of one per cent. of the wages bill, so that even if good lighting costs a little more than bad lighting, it is not economical to waste comparatively expensive manual labour in order to save a few pence in lighting costs.

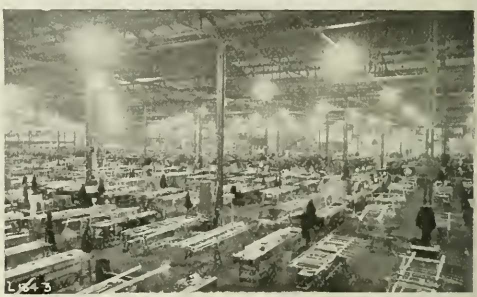

Fig. 1.—General Lighting with 1,000-watt Half-watt Lamps in "Industra" Semi-indirect Fittings in Main Bay of Sopwith Aeroplane Factory.

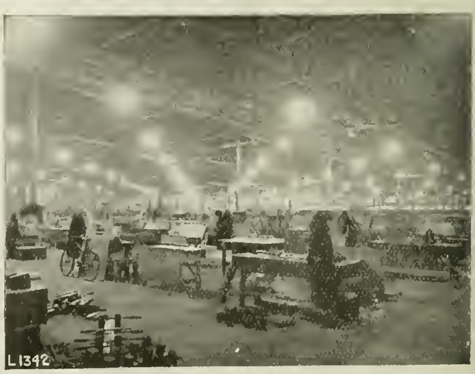

Fig. 2.—Another View of the Main Bay in Sopwith Factory. Showing the Uniformity and Comparative Shadowlessness of the Mazda Lighting.

An excellent example of artificial lighting, scientifically designed to meet the requirements of maximum 24-hour production, is afforded by the installation in the Sopwith aeroplane factory at Ham Common. In the war-time manufacture of aeroplanes the two chief considerations were speed and accuracy of production, and therefore it was essential that the artificial lighting should be adequate, comparatively shadowless and entirely free from glare. In the Sopwith factory these were secured by the use of Mazda half-watt type lamps in B.T.H. "Industra" semi-indirect fittings equipped with opalescent reflector bowls. The large main bays, shown in the illustrations, are lighted by 1,000-watt lamps, in pendant type "Industra" fittings, suspended at a height of 30 ft. and 42 ft. apart. In the galleries 300-watt lamps are used, also in "Industra" semi-indirect fittings.

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* Abstract of an article in the "Physical Review."

The average illumination intensity throughout the factory is 3·5 ft.-candles, which is amply sufficient for every process involved in the manufacture of aeroplanes. A study of the illustrations, which are reproduced from untouched photographs taken by the unaided light of the Mazda units, will indicate the approximate uniformity of the illumination and the absence of hindering shadows. This installation is a good example of the best modern industrial lighting practice. General lighting is employed because it is the only practicable method in large shops in which it is desired to have uniform illumination over the entire area, including passages and alley-ways, so as to give complete freedom in the location of machines and work benches; and, of course, a general lighting installation is considerably easier and cheaper to instal and maintain than a local lighting system. The "Industra" semi-indirect fittings eliminate glare and, by diffusing the light, soften and reduce shadows.

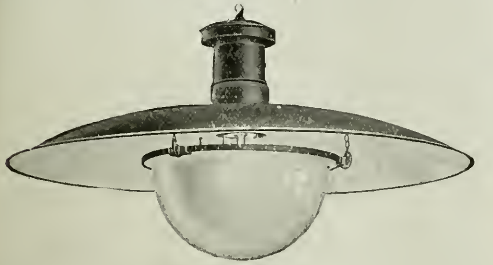


Fig. 3.—B.T.-H. "Industra" Semi-indirect Fittings, as used in Sopwith Factory.

Glasgow Electricity Works.

The Electricity Committee of the Glasgow Corporation paid an official visit to the new Dalmarnock power station on the 29th ult., and were shown over the works by Mr. Lackie, chief engineer and manager of the electricity department, and members of his staff. The following is a brief description of the station in its present state :—

The switch house is a four-story building in the centre, and measures 108 ft. × 45 ft. × 71 ft. high. On the ground floor there are transformers to be used for raising the pressure of electrical energy from 6,500 to 20,000 volts. Staff accommodation is provided on the first and second floors in the centre block. The third floor is occupied wich control cables and wiring; there is also a small battery. The fourth floor is the switch house proper. The control room measures 50 ft. × 50 ft. × 17 ft. There is a large storage battery situated in the basement of the central block.

For *Condensing Water* there are two inlet water ducts from the River Clyde, each measuring 6 ft. × 8 ft. The water is passed through revolving filter screens, and from these screens flows into one duct measuring 11 ft. wide by 14½ ft. high. The main water culvert runs along the whole length of the south wall of the turbine room. An outlet or return water duct runs along the whole length of the north wall of the turbine room, and is continued under the floor of the coal store to an outlet 330 ft. down the river from the inlet.

The *Turbine Room*, as at present completed, measures 225 ft. long by 75 ft. wide, but ultimately it will extend to double this length The plant now installed consists of two condensers, each having 5,500 tubes. The circulating water to each condenser amounts to 22,500 gallons per minute, and is supplied by means of a 36 in. pipe. One turbo-alternator of 18,750 kw. is almost completed. One turbo-alternator of 500 kw. is completed, and will be used for supplying energy to drive the auxiliary plant in connection with the main turbine, A 75-ton travelling crane is fitted.

No. 1 *Boiler House* is completed and measures 149 ft. × 80 ft. × 73 ft. There are two rows of four boilers, each with a steaming capacity of 50,000 lb. per hour, the steam pressure being 275 lb. per square inch. There is a pump house at the end of each row of boilers, in which are installed one electrically-driven and one steam-driven feed pump On the second floor are housed economisers, induced draught fans, hotwell tank and the bases of four chimney stalks. The basement floor contains ash conveying plant and forced draught fans.

The workshop measures 225 ft. × 30 ft., and has a 75-ton travelling crane.

There is an area for storage of coal of 630 ft. × 225 ft., which will give storage accommodation for 75,000 tons of coal. A travelling gantry, having a span of 190 ft., on which are fitted a grab and coal conveyor, can operate over the whole area of the coal store.

The official opening of the station will not take place before next summer, but it is hoped to have the first 18,750 kw. turbo-alternator set in commission before the end of the present year. The total amount of the contracts placed in connection with the new power station is £1,500,000 but the station when ultimately completed will cost over £3,000,000.

An Electrically-driven Rolling Mill at Sheffield.

The electric drive is steadily supplanting the steam drive for rolling mills. A recent instance is that of a mill at the works of the Hallamshire Steel and File Company, of Neepsend, near Sheffield. This mill, which is of the two-high-bar type for rolling spring steel, used to be driven by an old steam engine through belt and bevel gear. The conversion to electric drive involved the solution of a somewhat difficult problem as regards space, because the motor, with its gearing and switchgear, had to be accommodated in the space formerly taken up by the belt pulley and the gearing. This necessitated the erection of a switch room over the motor seen in the right-hand corner of Fig. 1.

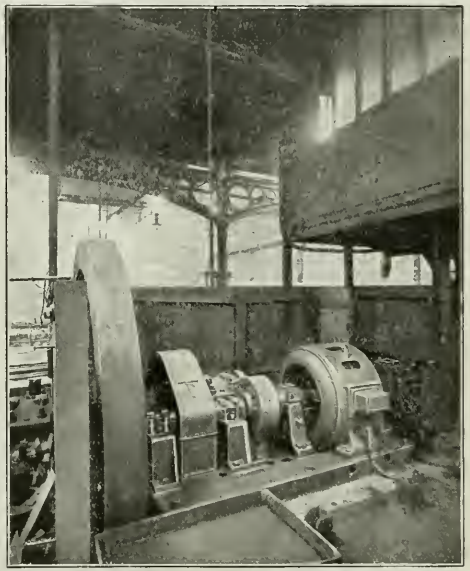


Fig. 1.—General view of 220 h.p., 3-phase Motor driving Two High-Bar Mill at the Works of the Hallamshire Steel & File Company, Ltd.

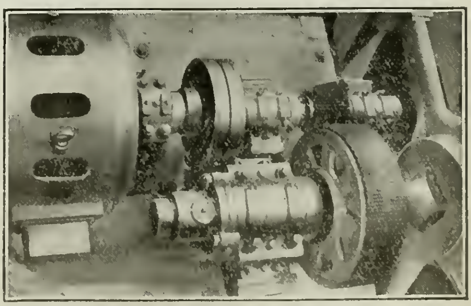


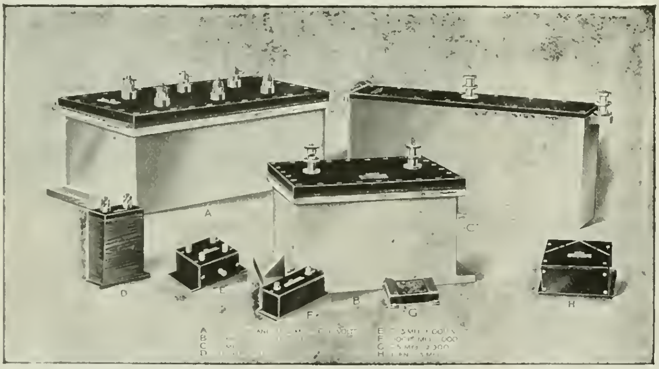
Fig. 2. Plan of Laminated Gearing and Flexible Coupling. View taken from the Switchboard Platform.

The motor is a standard three-phase slip-ring machine specially designed for mill work, the slip-rings and brush gear carrying the current continuously without short-circuiting gear. The normal load of the motor is 220 h.p., and it runs on a 3,300 volt, 50 cycle circuit at 588 revs. per min. For the transmission of power from motor to mill, an eminently satisfactory and compact drive has been obtained by the use of laminated gears supplied by Laminated Gears, Ltd. Owing to its special construction the gear runs with an almost total absence of noise and a minimum backlash. Normally it is enclosed in a gear case with inspection doors, but can be clearly seen with the case removed in Fig. 2. Between the motor and pinion shaft is a flexible coupling of the Sykes type, also made by Laminated Gears, Ltd. This form of coupling shows considerable improvement over older types, particularly for high speeds. The fly-wheel which had been used before the conversion was used with the new drive. It is of 10 tons weight, and 12 ft diameter.

Before the conversion of the mill several experiments were carried out by engineers of the General Electric Company, Ltd., in order to ascertain the size of the motor and amount of slip resistance necessary for the motor to slow up and enable the fly-wheel to take its share of the load on the heavy passes. The slip resistance is of the permanent grid type, with suitable adjustable tappings, so that the amount of slip can be varied if required. The motor control is on standard mill lines. A high-tension G.E.C. cubicle with free handle automatic oil-break switch is installed together with isolating links, ammeter and voltmeter. The starter is of standard liquid type, with slow motion screw on the hand-wheel. The whole of the conversion was carried out by the General Electric Company.

Dubilier Mica Condensers.

A booklet, entitled "The Wonderful Achievements of Radiotelegraphy in War and Peace," by Mr. William Dubilier, of New York City, traces some recent developments in wireless telegraphy during the war, and remarks on the importance in wireless work of a satisfactory condenser. A history is given of early experiments on Leyden jars, which exercised the ingenuity of many early investigations, prominent among whom was the French Savant the Abbé Nollet. It is estimated that before the war there were probably some 150,000 Leyden jars in general use for wireless operations. Dubilier's work on mica condensers began about 10 years ago. In 1910 a condenser of this type was submitted to the United States Government, and in 1913 evidence on the subject was given before the British War Office Wireless Committee. Subsequently the condenser was more completely developed, and though its cost is still somewhat higher than that of Leyden jar equipment, it has many compensating advantages. The Dubilier condenser consists of several sections within an aluminium casing. Each section comprises thousands of alternate sheets of mica and foil. Each section is also insulated from the rest by a special mica sheet. Air, moisture and vacuum pockets must be carefully eliminated from each unit, and, accordingly an insulating adhesive is forced through the entire condenser which deposits in a thin layer on each mica sheet. Finally, melted wax compound is poured into the casing, filling any empty spaces between the condenser section and the case. It is claimed that in the event of a rupture the condenser is "self-healing." the units are standardised, and among the advantages specified, as compared with the Leyden jar, are: increased efficiency, greater strength, elimination of brush discharge and inconvenient liberation of ozone, a life ten times that of the Leyden jar, economy in space and simplicity. The selection and use of the mica sheets demands great care as the thickness does not exceed a few thousandths of an inch, and there must be freedom from air bubbles, pin-holes, variation in thickness and other inequalities



Standard Dubilier Condensers.

The Gattie Transport Scheme.

The Board of Trade Committee to inquire into Mr. A. W. Gattie's transport scheme has continued its sittings.

In his further evidence Mr. Gattie said that he did not propose to alter the scale of railway charges. He would introduce the flat rate system into the clearing house. The scheme would provide complete trainloads of goods made up ready for their destination, so that the railway companies would be able to make the utmost profit out of their haulage. He denied that the new system would do away with the railway terminal profits, because there were no terminal profits. "The highest freight rates in the world which are now paid in England, are a great disadvantage to the trade of the country, and constitute a fiscal policy of protection in favour of the foreigner." The great number of different railway rates was very confusing to the traders. He denied that he or his company were opposed to the railways; he wanted to see them succeed. His company could quadruple the earning power of the railways and could enable them to carry five times the amount they now carried. The effective speed of railway transport before the war was three miles per hour. Instances were here given of the delay in handling goods traffic in the London area.

Mr. Gattie said that he did not propose to introduce a canal in connection with the London Clearing House, but it might be possible to do so in the case of provincial towns by running a railway line alongside the canal. He proposed to equip a special wharf at Blackfriars. He would like to see a set of hydraulic lifts introduced for lifting barges up and down, instead of the present system of locks. After reading a letter he had received in 1913 from Sir Eric Geddes, Mr. Gattie said that in June, 1914, he received a visit from Herr von Schawen, of the Ministry of Transport, Berlin, who (it was said) was sent by the ex-Kaiser to inspect the apparatus at the company's works. The visitor expressed approval of the system, his final remark being, "Yours is an unequalled instrument for mobilisation."

In conclusion, Mr. Gattie claimed that his scheme would benefit the railway shareholder by increasing dividends; work would be enormously cheaper, and expenditure would be greatly reduced. It should be possible to redeem £300,000,000 worth of land by the elimination of shunting. They would be relieved of the £5 a year upkeep per waggon on about 90 per cent. of the goods rolling stock, and they would have available for service all the locomotives now used in shunting.

On Tuesday, Mr. Gattie, who presented himself for cross examination, said he preferred his scheme to be run by private enterprise, as he had found the Government could spend money and employ labour, but he had never known a Government to provide enterprise. Personally he would like to see the railways under triple control—*i.e.*, of the shareholders, the railway workmen and traders. His proposal was for an entirely new railway company, but he did not suggest that the existing railway companies should not have shares in it. There would not be more than 10 clearing houses in England. His original scheme had been extended to include coal, minerals, and cattle where required and where advantageous. While he was prepared to begin the scheme at any adequate spot, London was the most desirable place. The cost of the establishment of the central station had been estimated at £14,000,000 in pre-war days, but now he would count it not quite double. The cost of equipping clearing houses all over the Kingdom was £300,000,000, but now it might be £1,000,000,000. He did not agree that unless the scheme were carried out on the scale proposed the economies which had been referred to would not be effected.

In reply to Mr. Clode, who asked whether any figures had been arrived at of the cost per ton of handling goods at the terminus, he said that a pre-war estimate for 80,000 tons daily was £4,772,792. The figure was hypothetical, because they could not get from the railway companies the number of tons handled daily. At present an increasing trade was done in containers. Messrs. Carter, Paterson & Company were going to use them almost universally. It was to be a rule that a container of some sort must be used with his system, but they would be able to break the rule if circumstances warranted it. Coal for retail delivery would be put into the sacks near the pit mouth; there was no advantage in sacking the coal in London. The box container for general goods was economical for transport, and was smaller than the average wagon. He favoured a 12-ton container, but some directors inclined to the view that that was too large.

Regarding the suggestion that an experimental station should be erected so that the system might be seen in operation, Mr. Gattie said, "The great thing has been to prevent my getting money to do it, and then to jeer. We want to know what tangible objection the railway companies have."

Bastian Electrically Heated Hot Water Tank.

In these days of fuel economy everyone is on the look-out for new heating devices, and readers will therefore be interested in the new Bastian electrical heated hot-water tank which we understand will be available very shortly. Success in heating water electrically is admittedly mainly dependent on the design of the tank and heating surfaces, and it is claimed that in the Bastian apparatus, wherein the ratio of surface area to capacity is reduced to a minimum and the cylinder is relatively large, the process is remarkably efficient. On the other hand, as is well known, small vessels and pipe systems are more difficult to heat efficiently owing to the relatively large exposed area and big radiation losses. An essential feature, in order to secure high efficiency, is the continuous application of heat. These tanks are intended to be left on circuit continuously, and therefore constitute a steady load of a very desirable nature to supply companies. It is, therefore, anticipated that the rate allowed in most districts should not exceed 0·75d. per unit, and that even 0·5d. per unit or less may be looked for where the authorities are anxious to encourage water-heating by electricity. After the first 24 hours it is estimated that even the smallest (10 gallon) size of tank will yield a daily supply of 10 gallons of scalding hot water (at 150°F.). Meters will not be necessary, as this is a continuous load, each size of tank being charged for at a fixed rate per annum. The cost per week, at 0·75d per unit, has been calculated as follows :—

Consumption (watts).	Daily output of scalding hot water at about 150°F. (65°C.). (gallons.)	Cost per week at 0·75d. per unit. (pence.)
150	10	18·9
300	20	37·8
600	40	75·6

The tank can be installed without special wiring, and if we assume that a 10-gallon tank accounts for 328 units in a quarter of 13 weeks, the cost on the above basis would be £1 0s. 6d. On the other hand, if 72 units were used for lighting at 6d. a unit, the corresponding charge would be £1 16s., making the total quarterly bill £2 16s. 6d. Apart from bathroom requirements, 2 gallons of hot water per head per day would suffice, so that a 10-gallon tank in the kitchen or scullery is ample for washing and culinary purposes for a household of five persons. The bathroom requires separate treatment by a supplementary heater, which can be switched on when required, and charged at the ordinary higher scale per unit.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1917 Specifications.

129,722 B. T.-H. Co. (G. E. Co.) Wireless signalling systems. (8,12,17.)

129,735 Sperry Gyroscope Co. Electrodes for arc lamp projectors. (18/12/16.)

130,011 Brockie, & Johnson & Phillips. Projector arc lamps. (14/12/17.)

30,012 Latour. Audion or lamp relay or amplifying apparatus. (30/11/16.) (Addition to 3,140/18.)

An amplifier for radio telegraphy and telephony is provided comprising one or more stages of high frequency, detection by means of a lamp and one or more stages of low frequency amplification, capacities being distributed over the low frequency circuits for the purpose of preventing arcings, the plate circuits of the lamps being supplied with current from one and the same source.

130,014 Latour. Dynamo-electric machines. (17/12/17.) (Patent of Addition not granted.)

130,020 Coates & Watford Electric & Mfg. Co. Electric arc furnaces. (19/12/17.)

130,022 Latour. Audion or lamp relay or amplifying apparatus. (20/12/16.) (Addition to 5,363/17.)

1918 Specifications.

112,939 Siemens-Schuckertwerke. Ventilating devices for electrical machinery or apparatus. (22/12/16.)

115,038 Bosch. Akt. Ges. R Electrodes or spark discharges. (16/4/17.)

118,618 Buess & Gutzwiller. Feeding polyphase current circuits from a monophase current source. (6/8/17.)

119,234 Baily & Cope. Electric melting furnaces. (4/9/17.)

123,066 Johnson. Electric fuse and circuit testers. (7/4/16.)

123,081 Ehret. Apparatus for electric wave transmission, particularly applicable to telephony. (1/2/18.)

128,562 British Westinghouse Electric & Mfg. Co. Electromagnetically actuated switches. (21/6/18.)

129,751 Heap. Electric relays. (14/5/18.)

129,752 Heap. Electric contacting-devices. (15/5/18.)

129,760 Morgan Crucible Co. & Speirs. Electric furnaces. (14/6/18.)

129,763 Ferguson, Pailin & Co., Ferguson & Pailin. Electrical oil switches. (19/6/18.)

129,774 Ayscough. Instrument for teaching the Morse alphabet and for transmitting wireless and other telegraph messages automatically by the Morse code. (13/12/18.)

129,788 Kuyser & British Westinghouse Electric & Mfg. Co. Windings for dynamo-electric machines. (15/7/18.)

129,805 Davies, Langdon-, & Soames. Current regulators for alternating current electric circuits. (17/7/18.) (Cognate application, 19,675/18.)

129,820 Marks. (Splitdorf Electrical Co.) Magneto operating mechanism. (23,7,18.)

129,828 Wilson. Control of dynamo-electric machinery. (29/7/18.)

129,841 West & Co. & Pickett. Transporting magnets. (9/8/18.)

129,853 Railing, Garrard & Wilson. Electric cut-outs. (29/8/18.)

129,858 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Welding controllers. (3/9/18.)

129,866 B. T.-H. Co. (G. E. Co.) Temperature indicators for electric transformers and the like. (16/9/18.)

120,041 Benjamin Electric, Ltd. Incandescent electric lamp-holders. (16/10/17.)

129,889 Chilton & Brush Electrical Engineering Co. Turbine and electrical generator plants. (23/10/18.)

129,910 Flory. Screw nut for securing a shade or gallery on the socket of an incandescent electric lamp fitting. (5/12/18.)

130,056 Latour. Audion or lamp relay or amplifying apparatus. (9/1/17.) (Addition to 5,363/17.)

130,064 B. T.-H. Co. (G. E. Co.) Wireless signalling systems. (11/1/18.)

A radiating antenna system comprising a primary radiating unit supplied by a source of radio-frequency currency and a plurality of secondary radiating units, the secondary radiating units being connected successively to a transmission line which supplies energy from the primary radiating unit to the secondary radiating units.

130,090 B. T.-H. Co. (G. E. Co.) Wireless signalling systems. (19/1/18.)

Comprises in combination a receiving antenna, a separate transmitting antenna in proximity thereto, a receiving system comprising a receiving coil having one end connected to the receiving antenna and its other end connected to a point which is of substantially equal potential, with respect to the transmitted waves, and an electromagnetic coupling between the transmitting antenna system and the receiving system.

130,094 Barr & Stroud & Maccill. Step-by-step telegraphic and like receivers working on the principle of magnetic gearing. (24/1/18.)

130,103 Latour. Audion or lamp relay or amplifying apparatus. (15/4/16.) (Divided application on 5,363/17.)

130,107 Marconi's Wireless Telegraph Co & Richmond. Apparatus for eliminating interferences in wireless telegraphy. (25/4/18.)

130,122 Longford, Longford & Clark. Sparking plugs for internal combustion engines. (16/7/18.)

130,137 Jones. Winding wire grids for electric resistances. (23/7/18.)

130,149 Jaynes. Tell-tale switchboards. (24/7/18.)

130,172 Colquhoun. Electric heating elements. (2/8/18.)

130,186 Brougham. (Deutsch.) X-ray apparatus. (15/8/18.)

130,187 Fuller Accumulator Co. & Welch. Electric safety lamps. (17/8/18.)

130,191 Alexander, Vint & Imbery. Electrical device for automatically indicating by visual or audible means the correct temperature of electrically heated steel before quenching in order to obtain correct hardening thereof. (22/8/18.)

130,205 Hoyle & Fawcett. Electric furnaces. (20/9/18.) (Cognate application, 222/19.)

130,207 B. T.-H. Co. (G. E. Co.) Electric contactors. (23/9/18.)

130,212 B. T.-H. Co. (G. E. Co.) Hermetic seals for the leading-in wires of electric lamps and like apparatus. (26/9/18.)

130,219 Western Electric Co. (Western Electric Co.) Modulating method and apparatus for high-frequency electrical signalling. (7/10/18.)

130,332 B. T.-H. Co. (G. E. Co.) Systems of electrical distribution. (30/10/18.)

130,233 McKay. Electrical connection fittings. (30/10/18.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

July 11, 1919.

17,426 Rotax Motor Accessories Co. Portable electric lamp-holders.

17,427 Dechelle. Electric lighters. (12/7/18, France.)

17,430 Johnson & Steed. Wheel-hub dynamo for electric lighting of vehicles.

17,441 General Electric Co. & Gossling. Electron discharge apparatus.

17,443 Rhodin. Electrolytically depositing copper, &c., on aluminium.

17,444 Jackson. (Sperry Gyroscope Co.) Flame arc lamps.

July 12, 1919.

71468 Davis. Electric bell apparatus.

17,469 Davis. Electric telegraphs.

17,470 Davis. Electric press-buttons.

17,472 Rolands. Electric dry cells.

17,479 & 17,480 Tregoning. Electric display sign.

17,491 Terkuile. Electric feeder arrangement for looms. (23/8/18, Holland.)

17,503 Foster. Motor vehicle circuit switch.

17,516 Holslag. Electrodes for electric welding, cutting, &c.

17,534 Railing & Wilson. Electric cut-outs.

17,534 Garrard. Electric cut-outs.

July 14.

17,583 B. T.-H. Co. (G. E. Co.) Radiating antenna systems.

17,596 Turnbull. Reactance coils.

17,601 Gush. Electrical apparatus for preventing of corrosion in boilers, &c.

17,603 Universal Accumulators, Ltd., & de Martis. Plates for electric accumulators.

17,620 Snell. Electro-plating process and attachment.

17,637 Quain. Electric heaters.

17,639 Siemens & Petithory. Electric cut-outs.

17,640 Siemens, Petithory & Sumner. Selecting devices for telephone systems.

17,641 Siemens & Sumner. Selecting devices for telephone systems.

July 15.

17,669 Brereton. Electric fuse carrier.

17,686 B. T.-H. Co. (G. E. Co.) Metallic filaments.

17,701 English Electric Co. & Weaving. Electric radiators, &c.

17,726 Pyne. Electric starting sets for engines.

17,727 Burgoyne. Starting device for lighting and charging sets.

July 16.

17,754 Hudson. Protecting glass pip on incandescent lamps.

17,764 Davies. Illuminating device for use with trolley poles of electric vehicles.

17,787 Perego. Safety transformers with low current coils.

17,790 Automatic Telephone Mfg. Co. Impulse transmitting devices for automatic or semi-automatic telephone systems. (13/9/18, U.S.)

17,800 Price. Electric starting appliances for engines.

17,803 Alloy Welding Processes, Ltd., & Sayers. Electrode holder.

17,821 Aktiebolaget Kafveindustri. Heating material or performing chemical processes in electrical furnaces. (12/4/19, Sweden.)

July 17.

17,869 (Cie Generale de Radiotelegraphic.) Telephone, &c., systems.

17,870 Norton. Low-tension oil switches.

17,891 Bureau Voor Uitvinders & Bakker. Distributing and drawn-in boxes. (24/10/18, Holland.)

17,893 & 17,894 Betulander. Switching apparatus for selecting and operating sets of electric contacts. (2/4/19, Sweden.)

17,895 Betulander. Circuit arrangements for telephone plants. (2/4/19, Sweden.)

17,896 Betulander. Electro-magnetic switching apparatus. (17/4/19, Sweden.)

17,902 B. T.-H. Co. & Hastings. Electric arc furnaces.

17,917 Archer & Brown. Device for locking electric lamps.

July 18.

17,944 Hughes. Reducing strength of electric current.

17,968 London Battery Co. & Clarke. Storage, &c., batteries.

17,973 Erskine Murray. Radio-navigational apparatus, &c.

17,974 Stiles. Telephone leads &c., for kite balloons, &c.

17,987 B. T.-H. Co. (G. E. Co.) X-ray tube shields.

17,988 Winne. Electric furnace control apparatus. (2/1/19, U.S.)

18,001 Runbaken & Robertson. Magnetos.

Commercial Topics.

Trading with Germany.

The idea of resuming trade relations with Germany must be distasteful to many of our readers, but it must be remembered that America, France and other countries have already commenced trading with Germans. In addition, the position of the exchange and the great need for increasing the export trade must be taken into consideration. At all events, the Federation of British Industries has opened a branch office in Cologne and has sent out a mission to collect information to investigate the financial standing of firms, &c.

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Ad Valorem Customs Duties in Australia.

The High Court of Australia has delivered an important judgment in an appeal against a decision of the Supreme Court of South Australia, which held that the duty on imported goods was assessable on the value at the time of the purchase. This judgment has been reversed by the High Court, which held that, though the Customs regulations relating to fair market value did not expressly indicate the time at which value was to be reckoned, it was the value at the time when the goods came into the country imposing the duty which must be considered.

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Import Duties and the Engineering Industry.

The British Engineers' Association has issued an interesting memorandum addressed to the Prime Minister by Mr. D. A. Brenner, Director of the Association. Figures are given showing that engineering is a high-wage industry, and that the pre-war exports of the iron and steel and engineering industries were second only to those of the textile industry. It is pointed out that abnormally high wages costs cannot possibly co-exist with an unchecked inducement to the wage-earner to spend his earnings on competitive products of other countries when the wages cost is substantially lower. On these and similar grounds it is urged that import duties should be imposed on engineering produce.

* * * *

Telephone Equipment for Brazil.

Practically the whole of the telephone lines in the State of Rio Grande do Sul are owned by one company, whose headquarters are in Porto Alegre. In the three largest cities—Porto Alegre, Pelotas and Rio Grande—the exchanges were equipped by the Siemens-Schuckert Company, but the switchboards are antiquated and require renewal. Extensions are also required in other towns, and British manufacturers would do well to keep an eye on the Brazilian market for telephone apparatus. According to the "Board of Trade Journal," the central battery system is used at Porto Alegre, but at Pelotas, Rio Grande and other places the subscribers ring by hand, and the induction system is in use. The capacity of the Porto Alegre board is 10,000 lines, and there are 5,000 subscribers; the Pelotas switchboard has a 5,000 line capacity, and there are 2,000 subscribers; and the Rio Grande switchboard has a capacity of 2,000 lines with 500 subscribers. Other cities, such as Bage, Caxias, Santa Cruz, Sao Leopoldo and Cachoeira, have exchanges, and the total subscribers for the entire State reaches a high figure. The company is making plans for the installation of an automatic exchange in Porto Alegre, and when this is effected the material replaced by the more modern equipment will be transferred to the smaller cities.

It is reported that many of the telephone exchanges in other Brazilian towns are in need of reorganisation or extension. Some plant is being obtained from the United States, but there should also be opportunities for British manufacturers.

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Siberian Industrial Outlook.

The Siberian section of the Canadian Economic Commission has recently issued an important report on the future possibilities of Siberia as a market for manufactured goods. In an abstract, which is given in the current issue of the "Board of Trade Journal," it is stated that the country is rich in mineral resources. From a list of the principal towns we notice that there are 12 towns with a population of 50,000 or over. Municipal enterprise is somewhat backward, but installation and improvement of electric light plants, telephone systems, waterworks, fire-fighting apparatus, roads and tramways in the towns will lead to a demand for a large amount of machinery and equipment. The only tramway system is that operated at Vladivostok, but before the war plans had been drawn up for the construction of electric tramways at Omsk, Tomsk, Irkutsk and Harbin, where the need of local transport is great. These plans will probably be carried out as soon as conditions become settled. Practically all the existing electric supply and telephone systems require extension and repair, while all the larger towns need the installation of up-to-date waterworks and sewerage systems. There has been very little building in Siberia since the outbreak of war, while, on the other hand, the population of all the towns has increased, so that building operations should commence with the restoration of normal conditions.

The report gives a long list of the articles required in Siberia, which, in the opinion of the commission, could be supplied from Canada, and includes agricultural machinery and appliances, hardware, dynamos, electrical apparatus, electric light fittings, boilers, railway supplies, electric and steam pumps, wood working and milling machinery, mining equipment, machine and hand tools, &c.

Electricity Supply.

BACUP Corporation has applied for permission to borrow £5,000 for mains and services.

Chesterfield Corporation is seeking authority to a loan of £5,000 for cable extensions.

Electric pumping is to supersede steam pumping at the WORCESTER waterworks.

ELLAND Urban Council is negotiating with the Yorkshire Electric Power Company for a bulk supply of electricity.

AYR Corporation has applied for authority to borrow an additional sum of £20,000 for its electric supply undertaking.

The strike of employees at the EPSOM electricity works terminated on the 28th ult, and the men resumed work on Friday.

Owing to the recent increase in the price of coal NEWPORT (Mon.) Corporation has increased its scale of charges for electricity supply.

FLEETWOOD Electricity Committee recommend the purchase of a 600 ampere battery for the electricity works at a cost of £2,000.

The TROWBRIDGE ELECTRIC SUPPLY COMPANY has notified an advance of 2d. per unit on the scheduled prices and an increase of 33½ per cent. on the meter rental.

WITHAM Urban Council is dissatisfied with the present gas lighting, and it has been unanimously decided to consider the question of introducing electricity supply.

In future the flat rate for electric current for lighting in BIRKENHEAD will be 6¼d. a unit, and in the out-townships 7¼d. per unit. The increase is ¼d. a unit, and is due to the higher cost of coal.

At BUXTON the price of electric current has been increased from 6d. to 8d. per unit for lighting, from 3d. to 3½d. for power up to 10,000 units, and 2½d. a unit beyond that amount.

DARWEN Council has increased the salary of the electrical engineer (Mr. F. M. Fletcher) to £400 per annum, and that of the tramways manager (Mr. G. A. Newsome) to £350.

The Board of Trade has extended for six months from July 31, 1919, the period within which the Deal and Walmer Gas & Electricity Company are required to lay mains in Ringwould.

BRIDGNORTH Council has asked its General Purposes Committee to report on the feasibility of using the water power of the river Severn in the generation of electricity for light and power purposes.

COLNE Council has increased the charges for electric current to 75 per cent. above the pre-war scale for lighting and 85 per cent. for power, whilst power for tramways purposes is to be increased by 10 per cent.

The charges for electricity supply in SOUTHEND have been revised, and from Oct. 1 electric current for traction will be 3d. a unit, for power 1½d. from 6 a.m. to 7 p.m. and 8d. 7 p.m. to 6 a.m., The other rates have been increased by 25 per cent.

ACCRINGTON Electricity Committee will supply a local firm of electrical contractors with electrical energy for display purposes at the power rate, but the articles displayed must consist solely of electrical fittings and appliances.

From the 30th inst. BARNSTAPLE Corporation has increased the charges for electricity as follows: Lighting, from 7d. to 8d. per unit, and meter rent from 1s. to 1s. 6d. per quarter. For power the rate will be 3d. per unit with a sliding scale for large consumers.

The Board of Trade has extended for six months from July 8, 1919, the periods limited by the Yeovil Electric Lighting Order, 1914, for laying mains, &c., and by one year from June 24, 1919, the time limited by the ORMSKIRK GAS & ELECTRICITY ACT, 1915, for the compulsory purchase of lands, &c.

As LETTERKENNY Urban Council is seeking powers to supply electricity, the Donegal County Council has decided not to authorise the erection of overhead wires by the Donegal Power & Lighting Company until the Board of Trade has dealt with the Urban Council's application.

LINCOLN Corporation has now taken over the St. Swithin's power station from Messrs. Clayton & Shuttleworth. Ultimately the whole of the supply for the city and the local engineering firms will be given from this station, and the Brayford works will be used as a sub-station; but additional plant must be put down before the change-over is effected.

The River Wear Commissioners will substitute electric motors for two gas engines which now drive the pumps of the hydraulic installation at No. 3 gateway of the SUNDERLAND Docks. The cost of the change is estimated at £1,211, and the British Westinghouse Company will supply two 15 B.H.P. motors for £541.

BURNLEY Electricity Committee has revised the scale of electricity charges and current for lighting will go up ¼d. per unit, bringing the cost to 1½d., and for power the approximate advance is $\frac{1}{10}$d. per unit. Applications for power purposes were never greater than at present, and there are nearly 100 prospective consumers on the waiting list.

The STALYBRIDGE, HYDE, MOSSLEY & DUKINFIELD Tramways and Electricity Board are increasing the price of electricity to 6d. per unit for ordinary lighting, 4½d. for mill and factory lighting and 2d. per unit for heating. An extra ½d. per unit will be charged for theatres and cinema supplies and for power exceeding 50 units per quarter an addition of 0·65d. per unit over pre-war rates will be made.

On Monday NOTTINGHAM Corporation authorised a revision of the tariff for electricity supply, and from June a charge of 6½d. per unit for lighting will be made for lighting and 2¼d. per unit for power. In explanation of the causes for the increase Mr. R. H. Swain said coal was estimated to cost £74,000 per year, compared with £54,000 last year, and £23,000 in 1914. The wages bill, which was £8,000 before the war, would now amount to £35,800.

The accounts of the Hampstead (London) electricity department for the year ended March 31, 1916, show revenue £74,573 (compared with £80,302 in the previous year), and total working expenses £58,404 (£53,112), leaving gross profit £16,169 (£27,190); interest required £7,382 (£7,697) and repayment of loans £21,931 (£22,001), the net result being a deficit of £13,144 (£2,508). Total income per unit sold was 3·95d. (3·69d.) and costs were 3·09d. (2·44d.), exclusive, and 4·64d. (3·81d.) inclusive, of loan charges. Total maximmu supply demanded was 2,577 kw. Units generated were 5,676,420 (6,593,259) and sold 4,533,321 (5,217,247).

The Electrical Development Association is exhibiting a refreshing vigour in the prosecution of the campaign in support of the extension of electricity supply for lighting, power and domestic purposes. It has recently issued three excellent pamphlets which should help in popularising electrical methods. Two of the publications (E.D.A., 16 and 17) deal with electricity in relation to coal economy, labour saving, &c.; and the third, entitled "The Land of Beautiful Reality," is a well-printed, beautifully illustrated booklet, which treats in a convincing manner of the advantages of electric heating and cooking. Further particulars may be obtained from Mr. J. W. Beauchamp, Director and Secretary of the Association, 84, Kingsway, London, W.C.2, who will supply copies at stated prices.

The Electricity Supply Commercial Association is organising a series of mass meetings in leading provincial towns for the purpose of developing the organisation and increasing its membership. Membership of the Association, which is registered as a trade union, is open to assistant and deputy managers, chief clerks and all commercial or clerical assistants of company and municipal electric supply, power or tramway undertakings in Great Britain. Meetings will be held at Manchester on Sept. 8, at Leeds on Sept. 9, at Liverpool on Sept. 11 and at Birmingham on Sept. 13. Already the Association has enrolled a large number of members, and has intervened successfully in various disputes as to war bonus awards and salaries of the staffs of electricity undertakings. It is also one of the constituent Associations of the Federation of Technical and Scientific Associations, and it is concerned with representation on Whitley Councils, the salaries, conditions of employment and other matters of interest to its members. The hon. general secretary of the Association is Mr. G. R. Smith, 36, Magazine-road, Well-road, Eltham, London, S.E.9.

Electric Traction.

Walthamstow Urban Council will purchase eight tramcars from London United Tramways, Ltd., at £570 each.

Willesden Urban Council has applied for sanction to borrow £18,489 for the purchase of 14 electric vehicles.

Preston Corporation has been authorised to borrow £2,657 for the purchase of two electric vehicles for dust collection.

The salary of the traffic superintendent of the Newport (Mon.) Corporation tramways has been increased to £312 per annum.

Nottingham Tramways Committee has recommended the Corporation to apply for Parliamentary powers to extend the tramways to Beeston and Hucknall.

Huddersfield Corporation has appointed a sub-committee, with full powers, to carry out the agreement to extend the Corporation tramway service to Brighouse.

All persons travelling on the Darwen tramways between 6 a.m. and 8 a.m. and 5 p.m. and 6 p.m. will be allowed to do so at workmen's fares Three new tramcars are to be purchased.

Sunderland Tramways Committee recommends the Corporation to adopt the principle of through running with the Sunderland & District Tramways Company.

The Llandudno & Colwyn Bay Electric Railway Company proposes to double the line between Rhos-on-Sea and the junction of Brompton-avenue and the Conway main road.

Greenock Corporation has instructed the Tramways Committee to report upon the advisability of purchasing the local tramways in 1921. Gourock and Port Glasgow Corporations are to be consulted, and the Committee has been empowered to obtain expert advice.

Owing to a failure of electric current, due to a breakdown at Lot's-road power house, the service of trains of the London Underground railways were suspended for about an hour on the 28th ult., and the complete service was not restored until after the lapse of over two hours.

The Commissioner of Police of the Metropolis recently appointed a committee to consider the powers and duties of the police in relation to the regulation of street traffic and the advisability of making uniform Rules for Traffic Regulation throughout the metropolitan police district. A code of suggested signals has now been prepared, and the Commissioner would be glad to be favoured with observations thereon at an early date.

Negotiations have continued during the week in connection with the demands of the Tramway Workers for Increased Wages and the merging of the war bonus into permanent wages. The Tramways & Light Railways and the Municipal Tramways Associations having intimated that they were not prepared to concede all the demands, a meeting of the workers and employers' representatives took place when the workers' representatives suggested that the demands should be referred to arbitration. Several undertakings have rejected the idea of arbitration.

Tottenham Urban Council has decided to purchase a fleet of 10 motor vehicles, including 10 electric tipping dust wagons, which have been ordered from Edison Accumulators, Ltd., at £1,304 each. Each of the electric vehicles will be of 3 tons' capacity, and will enable the dust collection of the whole district to be dealt with, thus displacing over 20 vans in use at present. To enable the electric batteries of the vehicles to be charged every night, £250 is to be spent in installing the necessary engine and dynamo at the refuse destructor.

The general manager's report on the Sunderland Corporation's tramways department for the year ended March 31, 1919, states that total receipts were £119,691 and working expenses £67,321. Interest required £7,265 and repayment of capital £18,000, the net balance being £27,105; and after providing for reserve and renewals, depreciation of investments, income tax, &c., £5,000 has been transferred to the borough fund. Traffic revenue per car-mile was 21·44d. (compared with 16·48d. in previous year), and working expenses, including power, were 12·23d. (9·71d.). Passengers carried were 26,251,700 (25,041,160) and car-miles run 1,321,019 (1,425,007).

Newport (Mon.) Tramways Committee, having considered a report from the borough electrical engineer (Mr. A. Nicholas Moore) as to the use of railless traction from the Corporation-road terminus to the Channel Dry Docks, and Caerleon-road to Chepstow-road, have decided to invite the opinion of the dry dock owners on the former route, asking what contributions they are prepared to make to such a scheme. The net cost of the overhead equipment and necessary feeder extension for the first route is estimated at £3,500, and the provision of six cars at £12,000. In Mr. Moore's opinion the second route is not suitable for the railless system.

Imperial and Foreign Notes.

The commercial community of Mauritius can now use the Imperial wireless station at Rose Belle, in the south of the island, for receiving and sending business messages. The charge is 62 cents (about 10¼d.) per word for ordinary messages and 38 cents (about 6¼d.) per word for commercial messages.

The directors of the Waihi Gold Mining Company have arranged to sell for £212,500 the Hora Hora hydro-electric works to the New Zealand Government, which will in future supply power to the mine and works on terms nearly similar to those it charges for supplying power to consumers at Christchurch.

It is announced that work will be started at once on the Toronto-Niagara Hydro-Radial scheme, as the Hydro-Electric Commission has authorised the execution of agreements with the various municipalities in connection with the construction of the line. Engineers are engaged on the final surveys, and as soon as these are completed construction work will be undertaken.

It is estimated that of the 2,200 factories in Greece, 580 are operated electrically.

The Federal Government has erected a drying station at Bahia (Brazil) for sterilising and improving cereals and cocoa. The machinery is driven electrically.

According to Reuter, wireless telegraph installations for communication between Berlin and other German towns continue to be reconstructed, and it is reported that the Government intend to lease receiving installations to private persons.

The Governor of the State of Santa Catharina, Brazil, has sanctioned a law of Congress authorising the raising of a State loan of £1,000,000 for various works, including the construction of an electric tramway uniting the capialt of the State (Desterro) with the neighbouring districts.

The Board of Trade have issued a general licence under the Trading with the Enemy Legislation authorising with certain reservations, the resumption of trade with Arabia. The licence does not remove the existing restrictions upon the payment of debts and the return of property due or deliverable to persons in Arabia in respect of pre-war transactions.

For the purpose of facilitating the development of commercial relations between British firms and Czecho-Slovakja, the Czecho-Slovak Legation is offering to secure the services of competent men for Czecho-Slovak correspondence and for the translation of catalogues into the Czecho-Slovak language. Communications should be sent to the Commercial Attaché, Czecho-Slovak Legation, 9, Grosvenor-place, S.W. 1.

A Royal decree has been issued providing for the conversion to electric traction of 6,000 km. (about 3,720 miles) of the Italian State Railways track, and all lines under private management wherever possible. The estimated expenditure will exceed £32,000,000. This important scheme is to be pushed forward with all possible speed owing to the shortage of coal and the desire to utilise the hydro-electric power available. In the new law proposed by the Minister of Public Works concerning the development of hydro-electric power, and for the construction of electric railways, &c., a subvention of 40 lire per horse-power generated will be granted for a period of 15 years, and freedom from taxes on house property is to be granted for the same period to all generating and sub-station buildings. The Bill provides for an annual expenditure of 80,000,000 lire, which should make it possible to obtain an increase in the power production of 8,000,000,000 kw., and thus effect a yearly saving of 8,000,000 tons of coal.

The Commonwealth Edison Company, of Chicago, adopted an interesting method of getting over the difficulty caused by the recent four-day strike of the elevated and street car men, which resulted in a complete tie-up of the transportation facilities of the city. As soon as the news of the strike became known, the officials of the company began to make their arrangements, and in a few hours had 11 electric automobiles on duty transferring its station operators and other station employees to the stations and to their homes. During the first day arrangements were completed for taking care of the company's other employees. Ten routes were laid out, covering practically all of the city except those parts that could be reached by train service, and 30 electric trucks were fitted up and assigned to these routes. Those employees who did not live near the railroads were given passes that entitled them to ride on the trucks. Although the usage to which the electric trucks were subjected was particularly severe, no serious difficulties were encountered. Many other large Chicago concerns, notably the department stores, also used their electric trucks to good advantage during the time. No bad results were noticed from the hard usage.

Miscellaneous.

In the note concerning Mr. John Schabert's Death, which appeared in our last issue, the correct description should have been chief works foreman, and not works manager, as stated.

The Eastern Telegraph Company announces that the contemplated reduction of Telegraph Rates between the United Kingdom and the Far East must be suspended, pending further arrangements with the Governments interested.

On behalf of the Western Telegraph Company, the cable ship "Colonia" (of the Telegraph Construction & Maintenance Company) has completed the laying of a New Submarine Cable from Ascension via St. Vincent and Fayal, to Rio de Janeiro. This is an excellent example of British enterprise, promptly undertaken and executed without unnecessary publicity The new line will give to the commercial and business community greatly inproved telegraphic facilities with South America.

The British Science and Key Industries Exhibition will be held in the Kelvin Hall of Industries, Kelvingrove, Glasgow, from Nov. 17 to 29 next. The Advisory Committee includes Prof. Desch, of the Royal Glasgow Technical College; Sir Andrew Gray, Glasgow University; and Mr. W. W. Lackie, chief electrical engineer to the Corporation.

In order to assist in the restoration of normal conditions, it has been decided to suspend the Restrictions on the Transport of Coal by rail under the Coal Transport Reorganisation Scheme. A general permit has been issued, and it will not be necessary (until further notice) to apply for permits in individual cases.

The wireless telegraph services between Great Britain and Holland and between Great Britain and Denmark were inaugurated on the 29th ult. Six hours daily are devoted by the Stonehaven station in transmitting to and receiving messages from Denmark (Lyngby), and six hours daily in communications with Holland.

In the revised edition of their pamphlet on Income and Super Tax, Messrs. Oliver & Boyd, of Tweedale-court, Edinburgh, give a summary of the changes made by the 1919 Budget. There is a tabular view of rates, exemptions, deductions, &c., with some concise "Reminders and advice" written in popular language. It should prove extremely useful to business and professional men. The published price is 1s. net.

The office of Engineer-in-Chief of the Post Office was created in 1870, with a salary of £1,000–£50–£1,200. This scale was reduced to £900–£50–£1,100 in 1878, and raised again in 1887 to £1,000–£50–£1,200, a level at which it now stands, plus the usual war bonus. The salary can scarcely be called a high one, seeing that the staff under the Engineer-in-Chief's control numbers 24,500, and the value of the plant, as new, at pre-war costs, is estimated at £42,000,000.

In an arbitration between Messrs. Dick, Kerr & Company (Preston) and the National Union of General Workers on Aug. 21, claim was made on behalf of the women employed by Britannia Lampworks for an advance of 6s. a week, and a further advance of 5s. a week to women in engineering shops, boiler shops and foundries. It was stated the normal working week had been reduced from 50 hours to 47 hours, for which the women received such sum as was payable for 50 hours. The award was that the claim had not been established.

On the 28th ult. Mr. Herbert W. Eckersley, who was applying an electrical vibrator to the upper part of his body in a bath, received a fatal shock. Artificial respiration was unsuccessful, and at the inquest on Saturday a verdict of accidental death was returned. The evidence showed that the vibrator was of the usual type, and was connected with the bathroom lighting circuit by a long flexible cord and adapter. On being tested the machine was found to be faulty, the wire at one point being bare and green owing to dampness and electrolytic action, making the case "alive," In one witness's opinion, electrical appliances of that description should not be used except under medical or other expert supervision. "It was a most dangerous thing, and the danger was intensified by being in a metal bath." When Mr. Eckersley got hold of the faulty vibrator he would not be able to leave go, and he was killed by a pressure of 100 volts.

A gathering of past and present members of the Yorkshire Electric Power Company's staff was held at Crow Nest Park, Dewsbury, on Saturday afternoon, when the opportunity was taken to have the groups of those attending photographed as a souvenir, as in consequence of various staff grievances, over 15 (including some senior and long service members) have arranged recently to leave the Company's service. The weather was fine and the excellent attendance, notwithstanding holidays and official duties, reflects the excellent "team" spirit animating the staff. We are informed that in May the grievances were viewed so seriously by the staff that over 70 members handed in their notices. Subsequently an agreement was arrived at with the directors and the management as a result of which the notices were withdrawn. From Saturday's gathering of leave-taking it is evident that some causes of friction still remain, and in view of the importance of the electricity supply industry it is hoped that harmony will soon be restored. Tea was served in the old mansion house, when the members were joined by friends, and after music, farewells and good wishes were expressed, and a most enjoyable afternoon was brought to a close.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during July, 1919, and (*b*) the aggregate figures from Jan. 1 to July 31, with increase or decrease compared with corresponding periods of 1918:—

Electrical machinery, (*a*) £90,713 (increase £55,495), (*b*) £338,772 (decrease £64,658); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £16,258 (increase £2,257), (*b*) £131,503 (increase £50,537); and electrical machinery unenumerated, (*a*) £74,455 (increase £53,238), (*b*) £247,269 (decrease £125,195); telegraph and telephone cables other than submarine, (*a*) £592 (increase £502), (*b*) £8,445 (increase £6,509); telegraph and telephone apparatus, (*a*) £35,239 (increase £25,895), (*b*) £170,839 (increase £137,832); other electrical wires and cables, rubber insulated, (*a*) £568 (increase £558), (*b*) £3,524 (increase £2,867); with other insulations, (*a*) £1,424 (increase £1,391), (*b*) £10,427 (increase £9,667); carbons, (*a*) £3,113 (increase £276), (*b*) £17,197 (decrease £8,142); glow lamps, (*a*) £6,596 (decrease £7,924), (*b*) £211,892 (increase £133,648); arc lamps and electric searchlights, (*a*) £28, (*b*) £28; parts of arc lamps and searchlights (other than carbons), (*a*) £8,067 (decrease £11,885), (*b*) £44,671 (decrease £18,320); primary and secondary batteries, (*a*) £2,270 (decrease £4,991), (*b*) £27,650 (decrease £72,074); meters and measuring instruments, (*a*) £3,279 (decrease £5,612), (*b*) £22,534 (increase £5,796); switchboards, (*a*) £58 (decrease £1,807), (*b*) £1,014 (decrease £1,117); electrical goods and apparatus unenumerated, (*a*) £39,065 (decrease £13,015), (*b*) £248,215 (decrease £61,898). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £100,289 (decrease £16,584), (*b*) £766,436 (increase £134,796).

Exports.—The exports of electrical machinery, material, &c., (*a*) during July, 1919, and (*b*) from Jan. 1 to July 31, with increase or decrease compared with corresponding periods of 1918, were as follows:—

Electrical machinery, (*a*) £183,027 (increase £111,322), (*b*) £810,541 (increase £190,428); including railway and tramway motors, (*a*) £2,949 (increase £60), (*b*) £27,822 (increase £4,831); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £98,216 (increase £43,446), (*b*) 457,925 (increase £76,122); and electrical machinery unenumerated, (*a*) £81,862 (increase £67,816), (*b*) £324,794 (increase £109,475); telegraph and telephone cables, submarine, (*a*) £107,265 (increase £83,965), (*b*) £349,328 (decrease £16,203); other than submarine, (*a*) £27,982 (decrease £6,527), (*b*) £203,241 (increase £30,292); telegraph and telephone apparatus, (*a*) £33,232 (increase £17,134), (*b*) £189,861 (increase £73,651), other electrical wires and cables, rubber insulated, (*a*) £88,452 (increase £84,339, (*b*) £376,943 (increase £339,307); with other insulation, (*a*) £106,413 (increase £91,343), (*b*) £431,380 (increase £389,586); carbons, (*a*) £1,597 (increase £1,320), (*b*) £5,034 (increase £1,728); glow lamps, (*a*) £17,992 (increase £11,213), (*b*) £84,620 (increase £35,665; arc lamps and searchlights, (*a*) £229 (decrease £1,878), (*b*) £6,781 (decrease £7,055); parts of arc lamps and searchlights (other than carbons), (*a*) £203 (decrease £373), (*b*) £7,514 (decrease £3,792); primary and secondary batteries, (*a*) £25,002 (increase £16,741), (*b*) £266,427 (increase £205,573); meters and measuring instruments, (*a*) £19,307 (increase £8,124), (*b*) £115,032 (increase £44,317); transformers, (*a*) £14,196 (increase £12,093), (*b*) £35,777 (increase £19,139); switchboards, (*a*) £9,209 (increase £6,974), (*b*) £26,214 (increase £6,347); electrical goods and apparatus unenumerated, (*a*) £92,935 (increase £58,543), (*b*) £624,361 (increase £377,480). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £544,014 (increase £383,011), (*b*) £2,722,513 (increase £1,486,035).

Educational.

Dr. J. K. Wood has been appointed lecturer in physical chemistry at the Manchester College of Technology.

Prof. Thos. Gray has been appointed director of the School of Chemistry at the Royal Technical College, Glasgow; and Mr. Forsyth J. Wilson, D.Sc., Ph.D., and Mr. Isidor M. Heilbron, D.Sc., Ph.D., F.I.C., become professors of inorganic and analytical chemistry and of organic chemistry respectively.

The courses of study at the Merchant Venturers' Technical College (which provides and maintains the faculty of engineering in the University of Bristol), include schemes of study for persons intending to engage in civil, mechanical, electrical or automobile engineering. These comprise not only the usual engineering subjects, but also instruction in French and German for scientific purposes, as well as in book-keeping, accountancy, work administration and organisation, commercial law, &c.

King's College, University of London, provides complete courses of study extending over three or four years in civil, mechanical and electrical engineering, and prepare for the engineering degrees of the University of London and for the diploma and certificate of the College. Various additions have been made to the engineering department, including two large drawing offices, lecture theatre and rooms for research, including wireless telegraphy for the electrical engineering department. There are six laboratories and facilities for research and post-graduate work.

Tenders Invited and Accepted.

Atherton Urban Council invites tenders (by Sept. 18) for one boiler plate cubicle equipped with instruments, bus bars, sweating sockets, &c. Tenders to the Clerk.

Westminster Guardians want tenders by noon Sept. 17 for the supply of electric lamps, fittings, &c. Forms of tender from the Clerk, Princes-row, Buckingham Palace-road, London, S.W.1.

The West Ham Guardians require tenders by 10 a.m. Sept. 25 for six months' supply of electrical fittings, ironmongery, oils, colours, &c. Forms of tender from the Clerk, Board Room, Union-road, Leytonstone, London, E. 11.

Portsmouth Tramways Committee invite tenders for supply of 3,000 tons steel girder tram-rails, 180 tons fish-plates, 40 tons fish-bolts and 85 tons w.-i. tie-bars. Specifications from the Engineer and tenders to the Town Clerk by Sept. 16.

Tenders are invited for two parcels of tungsten wire which is being sold by order of the Prize Court. Forms of tender, &c., from the brokers (Messrs. Morrison, Kekewich & Company), 270, Gresham House, Old Broad-street, E.C.2, and tenders to the Admiralty Marshal, Royal Courts of Justice, Strand, London, W.C.2, by noon Sept. 22.

West Ham Corporation invite tenders for the supply of lead-covered, paper-insulated underground cables. Specifications and forms of tender from the engineer and manager, Mr. Frederick W. Purse, M.I.E.E., 84-86, Romford-road, Stratford, E.15, and tenders to the Town Clerk by 4 p.m. Sept. 9.

Grimsby Corporation invite tenders for the supply and erection of two 1,000 kw. converters and c.c. and a.c. l.t. switchgear, e.h.t. switchgear and cables; coal and ash-handling plant and a 30-ton electrically-driven travelling crane. Specifications from the borough electrical engineer, Lieut.-Col. W. A. Vignoles, and tenders by Sept. 25

Edinburgh Corporation invite tenders for three 10,000 k.w. turbo-alternators and six water-tube boilers. Specifications from the engineer (Mr. F. Newington), Dewar-place, and specifications and drawings may be seen at the office of Sir Alex. B. W. Kennedy, 17, Victoria-street, London, S.W. Tenders to the Town Clerk by Sept. 11.

Ayr Council has ordered a rotary converter from Messrs. Vickers, Ltd., at £2,119.

Darwen Corporation has accepted the tender of the English Electric Company for the supply of three new tramcars.

St. Helens Corporation has accepted the tender of the British Insulated & Helsby Cables, Ltd., for the supply of cables.

Belfast Corporation Tramways Committee has accepted the tender of the Brush Electrical Engineering Company for the supply of 50 tram-car bodies and trucks.

Eccles Town Council has accepted the tender of the British Electric Transformer Company for three 500 k.v.a. three-phase transformers, at £2,105. Only two of the tenders complied with the specification.

Spenborough Council has accepted the following tenders: Phœnix Dynamo Mfg. Company, rotary converter, £1,498; British Thomson-Houston Company, for switchgear, £265; and Brush Company, Ltd., transformer, £580.

Grimsby Corporation has accepted the tender of John Spencer, Ltd., for high-pressure steam boiler feed and other pipes; that of the Pulsometer Engineering Company for an electrically driven centrifugal pump; and that of Aiton & Company, for a water storage tank.

Manchester Electricity Committee has accepted the following tenders:—British Westinghouse Company and Ferranti, Ltd., transformers; Ferranti, Ltd., Chamberlain & Hookham, General Electric Company, Ltd., British Westinghouse Company, meters; British Insulated & Helsby Cables, Callender's Cable & Construction Company, C. Macintosh & Company, Johnson & Phillips, Enfield Cable Company, Western Electric Company and Siemens Bros. & Company, cables; British Thomson-Houston Company, Veritys Ltd., Electromotors Ltd. and British Westinghouse Company, motors; Veritys Ltd. and A. Reyrolle & Company, motor starters.

Appointments Vacant and Filled.

Doncaster Corporation require a borough electrical engineer. Salary £550 per annum. Applications to the Town Clerk by Sept. 11.

Instructors in electrical installation work and electrical engineering are required for the East Ham Technical College. Applications to the Principal.

A tramways manager is required for the tramways in the boroughs of Stockton and Thornaby-on-Tees. Applications to the Town Clerk, Borough Hall, Stockton-on-Tees, by Sept. 27.

A chief lecturer in electrical engineering is required at West Ham Municipal Technical Institute. Salary £250—£10—£400 per annum. Applications to the Principal, Romford-road, Stratford, E. 15.

A senior lecturer in electrical engineering is required for the South Wales and Monmouthshire School of Mines, Treforest. Salary £450–£600. Further particulars from the Principal and applications by Sept. 23.

The delegacy of the City and Guilds (Engineering) College require three demonstrators in electrical engineering. Salaries £150–£200, with special bonuses of £120–£135. Applications to Prof. T. Mather, Exhibition-road, S.W.7., by Sept. 6.

The London County Council requires a rolling-stock engineer, a permanent way engineer, an assistant electrical engineer, a traffic operation superintendent, a traffic statistics assistant, a publicity assistant and two sub-station superintendents. Applications to the Clerk of the L.C.C. by 4 p.m. Sept. 25.

The Civil Service Commissioners announce that an examination will begin on the 28th prox. for filling vacancies as Assistant Examiners in the Patent Office. The examination will be confined in the main to candidates who have served in H.M. Forces, and will consist of a qualifying examination followed by interview by a Selection Board. The subjects of the qualifying examination are English composition, précis writing, general knowledge and *one* of the following: General chemistry, electricity and magnetism, mechanics and mechanism. The limits of age are 20-30. Initial salary, £150 a year together with a war bonus. Copies of the regulations and forms of application may be obtained from the Secretary, Civil Service Commission, Burlington-gardens, London, W. 1. The last day for making application is Sept. 18.

Mr. A. Anderson, manager of the Oldham, Ashton & Hyde Electric Tramway, Ltd., has been appointed manager of the Peterborough Electric Traction Company.

Mr. W. A. Christianson, who has been station-superintendent of the Yorkshire Electric Power Company for the past six years, has resigned in order to take up an appointment in the contract department of the B. T.-H. Company, Rugby.

Business Items.

The offices of the Wireless Press, Ltd., have been removed to 12 and 13, Henrietta-street, London, W.C. 2. Telephone, Gerrard 2807.

An order has been made restoring the patent dated March 20, 1913, and granted to Rebesi Limited and Mr. W. B. Good, for "An automatic Morse recorder."

The partnership between S. T. and E. Quilliam (trading as the Forest City Electric Service Supply Company) has been dissolved so far as concerns Mr. E. Quilliam.

The partnership between V. C. Bond, E. W. Clarke and C. C. Wilson (trading as the London Battery Company), Wilton-road, Hackney, London, has been dissolved so far as concerns Mr. Bond.

John Bruce Collier and Fredk. John Goring, trading as the Electric & General Lighting Engineering Company, 1, Station-road, Farnham, Surrey, have dissolved partnership. Debts by Mr. Collier.

Mr. F. Farndon has resigned his position as sales manager of the West Ham Corporation electric supply department, and is forming a company to carry on the business of consulting and constructional electrical and mechanical engineers, as from Oct. 1 next. Further announcements of the company's operations will be made later. His many friends in the electrical industry will join us in wishing Mr. Farndon every success in his new enterprise.

The Chloride Electrical Storage Company, Clifton Junction, near Manchester, has prepared a booklet which gives instructions for charging and operating "Exide" and "Clifton" starting and lighting batteries. The instructions are clear but concise, and there is a diagram of connections with a table of normal charging rates. A copy of the booklet, which should prove very useful to users of these batteries, is sent with each battery sent out from the company's works.

Mr. R. C. Atkinson, Assoc.M.Inst.C.E., A.M.I.E.E., A.M.I.Mech.E., who has for the last seven years been superintendent of the power station construction department of the Yorkshire Electric Power Company, has joined the firm of E. L. Thorp & Company (late Shepherd & Watney), consulting engineers, of 32, Greek-street Chambers, Leeds. The firm will in future practice under the title of "Thorp & Atkinson" at the same address, and will continue to advise upon the application of electrical power to industrial work, &c.

Arrangements have been made for amalgamating the undertaking of Messrs. A. & J. Main & Company, of Glasgow, with the engine works department of Sir W. G. Armstrong, Whitworth & Company. A new company, under the title of Messrs. Armstrong & Main, Ltd., has been formed, with Mr. John Noble as chairman, and Mr. J. A. Main as managing director; and in future the Clydesdale and Germiston works of Messrs. Main and the adjoining Glasgow engine works of Messrs. Armstrong, Whitworth & Company will be under one management.

The British Westinghouse Electric & Mfg. Company, Trafford Park, Manchester, have recently issued a number of pamphlets and circulars relating to some of their manufactures. These publications relate to the "Individual Motor Drive of Planing Machines," "Large Outdoor Switches and Transformers," "Bracket Pedestal Bearings," "Some Westinghouse Electric Winding Engines," "D.C. Motor Starters type S.D.," "Motor Generators," "Oil-Immersed Forced-cooled Single and Three-phase Shell and Core Type Transformers," "Single-phase Shell Type Oil-Immersed Self-cooled Transformers."

Electro-Metals, Ltd., 56, Kingsway, W.C.2., has issued two leaflets giving prices and particulars of its flexible shaft couplings. In leaflet No. 1,200 there is a description of the company's union type of coupling which is recommended for use in all classes of work. It is specially designed for exceptionally severe services, and a number are working successfully on rolling mill plant. It is claimed that the design is such that the coupling is capable of sorting up energy, so that the peak torques are absorbed by the spring and cyclic variations are thus damped out. Leaflet No. 1,207 is devoted to the company's Z.V. type of coupling, which is recommended as serviceable and reliable for non-reversing duty. Owing to the recent increased cost of coal, the company has increased the catalogue prices of the couplings by 5 and 7½ per cent. respectively.

Companies' Reports, &c.

The Brazilian Traction, Light & Power Company has declared a quarterly dividend of 1½ per cent. on the cumulative preference shares.

The Newcastle-upon-Tyne Electric Supply Company has declared an interim dividend of 2½ per cent. on the preference and ordinary shares.

At an extraordinary meeting on the 28th ult. resolutions were passed increasing the number and the remuneration of the directors of Marconi's Wireless Telegraph Company.

The City of London Electric Lighting Company, Ltd., has declared an interim dividend at the rate of 6 per cent. per annum (6s. per share), less tax, on the ordinary shares for the past half-year.

The directors of the Canadian General Electric Company have declared a dividend of 2 per cent. for the three months Sept. 30 on the common stock, and a half-yearly dividend of 3½ per cent. for the six months on the preference stock.

The profit of the Aberdeen Suburban Tramways Comyany for the half-year ended July 31 last was £2,908, which with amount brought forward makes £5,393. The directors have added £1,200 to renewal and depreciation acccount, and a dividend at the rate of 7 per cent. for the past year was declared, £1,907 being carried forward.

For the year ended June the profit of the Trafford Park Estates, Ltd., was £46,462, which, together with £58,227 brought forward, provides an available sum of £104,689. The directors recommend payment of a dividend at the rate of 7 per cent. per annum on 622,250 £1 shares for 12 months, and from Feb. 7 to June 30, 1919, on the 27,750 shares recently re-issued. The balance carried forward is £60,365.

Mr. J. H. Blake, who presided over the annual meeting of the Trowbridge Electric Supply Company, Ltd., last week, stated that the profit for the past year was £372, which, together with £57 brought forward, left £429 to be dealt with. After paying a dividend of 5 per cent. and placing £200 to depreciation, £64 was carried forward. He complained of the higher expenses, and said there was a great demand for electricity, especially for motive power. The progress made proved that the company was justified in coming to Trowbridge, even though they did not get the support they expected at the start. The company was now being asked to be at the service of almost everyone. To supply all demands would require a great amount of capital; the price of cables was almost prohibitive, and he regretted the attitude of the Council in refusing to allow overhead wires. That retarded any extension, and prevented people who wished to have electic light from being supplied.

New Companies.

ASTRAL INTENSIFIER, LTD. (157,890).—Private company. Reg. Aug. 13, capital £5,000 in 10s. shares, to adopt an agreement with A. Graham France for the acquisition of a patent for a reflector or intensifier for an electric filament lamp, &c. First directors: W. H. Timpson and A. Graham France. Acting secretary: M. Patt. Reg. office: 60, New Bond-street, W.

ATTENBOROUGH & TURPIN, LTD. (158,083.)—Private company; reg. Aug. 20, capital £2,000 in £1 shares, to carry on the business of electrical and mechanical engineers, &c. First directors are W. Attenborough and A. E. Turpin (both permanent). Reg. office, 5, Goldsmith-street, Nottingham.

BRITISH MAGNESITE CALCINING COMPANY, LTD. (158,119.)—Private company; reg. Aug. 21, capital £100,000 in £1 shares. Objects, to carry on the business of calciners, burners, grinders and pulverisers of magnesite, chrome, bauxite, dolomite or other refractory materials; manufacturers of and directors in stoppers, nozzles, dolomite and other bricks, tiles and pottery, smelters, engineers, &c. Secretary, R C. Rann. Reg. office, 14, Great George-street, S.W. 1.

CHIPPERFIELD, LTD. (158,088).—Private company, reg. Aug. 20, capital £1,000 in £1 shares, to take over business of electrical engineer carried on by F. Chipperfield at Oulton Broad, Suffolk. First directors are F. Chipperfield, C. Chipperfield and O. G. Scarle.

CONNOLLYS (BLACKLEY) LTD. (158,345).—Private company. Reg. Aug. 29, capital £50,000 in £1 shares. Objects: To enter into an agreement with the Enfield Electric Cable Mfg. Company, Ltd., and its liquidator, and the Enfield Ediswan Cable Works, Ltd., for the acquisition of the undertaking and assets of Connolly Brothers, Ltd., insulated wire and cable manufacturers. First directors are Viscount Grintson, John Aspin, Albert V. Downton and John Brown. Reg. office: Central House, Finsbury-square, E.C.2.

DELTA ELECTRICAL & GENERAL ENGINEERING COMPANY, LTD. (158,161)—Private company, reg. Aug. 22, capital £1,000 in £5 shares, to carry on the business indicated by the title. Secretary, T. Prior. Reg. Office: Kilnholme Hill, Stacksteads, Bacup.

DICK'S ASBESTOS COMPANY, LTD. (158,272).—Private company, reg. Aug. 27, capital £100,000 in £1 shares, to take over the business of Dick's Asbestos Company, and to carry on the business of manufacturers of and dealers in asbestos, fibres, non-conducting coverings, engine and pump packings, &c. First directors are W. F. Dick (governing), F. R. Williams and L. L. Mortlock. Reg. office: 47, Fenchurch-street, E.C.3.

LUNA LIMITED. (157,873).—Private company. Reg. Aug. 12, capital £3,000 in £1 shares. Objects: To carry on the business of manufacturers and sellers of luminous and other signs, guides, novelties, &c. First directors are S. G. Catt and E. S. Barralet. Reg. office: 3, Great Winchester-street, E.C.

MIDDLESBROUGH STEEL TUBE & CONDUIT COMPANY, LTD. (158,359) Private company. Reg. Aug. 29, capital £15,000 in £1 shares (14,900 ordinary and 100 management), to carry on the bnsiness of manufacturers of and dealers in conduit, boiler and steel and iron tubes, manufacturers of and dealers in electrical and mechanical appliances, &c. First directors are W. H. Mill (chairman), J. Mather, R. W. Perry and J. Mill (all permanent). Secretary: J. Reid. Reg. office: Lower Commercial-street, Middlesbrough.

NORWEGIAN ELECTRIC SMELTING COMPANY, LTD. (158,138.)—Private company; reg. Aug. 21, capital £30,000 in £1 shares, to carry on the business indicated by the title, and to enter into an agreement with G. J. Stock. First directors are G. R. T. Taylor, T. V. Miles, G. J. Stock and H. H. Blackburn (and secretary). Reg. office, 24, Bank-street, Bradford.

PETTIGREW & MERRIMAN, LTD. (158,178).—Private company, reg. Aug. 22, capital £20,500 in £1 shares (10,000 8 per cent. cumulative preference ordinary and 10,500 ordinary). Objects: to carry on the business of mechanical and electrical engineers, instrument makers, electricians, &c. First directors are T. Pettigrew, E. Merriman and P. H. Macintosh.

PRODUCTS & EQUIPMENT, LTD. (158,109)—Private company: reg. Aug. 30, capital £3,000 in £1 shares. Objects, to carry on the business of manufacturers, importers and exporters of and dealers in engineering apparatus, equipment, stores and tools. First directors are H. W. Luker and J. S. Davidson.

TAYLOR BROTHERS (CANNON STREET), LTD. (158,185).—Private company, reg. Aug. 22, capital £10,000 in £1 shares. Objects: to carry on the business of engineers, machinists and repairers of machinery, electricians, mechanical, chemical and electrical engineers, &c. First directors are A. Atkinson (managing), H. E. Taylor, A. J. Taylor and L. Taylor (all permanent). Reg. office: 46, Cannon-street, E.C.

VICKERS HELLENIC, LTD (150,188.)—Private company; reg. Aug. 22, capital £10,000 in £1 shares, to carry on the business of manufacturers of and dealers in steel, iron, brass and metals, shipwrights, electricians, &c.

X-RAYS, LTD. (158,010.)—Private company; reg. Aug. 16, capital £25,000 in £1 shares, to carry on the business of manufacturers of and dealers in electrical apparatus, and other things applicable to X-rays, &c. Reg. office, 10, Balham Park-road, S.W. 12.

Prices of Metals, Chemicals, &c.

Tuesday, Sept. 2.

		Price.	Inc.	Dec.
Copper—				
Best selected	per ton	£110 0 0	£1	—
Electrolytic bars ...	,,	£120 0 0	—	—
H.C. wire, basis ...	per lb.	1s. $3\frac{15}{16}$d.		—
Sheet	per lb.	1s. $3\frac{11}{16}$d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	per lb.	1s. $7\frac{15}{16}$d.	3¼d.	—
Brass 60/40—				
Rod, basis	,,	0s. $10\frac{15}{16}$d.	—	—
Sheet, basis	,,	1s. 2⅜d.	—	—
Wire, basis	,,	1s. 2¼d.	—	—
Pig Iron—				
Cleveland warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	£33 10 0	—	—
Lead Pig—				
English	,,	26 0 0	—	—
Foreign or colonial	,,	25 5 0	—	5s. 0d.
Tin—Ingot	,,	276 0 0	3 0 0	—
Wire, basis	per lb.	0 3 5	⅜d.	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £21.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s.

Copper Sulphate.—Per ton £43.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6¾d.

Shellac.—488s. October delivery 490s.

Rubber.—Para fine, 2s. 5¾d.; plantation grades, 2s. 1¼d.–2s. 1¾d. lb

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W.T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From The Electrician, Sept. 2, 1882.]

The Lancashire and Cheshire Telephone Exchange.—At the meeting of shareholders of the Lancashire & Cheshire Telephonic Exchange Company, convened for September 11, the directors will recommend a dividend at the rate of 5 per cent. per annum.

The Telephone at Derby.—Messrs. John Davis & Son, of Derby, have erected a telephone line between the mills of Messrs. Petera & Company, at Derby, and Borrowash, a distance of 5 miles. The Gower-Bell instruments are employed, and are said to work satisfactorily.

Electric Light for Shops.—Messrs. Shoolbred & Company, of Tottenham Court-road, W., have 40 electric lamps now in use, at least so says the "Daily News," and we have no reason to doubt the fact; but surely what follows is slightly inaccurate. Our contemporary says that the lamps are "supplied by two eight horse-power engines, each engine worked by a Gramme machine of twenty lights"!

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ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

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Notes.

Addresses to the British Association.

IT was not unnatural that the Presidential Address by Sir CHARLES PARSONS to the British Association, and also the Addresses of Chairmen to the sections, should deal to a considerable extent with our activities during the war. The veil is being gradually lifted from what was done during those four years. Considering the slowness with which scientific developments are usually evolved into practical applications it is evident how intense the work must have been. Among the more interesting work which proved of great value, and to which reference is made by Sir CHARLES PARSONS, we may mention sound ranging. A testimonial to its accuracy is given by the statement that a single set of good observations could be relied upon to give the position of an enemy gun to about 50 yards at 7,000 yards range. The system could be carried on during considerable artillery activity, and thus during 1917 sound ranging stations became very numerous. Equally important were questions of sound transmission under water, which introduced very abnormal conditions. To detect sound in still water by means of a hydrophone, free from sounds in the immediate neighbourhood, was comparatively simple; but to detect sounds at a distance when the hydrophone is being drawn through the water at a considerable speed and by a vessel which might be travelling in rough water was a very different problem. The sounds in the immediate neighbourhood then introduce too much interference. The solution was found by taking council with those working in other branches of science. It was known by the biologist that sea lions can hear under water when travelling up to speeds of 6 knots, and from the construction of the ear of the whale it follows that the sound waves received by this mammal must be transmitted through the head rather than through the ear This led to the placing of the hydrophone in a hollow body in the form of a fish made up of celluloid or very thin metal, the hydrophone being fixed in the centre of the head and the body being filled with water. When such a device was towed at some distance behind the chasing ship, disturbing noises were found to be small and enemy noises could be heard up to speeds of 14 knots and at considerable distances. One of the many valuable investigations arising out of the war and mentioned by Sir CHARLES PARSONS is that of the rapid erosion of the propellers of some of the ships doing arduous duties. A committee of inquiry was appointed by the Admiralty and it was found that the erosion was due to the intense blows struck upon the blades of the propellers by the water closing up the vacuous cavities against them. Although the pressure bringing the water together is only that of the atmosphere, it was proved that at the nucleus a pressure as high as 20,000 atmospheres might be produced. It was shown that when water flowed into a conical tube which had been evacuated a pressure of over 140 tons per square inch was recorded at the apex. Such a pressure is capable of eroding brass and steel, even of the hardest variety, if sufficient time is allowed.

Utilisation of Scientific Men During the War.

IN his Address to Section A, Prof. A. GRAY referred at some length to the work of scientific men during the war and the difficulties under which they laboured. The statement is made that the Germans had a complete record of men fitted only for the rank and file and of those who had been trained to observe and to measure. It is perfectly true that some education is necessary even in taking simple measurements, and this education could be very easily given in Germany. In this country the authorities were not aware of any such need. It was only natural, therefore, that a good deal of chaos should arise when the new armies were organised under conditions of very great stress. The work of Prof. GRAY himself was concerned with the Inventions Panel of the Ministry of Munitions. Here there were two main difficulties. One was due to the ignorance of the public, which was comparatively harmless, and the other to lack of appreciation of scientific matters in the Army itself. Many of the inventions suggested were merely ideas and quite hopeless at that. For example, a favourite notion was that a magnet should be taken up by an aeroplane and used to attract Zeppelins and other aircraft! Any magnet was apparently sufficient for the purpose. Other people suggested electromagnets fed by machines which would have involved the carrying of a fully equipped power house upon the aeroplane. Such examples serve to show the lack of knowledge on the part of the public and the self-confidence with which such subjects are tackled. Otherwise they are rather amusing, but no doubt they led to waste of time when time was valuable. The more serious difficulty, however, was that when approved appliances were sent to G.H.Q., a thoroughly well-informed and capable officer might not always be present to explain their action. In such cases delay often resulted, and probably rejection, through the ignorance of those who handled them. It is not surprising that Prof. Gray, while not wishing to scoff at the "playing fields of Eton," holds the view that scientific laboratories and good intelligent work in them are also indispensable. There also appears to have been the difficulty that human nature sometimes played a part in the inventions which came from outside, because these occasionally brought about the solution of problems upon which technical officers were already engaged. It was only natural that these officers should come to regard the solving of these problems as their own special job and therefore did not welcome the coming of an outside inventor. Obviously, it would have been better not to put certain inventions into the hands of these technical officers. This experience leads Prof. Gray to suggest that an impartial board for the purpose of testing inventions of national importance would be of very great advantage. Such a board should be provided with a properly qualified staff, and the whole organisation should be free from inventors of similar appliances, so that an open mind on the inventions submitted would be obtained. There is a great deal to be said in favour of such an organisation, but we do not doubt that it would be opposed by just that class of technical officers to whom Prof. Gray refers.

Patent Office Reforms.

While the question of patent law reform is under consideration the allied question might well be considered whether some improvements might not be constituted in the patent office machinery which, while doubtless fairly efficient so far as it goes, has admitted limitations. One of the weaknesses of the present conditions is the uncertainty whether any patent, even if readily granted is not ante-dated by some previous one. While a perfunctory search is made by the Patent Office it is admittedly not meant to be exhaustive, and the circumstances of many private inventors are such that they cannot make a really adequate search for themselves. Another question that may be raised is the large number of worthless patents that are accepted under the present system. We know that there is one school of thought that regards this as essentially the patentee's affair, and consider that it would be dangerous for the State to offer advice to applicants. On the other hand, it may be urged that a simple bureau to which application might be made for advice would save us from a very large number of useless patents, the publication and recording of which is really labour lost, not to speak of the waste of the patentee's own time. We are, of course, speaking here of obviously futile patents, not patents whose value is a matter of opinion. We recall that a movement in the United States in this direction was initiated early in the present year. The necessity for more rigorous search was insisted upon and it was suggested that applicants should be given more helpful information. To this end separate bureaus dealing respectively with information and education, publications on patents, validity examinations and priority of inventions were proposed. There is here an indication of the still broader view that is sometimes taken of the functions of the Patent Office, according to which it should combine with its present functions the general tabulation of information on research, discovery and invention. If tabulation of this information were attempted, experimenters might, on payment of a fee, obtain information on any specific research before taking out a patent, thus initiating the saving of useless labour at an even earlier stage.

* * *

Gift to Sheffield University.—Mr. John Dixon Brunton, of Musselburgh, has given £1,000 to the Applied Science Department of the Sheffield University, the income from the sum to be expended yearly on a medal and premium for the best metallurgical research work done at the University during the year.

Convention of Iron and Steel Electrical Engineers in the United States.—We notice that the Association of Iron and Steel Electrical Engineers in the United States will hold its thirteenth annual convention in St. Louis on September 22-26. Reports are to be submitted by the committees on standardisation, education, safety and electric furnaces, and a variety of Papers on subjects of joint interest to electrical engineers and iron and steel experts has been arranged.

Proposed Submarine Tunnel in Japan.—According to the "Journal" of the Royal Society of Arts, it has been decided to cut a tunnel under the Shimonoseki Strait in Japan, thus linking together the railway stations of Honshu and Kyushu, which are at present connected by ferry-boats. It is anticipated that two years will be spent in a preliminary survey of the sea-bed and in drafting the general plans, and that the work will be commenced in 1921 and completed in 1928. The total length of the tunnel will be seven miles, of which one mile will be completely under the sea.

Industrial Council for Electric Cable Makers.—The first meeting of the Joint Industrial Council for the Electric Cable Making Industry was held at the Ministry of Labour on the 4th inst. Mr. Bertram Wilson, of the Ministry of Labour, who presided during the earlier part of the proceedings, pointed out that that was the forty-fifth Joint Industrial Council to be formed. Mr. L. B. Atkinson, Cable Makers' Association, was elected chairman, and Mr. A. Allison, of the India Rubber, Cable and Asbestos Workers' Union, vice-chairman; and the following were appointed as Joint Secretaries: *For the Employers' Side*, Mr. H. Standring (Messrs. Frankenburg & Sons, Ltd.); *For the Employees' Side*, Mr. H. McCale (Workers' Union).

Railway Electrification in France.—A scheme of considerable magnitude has been put forward by the Compagnie des Chemins de fer de Paris-Orléans for the electrification of its railway system, an application having been made to the State for permission to develop practically all the available water-power in the Dordogne and its tributaries. The "Revue Générale de l'Electricité" gives a summary of the potential power of the various sources specified, which are capable of developing a total of nearly 100,000 h.p. Exception has, however, been taken to the proposals by the Chamber of Commerce of Clémont-Ferrand, which, while recognising the advantages of electrification, questions whether it is necessary to reserve all the sources of power requested.

Rhone Power Scheme.—The French Ministry of Public Works has under consideration a scheme for the utilisation of the water-power of the Rhone and Central France. A derivation canal will be constructed, which will make the river navigable for ships of 1,200 tons from the sea to Switzerland, and power stations will be erected along the whole length of the river. By means of improved electric power the navigation and irrigation of the whole district will be transformed. The concession for the scheme will be given to one company to be formed by the departments bordering the Rhone and the department of the Seine. The capital will be £8,000,000. The City of Paris, which is expected to subscribe £4,000,000, is prepared to take over 200,000 kw. of power to be supplied by the Rhone power stations.

Bulletin of the Federation of British Industries.—The issue of this bulletin for September 8th contains evidence of the steady activities of the Federation, which include the despatch of a commissioner to the East Coast of S. America, and the opening up of communications with the Commercial Secretary of the British Legation in Prague, Mr. R. Parker, who is now on a visit to this country from Czecho-Slovakia. Among the topics discussed the removal of import duties naturally receives much attention. An account is also given of the annual meeting of the Leicester branch of the Federation on August 29th. Other items include the formation of an information bureau, under Mr. G. O. Blacker, at Singapore, for the promotion of trade with the East Indies, and a report by Major E. Kennard on Prospects in the Balkan States.

Provision of Light Under Large Generators.—The "Electrical World" draws attention to the need for lighting efficiently the pits underneath generators. This is one of those simple matters that are apt to be overlooked. It is common practice to rely upon hand-lamps for the inspection of interiors in which case the workman frequently has to insert his lamp through the opening down which he is looking; inspection in these circumstances is difficult. Accordingly, in the new hydro-electric plant at Lowell, Michigan, lamps are permanently installed at the sides of the pit, outlet boxes and conduit being embedded in the concrete support. The arrangement has been found to facilitate inspection considerably.

Industrial Council for the Tramway Industry.—The first meeting of this Council was held at the Ministry of Labour, Whitehall, London, S.W., on Friday. The following officers were appointed: *Chairman:* Mr. W. J. Sqnires (Chairman, Highways Committee, London County Council); *Vice-Chairman:* Mr. Stanley Hirst (Amalgamated Association of Tramway and Vehicle Workers); *Joint Secretaries:* (Employers) Mr. J. Beckett, F.S.A.A., Municipal Tramways Association, Gothic House, Accrington; Mr. A. de Turckheim, Tramways and Light Railways Association, 33, Tothill-street, Westminster, S.W. 1; (Employees) Mr. J. Cliff, Amalgamated Association of Tramway and Vehicle Workers, 5, Leaf-square, Pendleton, Manchester. This is the forty-sixth Joint Industrial Council to be formed, and the fifth dealing with industries in which both municipal and company-owned undertakings are concerned.

Birmingham Electric Club.—This club will open its winter session on Saturday, the 13th inst., with a Paper by Mr. E. F. Steventon on "High Efficiency Projector Areas." The club was established in 1905 "to facilitate the exchange of information and ideas in electrical engineering," and incidentally to provide a social link between men engaged in the profession and business. There are now about 100 members. Its meetings are invariably successful, and anyone engaged in electrical work who happens to be in Birmingham on Saturday evenings will be sure of a welcome and may possibly acquire some useful information. The meetings are held fortnightly at the Grand Hotel at seven o'clock. On October 11th there is a Paper on "Thermo-electric Generators," by Mr. C. M. Walter. On November 8th the Paper is by Mr. T. Pettigrew, of London, on "Automatic Telephones," on which occasion a working equipment will be shown.

Industrial Welfare Society.—During the last three years, inspired by the efforts of far-seeing firms, the Welfare Movement has made very rapid strides in this country, and the wide recognition now being given to it by employers, workers and public men leaves little doubt but that within a few years it will occupy a very prominent position in the industrial world. So far no real attempt has been made either by State or voluntary agencies to collate information regarding various phases of the work; in fact, the names of firms interested in the movement are not even recorded in any place. The Industrial Welfare Society, which has now been formed, is anxious, for the benefit of industry generally, to collect from the pioneers of this movement, information regarding their doings in connection with welfare work. Those firms who are willing to assist in this way are requested to apply for particulars of the information desired to the Industrial Welfare Society, 33, Tothill-street, Westminster, S.W.1.

Wireless Society of London.—We understand that the officials of the Wireless Society of London are in close touch with St. Martin's le Grand on the question of licences. It will be remembered that before the war they appointed a strong Advisory Committee to assist the officials of the Post Office in sifting their numerous applications for licences and recommending those which should be accepted. The honorary secretary, Mr. Leslie McMichael, of 30, West End-lane, West Hampstead, N.W.6, informs us that the offer of their services has again been accepted in the same capacity. Several questions in connection with the proposed new licences have still to be decided, particularly with respect to transmitting, but we gather that the genuine experimenter and the amateur who is prepared to conform to reasonable regulations, may rely upon the Society doing all that can be done at the moment to further their interests.

Obituary.

We regret to record the death on Tuesday last of Mr. EDWIN O. SACHS, F.R.S.E., F.R.G.S., consulting engineer for stage mechanism and lighting. Although only 49 years of age, Mr. Sachs had practised in London as an architect since 1892. He made a special study of fire prevention and wrote several books on the subject. In 1897 he founded the British Fire Prevention Committee. He was the inventor of the Sachs system of electrical operation of stage mechanism, which was adopted at the Covent Garden and Drury Lane Theatres.

Personal.

Capt. Henry Kernick, M.C., of Cardiff, left for Singapore last week to take up the position of manager of the Singapore Electric Tramways Company. Some years ago Mr. Kernick served under Mr. Arthur Ellis, at the electricity works, Cardiff.

Ill-health has necessitated the resignation of Mr. Billington, general manager of the Wigan Corporation tramways, and the Tramways Committee propose to allow him six months' salary in lieu of notice.

Mr. J. Beckett, for many years borough treasurer at Accrington, has commenced his duties as secretary of the MUNICIPAL TRAMWAYS ASSOCIATION. Last week his services at Accrington were recognised by the presentation by the corporate officials of an English gold lever watch and gold albert.

Mr. J. W. Turner, station superintendent at BLACKBURN for the past eight years has been promoted to the position of deputy borough electrical engineer in succession to Mr. E. Moxon, who was recently appointed chief electrical engineer of South Shields. Prior to his departure Mr. Moxon was the recipient of an electric "floor standard" from the local electrical contractors as a recognition of the courteous manner in which he had always dealt with them in their business relations. The staff and workpeople at the Blackburn electricity works presented Mr. Moxon with a timepiece.

Mr. W. J. Hamilton Porter was entertained to dinner on Friday at Cardiff on the occasion of his resignation of the post of district manager of the British Westinghouse Company in order to commence business in the district as a mechanical and electrical engineer. Mr. P. J. Plevin, M.I.Mech.E., Mr. Porter's successor as district manager of the British Westinghouse Company, presided. At the same gathering Mr. H. Townend, who is leaving the staff of the company in Cardiff, was presented with a gold-mounted cigarette case.

Arrangements for the Week.

SATURDAY, Sept. 13th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At the Grand Hotel, Colmore-row, Birmingham. Paper to be read on "High Efficiency Projector Arcs," by Mr. H. F. Steventon.

WEDNESDAY, Sept. 17th.

THE MUNICIPAL TRAMWAYS ASSOCIATION.

11 a.m. At the Albert Institute, Dundee. Conference. Presidential Address by Mr. T. B. Goodyer; "A Short History of the City of Dundee," by Mr. P. Fisher. Paper to be read on "Where do we Stand?" by Councillor Kelly.

2.30 p.m. Resumption of Conference.

THURSDAY, Sept. 18th.

THE MUNICIPAL TRAMWAYS ASSOCIATION.

10.30 a.m. At the Albert Institute, Dundee. Paper on "Motor Omnibus Services," by Mr. A. E. Fearnley.

3 p.m. Annual Business Meeting.

IRON AND STEEL INSTITUTE.

10.30 a.m. and *2.30 p.m.* At the Institution of Civil Engineers, Great George-street, London, S.W. General Conference on Fuel Economy.

FRIDAY, Sept. 19th.

IRON AND STEEL INSTITUTE.

10 a.m. Papers to be read on "Synthetic Cast Iron," by Mr. C. A. Keller; "The Fluxing Action of Iron Oxides on Acid Furnace Structures," by Mr. J. H. Whiteley and Mr. A. F. Hallimond; and "On the Woody Structure of the Fractures of Transverse Test Pieces from Special Steels," by Mr. J. J. Cohade.

2.30 p.m. Papers to be read: "Nickel-Chrome Forgings," by Messrs. J. H. Andrew, J. N. Greenwood and G. W. Green; "Brittleness in Nickel-Chrome and other Steels," by Mr. F. Rogers; "Temper Brittleness of Nickel-Chrome Steel," by Mr. R. H. Greaves; "Experiments with Nickel-Steels," by Mr. N. Hudson; and "On the Cause of Irreversibility in Nickel-Steels," by Mr. K. Honda and Mr. H. Takagi.

The Measurement of Alternating Waves with the Braun Tube.[*]

By E. LÜBKE.[†]

Summary.—(1) An inertialess contact maker, consisting of the ionising of a gas by means of cathode rays, is described, for the purpose of delineating oscillatory curves by the Joubert method. This is discussed, and the tracing of alternating current curves between frequencies of 50 and 3×10^5 ~ per second carried out. (2) The delineation of oscillatory curves up to 100 metres wave length and with greater accuracy is possible, using the special double Braun tube, in which a glowing cathode and a steady voltage of 220 is used. Since the current requirements of this arrangement are exceedingly small, it lends itself to the measurement of high-frequency fields.

Introduction.

For delineating alternating-current waves the oscillograph is generally used in the case of commercial frequencies, and the Braun tube in the case of electric oscillations. The oldest method of tracing wave shapes is that of Joubert.[‡] This consists in observing the instantaneous value of the wave at each point by means of a voltmeter with the help of a synchronously running commutator. It was desired to operate the Joubert method in the region of electric oscillations. On account of the excessive velocity, a synchronously running commutator of a mechanical kind is impossible. It is, therefore essential to have a commutator without inertia, or of so small a mass that its inertia is negligible in relation to the very high rate of rotation. Such a contact maker, making use of the cathode rays produced by a Braun tube, is described below. The electrical oscillations produce a rotating field which traverses the Braun tube. Under the influence of this field, the cathode ray describes a hollow cone, whose trace on the fluorescent screen is a circle. A radial slit is provided in the screen so that at a particular position of the circularly rotating ray, and hence at a particular phase of the oscillation the ray enters a box and ionises the gas between the plates of a small condenser. This ionisation causes the gas between the plates to become conducting at this particular instant during the period. The instantaneous voltage of the alternating wave can, therefore, be measured on an electrometer.

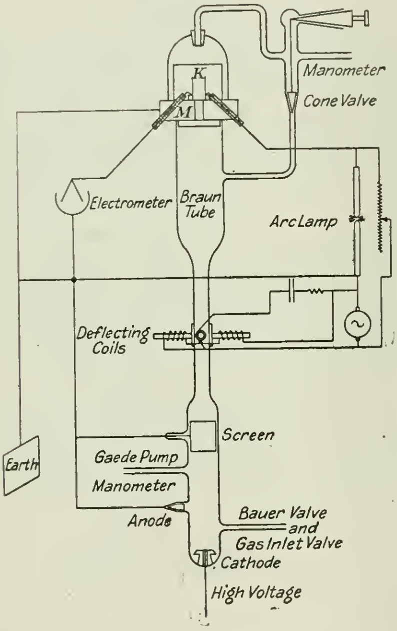

Fig. 1.

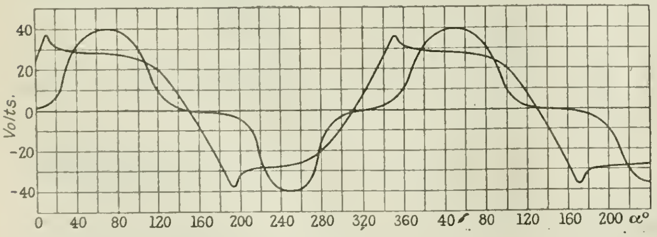

Fig. 2.

By turning the coils which produce the rotating field, any point on the voltage curve can be measured, and so the whole curve may be traced out point by point.

Scheme of the Investigation.

The details of the arrangement are shown in Fig. 1. The connections are arranged for observing the voltage wave form of an alternating arc. To operate the cathode ray, a steady voltage of 23,000 is used, in series with a cadmium iron resistance. The high voltage was obtained from an improved[*] high voltage apparatus, due to Des Coudres.[†] A preliminary test showed that the self-ionisation in the Braun tube was so great that there was sufficient conductivity to show between the plates of the condenser all the time. The ionisation chamber K was therefore screened by a metal plate M.

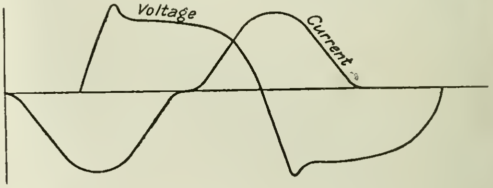

Fig. 3.

The radial slit through which the cathode ray reached the condenser plates was closed by a Lenard window. The ionisation chamber was attached to the Braun tube by means of a ground bell jar. Any desired vacuum can therefore be obtained both in the tube and in the ionisation chamber by means of a Gaede mercury pump. An air valve as used in the Bauer Roentgen tube[‡] has proved itself valuable. By its means the pressure in the tube may be accurately adjusted for all the measurements. The condenser in the ionisation chamber was very carefully constructed. All the known precautions were taken to avoid errors due to charges on the glass, static fields, &c.

The electrometer used in the measurements was a Wulf bifilar instrument,[§] a single fibre electrometer by Elster and Geitel[‖] was also available.

The deflecting coils were on ebonite bobbins and attached directly to the glass neck of the tube in a manner to allow of rotation round it. For the frequencies of 50, 250 and 500 enamelled wire coils were used, set at 90 deg. to one another in the plane of turning. The currents traversing them had a phase displacement of 90 deg.[¶] For the oscillations the rotating field was produced by the electrical field from a small condenser, and the magnetic field of two coaxial coils of seven turns each, having an area of 8×4 cm.². The angular setting of the coils with respect to the glass tube was read by a fixed pointer to an accuracy of 0·5 deg.

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[*] "Archiv. für Elektrotechnik," V., pp. 314-334, 1917; and VI., pp. 161-164, 1917.

[†] "Jahrbuch der Drahtlosen Telegraphie," July, 1918.

[‡] J. Joubert, "Ann. de l'école Norm.," X., p. 31, 1881.

[*] H. Krönke, "Diss. Göttingen," 1913.

[†] H. Th. Simon, "Phys. Zeit.," VII., p. 412, 1916.

[‡] H. Krönke, "Diss. Göttingen," 1913.

[§] P. Th. Wulf, "L'électrometre bifilaire, Louvain," 1910.

[‖] J. Elster and H. Geitel, "Phys. Zeit.," X., p. 664, 1909.

[¶] A. Lampa, "Wechelstromwersuche," Braunschweig, 1911, p. 90.

Experiments with the Contact Maker.

In the ideal case, the contact maker is perfect if the cathode ray when passing between the condenser plates produces, in the ionisation chamber, perfect conductivity; during the remainder of the time no trace of conductivity should exist. The conductivity, however, depends (1) on the number of ions produced by the cathode ray, and (2) on their mobility. The ideal will be attained when (1) at the instant of contact, all the gas molecules between the plates are ionised, and (2) when all the ions produced are driven on the plates. For the fulfilling of condition (1) so great a velocity and current strength of the cathode rays available for ionisation would be required as would be very difficult to obtain practically. For condition (2) an infinite mobility of the ions is required. This is, of course, not the case, it is therefore seen that the contact maker is far from being ideal.

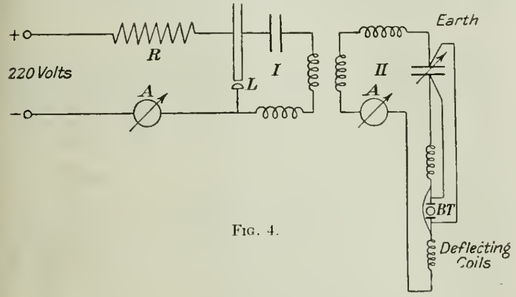

Fig. 4.

The conductivity of the contact depends on the kind of residual gas and its pressure, as well as upon the velocity and current strength of the ionising ray. With increasing gas pressure and denser gases the number of ions produced increases, but their mobility decreases. By systematic investigation of these effects with the gases air, steam and carbon dioxide through a range of pressure from 85 to 0·1 mm., the best conditions were sought to make the ionic contact maker as perfect as possible. For this purpose, air was found to be the best gas. The most suitable pressure was found to lie between 0·1 mm. and 1·0 mm.

Influence of Wave Shape, Phase and Frequency.

When the contact maker is adjusted to its optimum condition, it will still not measure accurately the instantaneous value of an alternating voltage, because, during the time of contact, the field between the condenser plates changes, more or less, owing to the finite distance between them. The greater the rate of change of field during the time of contact, the greater is the inaccuracy of measurement produced. For this reason the wave shape and the frequency have an effect on the measurement. The condenser plates are 0·5 cm. apart.

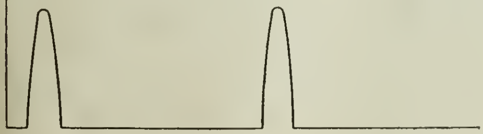

Fig. 5.

The cathode ray requires a known time, and during this time the phase of the alternating voltage on the condenser plates changes. It follows that only the mean value is measured. The distortion thus produced in the shape of the wave being measured can be reduced by increasing the diameter of the circle described by the cathode ray, and by decreasing the distance apart of the condenser plates. Another source of error having the same effect is due to the ionisation virtually not disappearing instantaneously, causing the current through the condenser to decay away instead of disappearing instantly, thereby blurring the curve. This decay was not experimentally demonstrable. The question finally remains as to what limits of frequency this Joubert method has when applied by the ionic contact maker. At very high frequencies the mobility of the ions will require to be very great; with the very short interval of time for contact the current does not attain the steady state completely. The mobility of the ions is known from the nature and pressure of the gas, the workableness of the contact maker becomes less and less as the frequency increases. It is found that the useful practical limit of frequency is of the order of $10^6 \sim$ per second.

Examples of Curves.

As the first example is shown the current and voltage curves of an alternating current arc, frequency 50 per second. The circuits were as shown in Fig. 1. Fig. 2 gives the curves obtained by the contact maker. Fig. 3 gives the same curves as given by a Siemens and Halske oscillograph under exactly similar conditions. In general, the curves are in complete agreement, the peak on the voltage curve where the arc is struck is slightly diminished in the case of the contact maker, for the reasons given above.

The most interesting curves to delineate are those of oscillations. The scheme is as shown in Fig. 4. The source of oscillations was a Telefunken high-frequency arc as used by H. Th. Simon.[*] The voltage and capacity in circuit (2) were measured. This voltage is proportional to the current flowing in the oscillatory circuit (2). Assuming that the coupling and disposition of the conductors do not distort the wave shape we should obtain the curve as theoretically calculated by H. Barkhausen.[†] Fig. 5 gives such a Barkhausen curve. This curve answers to the second type of oscillatory arc and has been obtained by the oscillograph[‡] for a wave-length of about 1,000 metres. My curves, Fig. 6 and Fig. 7 give the same form, and are in good agreement with the theoretically obtained curve. The wave-lengths were—For Fig. 6, 560 metres, and for Fig. 7, 950 metres.

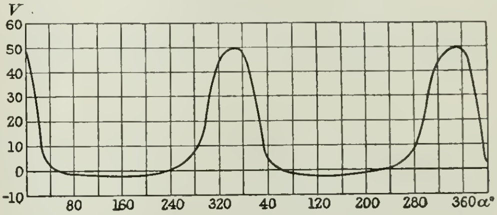

Fig. 6.

The small differences between the curves are easily understood, since at low gas pressures the number of free electrons is not negligibly small compared to the ions produced, and so when the electrical field between the plates is zero, it is easy for the small capacity of the electrometer to acquire a negative charge during the long time necessary for observation.

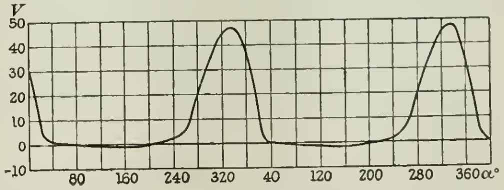

Fig. 7.

Arrangement for High Frequency.

The small mobility of the ions in the foregoing method sets a limit to the measurement of high frequency curves. If one uses, not the ionising power of the cathode rays and the slow ions produced by them, but the quick electrons only, the Joubert method may be modified to enable the curves of very high frequencies to be measured.

The construction of the Braun tube is modified in the manner shown in Fig. 8. The cathode *K* is in the form of a heated filament,[§] and supplies the cathode rays having the more desirable velocity.

The cathode rays from *K* go through the screen *A*, which at the same time serves as anode; they then pass into the deflecting space *D*. In the space between *D* and *S* rotates the cathode stream in the form of a hollow cone. The ray goes through the slit *Sp* once in each revolution into the second small Braun tube. In this tube the deflecting plates at *M* deflect the beam proportionally to the strength which the field has at the instant when the ray passes through the slit. This deflection is observed on the fluorescing screen *F*. If one rotates the turning field *D* the illuminated spot of the cathode ray traverses the screen *F* in a straight line. The scheme of connections given in Fig. 9 is identical with that in Fig. 1 for the ionisation method.

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[*] H. Th. Simon, "Jahrbuch," I., p. 16, 1907.

[†] H. Barkhausen, Leipzig, 1907, p. 74.

[‡] H. Th. Simon, "Jahrb.," I., p. 60, Fig. 32, 1907.

[§] W. D. Coolidge, "Phys. Rev.," Dec., 1913; F. J. Koch, "Fortschr. Geb. d. Röntgenstr.," XXIII., p. 1, 1915.

Sources of Error and Limitations of the Double Tube Method.

The velocity of the cathode rays is not infinite, but dependent on the voltage difference between the cathode and anode and may be calculated by the formula $a = 5{\cdot}95\ \sqrt{V} \cdot 10^7$ cm. sec., V being measured in volts.

There is therefore a definite interval of time between the instant when the cathode ray passes through the turning field *D* and when it arrives at the deflecting plates *M*. If the rate of propagation of the cathode ray is not great compared to the frequency of the oscillations then the cathode ray is not twisted by the turning field *D* at the same phase as it is bent by the deflecting field *M*, but with a time interval. The cathode ray passing through the slit *Sp* is shifted by an angle with regard to the phase angle read by the index at *D*, whose electrical amount depends on the frequency of the alternating current being measured, and on the velocity of the cathode ray. Taking a distance from *D* to *M* equal to 40 cm. the amount of this phase displacement is shown in the following table, under *D—M* for various values of wave length of oscillation, and voltage exciting the cathode ray. The cone which the cathode ray describes appears also twisted about its axis.

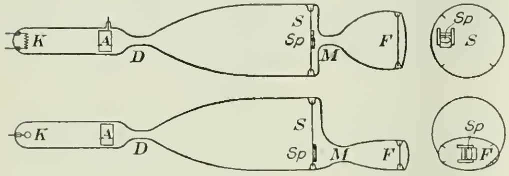

Fig. 8.

Wave length meters.	220 volt Rays.		440 volt Rays.		1,000 volt Rays.		2,300 volt Rays	
	D—M.	M.	D—M.	M.	D—M.	M.	D—M.	M.
10000	0·49°	0·04°	0·29	0·02°	0·23°	0·02°	0·05	0·00
1000	4·89	0·36	2·92	0·22	2·29	0·17	0·48	0·04
100	48·9	3·65	29·2	2·18	22·9	1·72	4·80	0·36
10	489·0	36·5	292·0	21·8	229·0	17·2	48·0	3·60
1	4890·0	365·0	2920·0	218·0	2290·0	172·0	480·0	36·0

Since the phase displacement for a known cathode ray velocity and a known wave length remains constant for all values on the curve one can correct for this by setting the zero of the angular scale on the turning field *D* at the appropriate reading.

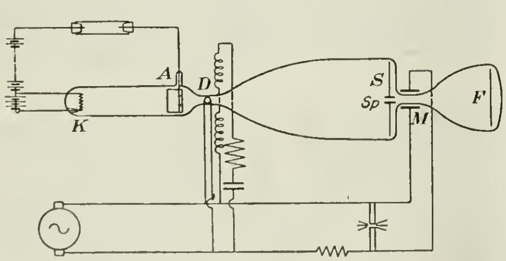

Fig. 9.

In the second small tube the final speed of the cathode ray is of importance only during its motion between the deflecting plates. When the cathode ray has left the deflecting field *M* it proceeds in a straight line to the screen *F*. Errors can only occur here if the phase of the alternating voltage on the plates varies, altering the field while the cathode ray passes through (length of plates, 3 cm.). The phase variation of the alternating voltage during this time is given under *M* in the table. Allowing that the maximum value of the curve during 0·01 period is indistinguishable from the true curve, then the table shows that for 220 volts rays a wave length of 100 metres and for 23,000 volts rays a wave length of 10 metres can be measured. Since the excitation of undamped oscillations of 10 metres wave length and fair energy presents practical difficulties, it may be taken in general that for the working of this method the easily obtained voltage 220-440 suffices. For the above accuracy, however, it is necessary that the width of the slit *Sp* is not greater than $\frac{1}{100}$ of the circumference of the circle described by the ray on the screen *S*. Good observations can be obtained with a slit *Sp* of 1 mm. wide, and a circle traced on the screen *S* of 30 cm. circumference, thus corresponding to $\frac{1}{300}$ of a period.

The weak 220-volt rays have the further advantage that very moderate voltage on the deflecting plates *M* are suitable. For a maximum deflection of 5 cm. from the zero and a distance between the plates *M* of 2 cm. with a length of 3 cm. a voltage of 79·2 is necessary (distance *M* - *F* 17 cm.) or 1·59 volts for a deflection of 1 mm. The maximum value of the applied voltage may be easily raised by increasing the distance between the plates *M*. The calibration of the measuring device *M* can, of course, be readily done with steady voltage.

Deductions.

According to the previously published ideas of H. Busch* regarding the use of exploring electrodes it is necessary to have these of metal in general for measuring high frequency electric fields. The distribution of the field can be measured point by point independently of the phase. The double tube method now described will allow the magnitude of the field to be measured at each point in relation to the phase of the source of oscillations. By a combination of probe and double tube contact maker it should be possible to carry out the prize essay presented for solution in 1913 by the Gottingen Philosophical Faculty, and experimentally to carry out the research on the distribution and phase relationships in the immediate neighbourhood of oscillations. The effect of the form of the oscillator would be specially interesting. The carrying out of these investigations and the establishment of the double contact maker was rendered impracticable on account of the war.

The Effect of Electric Light on the Eye.†

By Herr REICHENBACH.

Modern developments regard improvements in electric light as a case of increased efficiency, leading in the end to a lowering of prices. The effects from the point of view of hygiene are not considered; though any improvement of this sort would be welcome, it is not by any means a deciding factor. Still, hygienically considered, much progress in the sphere of lighting has been made, mainly owing to the cheapness at which electric light can be supplied. In 1901 Prausnitz said that it was impossible to provide 10 lux for reading and writing; moreover, he considered that even if it were possible, it would be unnecessary. H. Cohn has now shown by his important work that this figure should be regarded as a minimum. Cohn thinks that 50 meter-candles are desirable, based on the Wallrat candle-power, which corresponds to 57 lux, determined by the Hefner candle power. There are certain objections to be made to Cohn's methods and assumptions; still the author thinks that 60 lux ought to be regarded as the desirable mean value for the illumination. Having regard to the eye's mean capacity for clear vision, 25 lux should be taken as a minimum, and there are no difficulties nowadays in providing light on this scale. It can even be obtained by indirect illumination, which is specially good for the eye. The heating caused by the usual electric lights is so small that it may almost be neglected, even in the case of workshops. Still, white-hot bodies always emit a not inconsiderable amount of infra-red radiation, toward which, according to Vogt, the refractive media of the eye are comparatively transparent, more so than has been commonly supposed to be the case with heat rays. But it is doubtful whether any injury results, and this cannot be determined without further experience.

The quantitative changes of the newer types of light depend mostly on the higher temperature of the illuminant; this increases the brightness of the surface, the colour over the visible portion of the spectrum changes and more ultra-violet rays are emitted. It is partly of a physical and partly of a physiological nature to determine what ill effects are to be ascribed to an increased brightness in the surface of the illuminant; in fact, to find out what are the effects of "glare" is a somewhat complex problem. The length of time over which the eye is exposed is a part of the question; obviously this must not continue till permanent injury results. Further, there is the breadth of pupil in the individual, the conditions of adaptability, irradiation (the filaments of a glow lamp always appear broader than they actually are), and the distance of the light; also the amount of the light from unit-surface that actually reaches the eye, and the effect produced by this light. Of the present illuminants, none correspond even distantly to Stockhausen's maximum of 0·75 Hefner candles per square centimetre, or even to the Hertel-Henker standard of 0·2 or 0·3. Therefore, we can only attempt to make this great surface-illumination as little harmful as possible. The author suggests that lamps should be surrounded with diffusing media; they should not be centrally before the eyes; it would even be well if the glare did not fall on the eye from the side, as this is known to be physiologically harmful. Shades, covered with green, are useful. The indirect system of lighting has many advantages, but the absence of shadows is in some cases a positive disadvantage, as in the workshops of a scientific instrument maker. A number of small lamps on the ceiling is a very advantageous system, and would be more efficient than the indirect method were it not for the fact that the small lamps in themselves are less efficient than one large illuminant. But in all cases the engineer should be consulted as well as the architect, if serious mistakes are to be avoided. Staerkle, in 1904, found that seamstresses suffered from the newer kinds of lighting, and this was attributed to an excess of ultra-violet radiation. Schanz and Stockhausen have further investigated the effects of this kind of radiation and recommend the use of Euphor glass as a protection to the eyes, as it excludes the rays between 300 and 400 μμ. Many experiments were carried out by them and others on animals; they proved that injury might be done to the substance of the eye and that inflammation of the outer surfaces might be caused by ultra-violet rays, which did not, however, pass through to the retina. But they used lights of such intensity as are never used in commercial work. In particular Voige showed that only the arc lamp and the quartz lamp without glass globes produce more ultra-violet light than the light of the sun: no injuries are traceable to the latter except at high altitudes; moreover, neither the quartz lamp nor the arc lamp would be used for needlework without protecting glass globes. There is the question of the increased blue and green radiation in the newer lamps. The author has carried out experiments on this point with Des Condres and others. He has found that the capacity for clear vision is less over these parts of the spectrum, if the total illumination is the same. If the coloration of the light is of no importance, this difficulty is outweighed by increased efficiency. Experiments on the fatigue of the eye have as yet given no very certain result; but subjectively it is known that green and blue lights provide agreeable sensations. For determining clearness of vision, reading tests are the simplest and best; but differences in individuals must be taken into account.

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* H. Busch, "Jahrb.," VIII., p. 554, 1914.

† Abstract of a Paper read before the Deutsche Beleuchtungstechnische Gesellschaft. See "Elektrotechnische Zeitschrift," No. 9, 1919.

An Electrostatic Direction Finder.

By E. BELLINI.

There are three ways of coupling two oscillating circuits: the magnetic, the electrostatic and the ohmic. The latter is not generally convenient for well-known reasons.

The Bellini-Tosi radiogoniometer* utilises the magnetic coupling: the exploring coil, in the case of reception, is energised by the high frequency magnetic field generated by currents flowing through the fixed coils. In the case of transmission, it is the high frequency magnetic field produced by the current flowing through the movable coil that energises the fixed coils and the aerials connected to them.

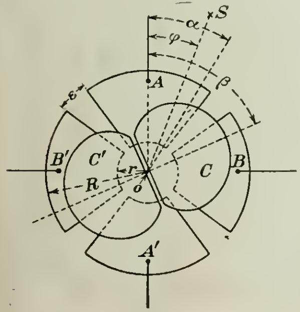

FIG. 1.

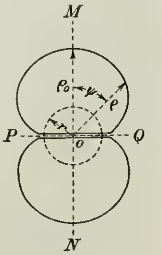

FIG. 2

In this article I will describe a new radiogoniometer, which, though not exactly so, can nevertheless be named an "electrostatic radiogoniometer";† as it utilises the electrostatic coupling between the aerials and the apparatus for detecting or generating the oscillations. The new radiogoniometer can assume two different forms.

The first form is constituted (Fig. 1) as a special multicellular Kelvin electrometer by four systems of fixed plates, A, A' and B, B' (in the case of two perpendicular directive aerials) connected to the directive aerials through the syntonising devices and by a couple of movable plates, C, C' of special form, subjected to the influence of the fixed plates (or influencing them) and conveniently connected to the detector and telephones or to the oscillation-generating devices.

The system of the fixed metallic plates forms a kind of ring (or of several equal superposed rings) of external and internal radius R and r, each plate or system of plates being separated from the adjacent ones by the angular widths ε. The plates A, A' are connected to a directive aerial, practically a frame, the width of which is supposed to be so small in comparison of the wave-length of the impinging (or radiated) waves that the amplitude of the E.M.F. generated in it (or the intensity of the electromagnetic field generated in the space) can be assumed to vary according to cos φ, where φ represents the angle that the direction of the sending station (or that of the receiving station) forms with the plane of the aerial. The second couple of plates B, B' is equally connected to an identical aerial, orientated 90 deg. from the former.

The movable plates C, C' have the form shown more in detail in Fig. 2. The equation of the line limiting these plates is

$$\rho=\sqrt{(\rho_0{}^2-r^2)\cos\psi+r^2},$$

cos ψ being always taken with the positive sign, and ρ_0 being smaller than R. The said equation really represents a single plate; but a saw-cut POQ divides it into two equal halves, electrically insulated from one another. Let us call the straight line MON the "axis of the movable plates."

In the theory of the magnetic radiogoniometer* it was assumed that the re-action of the movable coil (in the case of the reception) had no sensible influence upon the magnetic field generated by the currents flowing through the fixed coils. Similarly, we shall assume in the case of the electrostatic radiogoniometer that the reaction of the movable plates (always in the case of the reception) has no sensible influence upon the potentials of the fixed plates produced by the electric currents generated in the aerials by the sending station S.

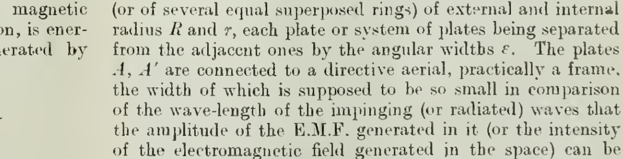

FIG. 3.

Let us take as origin line the line OA, and call φ the angle between the direction of the sending station and the origin-line.

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* British Patent No. 21,299/07, THE ELECTRICIAN, Feb. 28, 1908.

† British Patent No. 22,879/14.

* THE ELECTRICIAN, *loc. cit.*

a the variable, β the angle between the axis of the movable plates and the origin-line. The potentials of the fixed plates will, consequently, be the following :—

Plate A : $Ve^{-\delta t}\cos\varphi\sin\omega t$.

Plate A' : $-Ve^{-\delta t}\cos\varphi\sin\omega t$.

Plate B : $Ve^{-\delta t}\sin\varphi\sin\omega t$.

Plate B' : $-Ve^{-\delta t}\sin\varphi\sin\omega t$.

The diagram of the potentials in the immediate neighbourhood of the system of fixed plates, and for points equidistant from the centre O is shown in Fig. 3.

To find the analytical expression of the potential aforesaid as a function of the variable a, we will proceed as in the case of the analogous problem of the forms of the curves of alternating currents. Without giving here the rather long calculations, we will limit ourselves to give the result

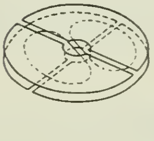

Fig. 4.

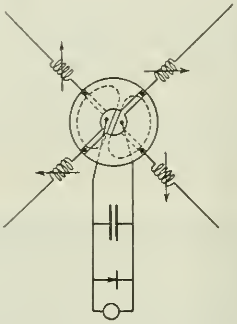

Fig. 5.

$$v=\frac{2\sqrt{2}}{\pi}Ve^{-\delta t}\sin\omega t\cos\varphi\left\{\left(\cos\frac{\varepsilon}{2}-\sin\frac{\varepsilon}{2}\right)\cos a+\tfrac{1}{3}\left(\cos\frac{3\varepsilon}{2}+\sin\frac{3\varepsilon}{2}\right)\cos 3a\right.$$
$$\left.-\frac{1}{5}\left(\cos\frac{5\varepsilon}{2}-\sin\frac{5\varepsilon}{2}\right)\cos 5a-\frac{1}{7}\left(\cos\frac{7\varepsilon}{2}+\sin\frac{7\varepsilon}{2}\right)\cos 7a+\ldots\right\}$$
$$+\frac{2\sqrt{2}}{\pi}Ve^{-\delta t}\sin\omega t\sin\varphi\left\{\left(\cos\frac{\varepsilon}{2}-\sin\frac{\varepsilon}{2}\right)\sin a-\tfrac{1}{3}\left(\cos\frac{3\varepsilon}{2}+\sin\frac{3\varepsilon}{2}\right)\sin 3a\right.$$
$$\left.-\frac{1}{5}\left(\cos\frac{5\varepsilon}{2}-\sin\frac{5\varepsilon}{2}\right)\sin 5a+\frac{1}{7}\left(\cos\frac{7\varepsilon}{2}+\sin\frac{7\varepsilon}{2}\right)\sin 7a+\ldots\right\}.$$

By taking into account that

$$\cos\varphi\cos na\mp\sin\varphi\sin na=\cos(\varphi\pm na)$$

the expression aforesaid transforms itself into the following :

$$v=\frac{2\sqrt{2}}{\pi}Ve^{-\delta t}\sin\omega t\left[\left(\cos\frac{\varepsilon}{2}-\sin\frac{\varepsilon}{2}\right)\cos(\varphi-a)+\tfrac{1}{3}\left(\cos\frac{3\varepsilon}{2}+\sin\frac{3\varepsilon}{2}\right)\cos(\varphi+3a)\right.$$
$$\left.-\frac{1}{5}\left(\cos\frac{5\varepsilon}{2}-\sin\frac{5\varepsilon}{2}\right)\cos(\varphi-5a)-\frac{1}{7}\left(\cos\frac{7\varepsilon}{2}+\sin\frac{7\varepsilon}{2}\right)\cos(\varphi+7a)+\ \ldots\right].$$

The potential in the immediate neighbourhood of the fixed plates can, therefore, be considered as the resultant of component potentials of space frequencies $\varphi-a$, $\varphi+3a$, $\varphi-5a$, $\varphi+7a$, &c.,

Let us consider now the movable plates.

An element dS of their surface comprised between two radii-vectores differing angularly by $d\psi$ (Fig. 2) is

$$dS=\tfrac{1}{2}\rho^2d\psi=\tfrac{1}{2}(\rho_0{}^2-r^2)\cos\psi d\psi+\tfrac{1}{2}r^2d\psi.$$

But, as the surface-element $\tfrac{1}{2}r^2d\psi$ is not submitted to the action of the fixed plates, it must not be taken into account in our calculations. We will limit ourselves to the surface-element $dS=\tfrac{1}{2}(\rho_0{}^2-r^2)\cos\psi d\psi$.

In Fig. 1 $\psi=\beta-a$, and, consequently, $d\psi=-da$.

If the two half-plates be connected by a circuit containing inductance, capacity and resistance, the current intensity through this circuit will be $i=K\int vdS$, where K is a coefficient of proportionality.

$$\text{As}\int_{\beta-\pi/2}^{\beta+\pi/2}\cos(\beta-a)\cos(\varphi\pm na)da=0,\text{ when }n=3, 5, 7,\text{ \&c.}$$

$$i=K\frac{\sqrt{2}}{2}(\rho_0{}^2-r^2)Ve^{-\delta t}\sin\omega t\left(\cos\frac{\varepsilon}{2}-\sin\frac{\varepsilon}{2}\right)\int_{\beta-\pi/2}^{\beta+\pi/2}\cos(\varphi-a)\cos(\beta-a)da=$$
$$=K\frac{\sqrt{2}}{2}(\rho_0{}^2-r^2)Ve^{-\delta}\sin\omega t\left(\cos\frac{\varepsilon}{2}-\sin\frac{\varepsilon}{2}\right)\cos(\varphi-\beta).$$

The current i varies, consequently, according to $\cos(\varphi-\beta)$, exactly as the current through the exploring coil of the magnetic radiogoniometer.

It is interesting to remark that the law of variation aforesaid is independent of the value of ε, which has influence only upon the amplitude of the current intensity. Two particular values of ε are of special interest—that of ε very small (Fig. 6) and that of ε slightly smaller than -90 deg. In this last case each plate occupies almost 180 deg., and, therefore, the four fixed plates cannot be contained in the same plane, but must be contained in two parallel planes to avoid their contact, as shown in Fig. 4, the movable plates being between them and at equal distances from the two planes.

We have admitted from the beginning that, as in the case of the magnetic radiogoniometer, the secondary circuit did not sensibly react upon the antennæ circuits. In the case of the magnetic apparatus this result is obtained by adopting a sufficiently loose coupling between the circuits. In the case of the electrostatic radiogoniometer the same result can be obtained in two different ways, either by reducing the "degree of electric coupling" between the circuits or by rendering practically constant—viz., independent of the orientation of the movable plates—the capacity between the fixed and the movable plates. As a matter of fact, in the electrostatic radiogoniometer the movable plates form with the fixed plates a system of periodically changing capacities which influence the conditions of tuning.

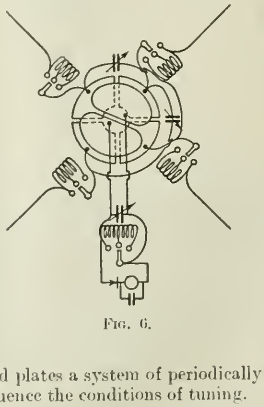

Fig. 6.

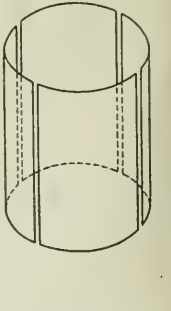

Fig. 7.

If ε is sufficiently different from -90 deg. (Figs. 1 and 6), the first method alone is applicable. It is necessary in that case to connect in parallel with the pairs of fixed plates equal condensers of sufficient capacity, and eventually to connect also a condenser of suitable capacity between the movable plates. When the first condensers are variable for tuning purposes, their common minimum capacity must not be lower than a certain value, which depends upon the "space capacity" of the fixed plates, upon the minimum capacity of the secondary condenser and upon the extreme values of the capacities between each fixed plate and each movable one.

If ε were equal to -90 deg. (Fig. 5) and if the couple of movable plates were connected by a wire without resistance, capacity or inductance, it is easy to see that the capacity (and, therefore, the tuning conditions) would be independent of the orientation of the movable plates. In practice, ε is always a little smaller than -90 deg., in order to avoid the contact of the fixed plates, and the movable plates cannot be short-circuited in order to allow the detector to be submitted to a P.D. different from zero. It is, therefore, sufficient, as shown in Fig. 5, to bridge the movable plates with a fixed condenser of sufficient capacity to render the said variations negligible and allowing at the same time a good sensitiveness at the detector to be obtained.

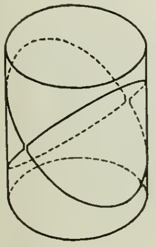
Fig. 8.

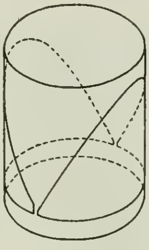
Fig. 9.

The last diagram of connections (Fig. 5), as compared with the first one (Fig. 6) has the advantage of maintaining a constant coupling, as the tuning can be obtained merely by variable self-inductions inserted in the aerials, and, if a secondary tuned circuit exists, by a variable inductance inserted in this circuit. But, as shown in the figure, the secondary tuned circuit can be non-existent without loss in sensitiveness, and with advantage from the point of view of simplicity.

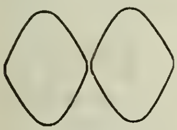
Fig. 10.

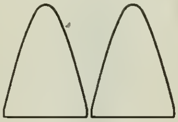
Fig. 11.

The electrostatic radiogoniometer, as it was constructed by the "Compagnie Générale de Radiotélégraphie," of Paris, corresponds to the diagram of Fig. 6. A view of the apparatus is shown in Fig. 13. The range of the wave-lengths extends, for aerials of ordinary sizes, between 200 and 2,000 metres. The variable condensers are the well-known air-condensers built by the company of a maximum capacity of about 2,000 cm. The two aerial condensers are controlled by the same handle through toothed-wheels. A special device suppresses any backlash in these wheels, and a small compensating condenser allows exactly the same capacity in the aerials to be obtained, or, if the aerials are slightly different, to obtain the capacities required to tune each of them.

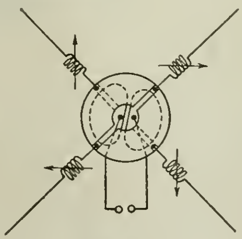
Fig. 12.

The second form of the electrostatic radiogoniometer is constituted (in the case of a couple of directive aerials) by four equal rectangular plates (Fig. 7) bent so as to form a cylinder, and connected to the aerials; and by a couple of movable plates of a special form bent so as to form a cylinder of a slightly smaller diameter than the former, and connected to the secondary tuned circuit or directly to the detector and telephones, or, in the case of the transmission, to the oscillation-generating devices. The movable plates can have either the form of a double sinusoid (Figs. 8 and 10) or of a simple sinusoid (Figs. 9 and 11).

It is easy to demonstrate that in this case also the direction of the maximum intensity is obtained when the axis of the movable plates (viz., the diameter connecting the apices of the diametrically opposite sinusoids) points towards the transmitting station.

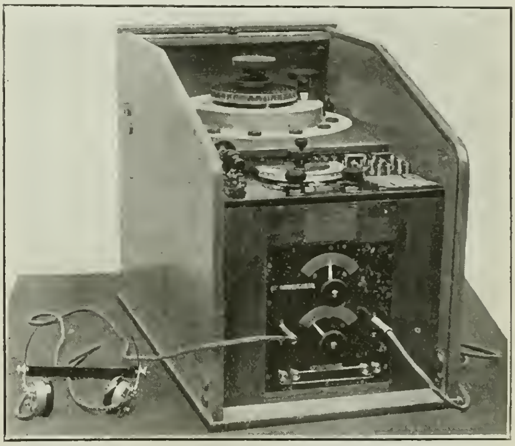
Fig. 13.

The diagrams of connections and the general properties of the apparatus are the same as for the first type.

The application of the two forms of the electrostatic radiogoniometer, to the transmission is evident, and the diagrams of connections are analogous to those already examined for reception. One point, however, is worth noting. Adopting the diagram of connections shown in Fig. 12 (which corresponds to that for reception shown in Fig. 5), the aerials, supposed to be constituted by frames, can be excited directly. The wave-length can be changed by changing the values of the inductances inserted in the aerials.

Tests of Wire Rope.—A new publication of the Bureau of Standards (Technologic Paper No. 121), entitled "Strength and Other Properties of Wire Rope," has been recently issued, and presents the results of tensile tests upon 275 wire rope specimens selected under the specifications of the Isthmian Canal Commission. The specimens ranged in diameter from ¼ in. to 3¼ in., and comprised five of the more common classes used in engineering practice. The laws of construction of the specimens were determined and were used as the basis of the analysis of their physical behaviour under stress. Numerous comparative physical and chemical tests were presented of the wires, fibres and lubricants used in wire rope construction. Copies may be obtained on application to the Bureau.

Large Power Transformers.*

By A. G. ELLIS and J. L. THOMPSON.

(Continued from p.255)

Summary.—The authors first refer to the progress towards increased size of modern stations generating units and transformers, and the tendency to higher pressures. Limiting sizes of transformers as effected by handling and cooling are discussed, and prices per kilovolt-ampere in relation to output, voltage and cooling are presented. The condition affecting choice of types and relative advantages of shell and core transformers are next dealt with. Subsequently safety factors, transformers for interlinking and the operation and care of transformers (switching in and out, drying out, &c.) receive attention. The final section of the Paper discusses the influence of war conditions.

6 Comparison of Core and Shell Types.

The relative merits of core and shell-type transformers have been much discussed. Both types can be satisfactorily built in either single-phase or three-phase. But the types recommended by individual manufacturers depend largely on their experience and manufacturing facilities.

The general manufacturing considerations influencing this question are as follows :—

Core Type.—This type has usually cruciform-section cores and circular coils, and lends itself better to small and high-tension units, as small conductors can be better wound in circular coils, and insulating is simplified. For medium size units the three-phase core type is satisfactory, but in very large units the bracing and cooling become quite a problem. It will then be preferable to split up into three single-phase units forming a three-phase group, which can be more conveniently handled and the windings more efficiently braced and ventilated.

Shell Type.—This type has usually rectangular coils with core punchings assembled around them with lap joints. It is generally preferable for single-phase units except for small sizes at high voltage. The construction is simpler, more robust and less liable to damage in handling and transport. The windings can be very rigidly braced, and the construction gives very large cooling surfaces of windings and core.

Regarding electrical performances there is little to choose between the two types for the same amount of active copper and iron. Also for the same electrical performance there is little difference in cost.

From the standpoint of service requirements the principal considerations relate to shrinkage of windings, coil bracing, insulation, robustness and ability to withstand short-circuits.

Shrinkage—Due to Construction of Insulation.—The core-type windings are in general more liable to shrinkage, as the weight of the copper in the coils always bears directly on the insulation, which is under a permanent compressive stress. With the insulation between coils, in section-wound or coil-wound transformers, the total shrinkage after 12 months in general service may be $2\frac{1}{2}$ per cent.—*i.e.*, 1 in. in 40 in. of winding length for a 20,000 volt transformer.

In shell-type transformers the shrinkage is practically nil because the dead weight of the copper in the coils exerts no pressure on the insulation in the usual construction. When the transformer is dried out the insulation tends if anything to swell, by reason of the hot oil, rather than to shrink. Further, the electromagnetic interaction of the primary and secondary coils tends to produce a repulsive action between the two windings which relieves the insulation of any possible compressive stress.

Shrinkage Due to Expansion of Copper.—In core-type transformers the continued influence of hot oil and the pressure due to the expansion of the copper and the weight of the coils compresses the insulation of sheet pulp material permanently, whereas woven insulating material does not contract appreciably

In shell-type transformers the expansion of the copper is much less than in core-type transformers, as the copper constitutes a much lower percentage of the total axial length of winding ; further, there is no compression due to the weight of the coil, and consequently no periodic adjustment of the coil supports is necessary under normal service conditions.

Bracing of Windings.—In both core and shell-type transformers all coils should be rigidly supported so that any movement due to short-circuit, vibration or other source of disturbance is precluded. Some form of coil support is essential in all transformers. It may also be necessary to provide means of adjustment to compensate for the shrinkage.

In section windings of core-type transformers the winding is sub-divided into a number of coils or sections connected together. The function of adjustable coil supports is to take up shrinkage by adjustment from time to time, whenever the transformer is opened up for inspection or shows evidence of requiring attention. In single-layer spiral windings the play introduced by shrinkage is practically negligible. When such windings are provided with adjustable coil supports the adjustment is done once and for all after drying out the transformer in the factory. After this the adjustable coil supports are not required for adjustment. With shell-type transformers as usually constructed, the function of adjustable coil supports is to brace those parts of the windings which would otherwise tend to move during abnormal operating conditions. Adjustable coil supports when provided are part of the ordinary constructional design of the transformer, and are not provided with a view to counteracting shrinkage, which in shell-type transformers is of no great consideration.

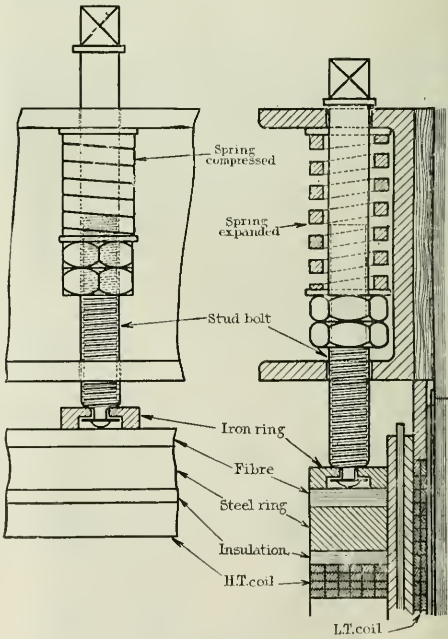

Fig. 3.—Spring Coil Supports for Automatically Taking up Shrinkage of Windings.

Automatic Adjustment for Compensating Shrinkage on Core-type Windings. Various suggestions have been made for automatically compensating the shrinkage in the windings of core-type transformers. These generally take the form of spiral springs arranged so as to exert an axial thrust on the coils tending to oppose directly any axial movement due to the shrinkage of the insulation (*see* Fig. 3). Such springs follow up any shrinkage that may occur, but the more the springs expand, the lower the pressure they are able to resist without movement. Consequently the windings, even during normal operation, may be in a state of permanent vibration. Any such movement is naturally undesirable as it will tend to damage the insulation. Another disability of the use of springs for automatic adjustment occurs in core-type transformers with very long cores, especially for high voltages and large outputs, where the shrinkage of the windings may be as much as 1 in. to $1\frac{1}{2}$ in. A spring able to follow this amount of shrinkage and still be able to exert sufficient pressure on the windings would necessarily be large and cumbersome. It might even be necessary to sub-divide the spring into several springs placed at different parts of the winding axially. This leads to a complicated and inefficient construction and involves loss in winding space and higher core loss. The above disabilities outweigh, in the authors' opinion, the resulting advantages claimed.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

The above constructions all relate to core-type transformers, where the question of shrinkage of windings is of much greater significance than in the shell type. In the latter type, as the shrinkage is practically negligible, automatic adjustment is unnecessary.

Radial Coil Supports.—These have been sometimes employed, but are not generally necessary except in very large core-type transformers. They act as an additional safety factor in cases where the circumferential stress in the copper under short-circuit might become excessive.

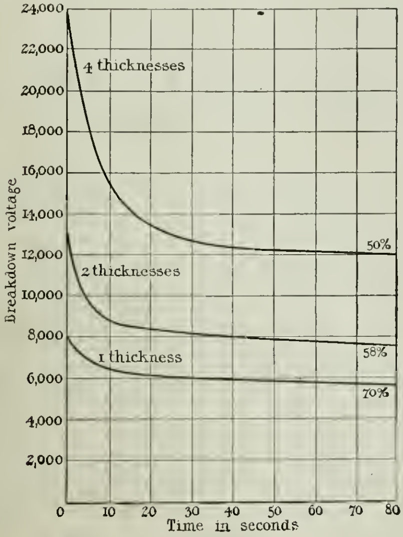

Fig. 4.—Curves showing Relation of Breakdown Voltage and Time for Sheet Insulating Materials.

Insulation.—In comparing core-type and shell-type transformers from the standpoint of insulation, there is in general very little to choose between the two types. The decision depends largely on the individual manufacturing facilities. However, a number of general considerations may be mentioned :—

Voltage Between Turns.—In the shell-type the voltage per turn is higher than in the core type, as the total iron section is generally much larger. Hence the insulation between turns must be heavier for shell-type designs, and this becomes more important in very large outputs.

Reinforcement of Insulation.—The reinforcement of the insulation of the end turns is to some extent easier in shell-type designs, as the total number of turns is smaller and fewer turns have to be reinforced. For power systems with underground cables the end-turn reinforcement is less important than in transformers connected to overhead transmission lines subject to atmospheric disturbances. Underground cable systems are at present in use on the Continent and in America up to 30 kv., and some systems in this country are adopting this voltage. Up to this voltage, experience shows that reinforcement to the extent of about 1 per cent. of the winding per 10 kv. of line voltage is sufficient—*i.e.*, for 30 kv. 3 per cent. of the winding from each line terminal is reinforced. The reinforced insulation should be able to withstand normal line voltage momentarily between adjacent turns, in about 1 per cent. of the winding. For transformers connected to overload transmission lines up to 100 kv. the number of reinforced turns should generally be about 5 per cent. of the total winding.

The curves of Fig. 4 show the relation between breakdown voltage and time for sheet insulating materials commonly used in transformer construction.

Taking average figures from these curves shows that the insulation between the end turns of the winding need be sufficiently thick to withstand full voltage for, say, one second, which corresponds to about 60 per cent. of normal voltage applied for 1 minute or more.

Robustness.—The shell-type transformer is stronger in construction and is less susceptible to damage in handling and transport. The windings are more or less completly ironclad, and are thus naturally well anchored and braced. Core-type windings can be braced and supported almost as rigidly, but this involves elaborate and costly details of construction in coil supports.

In general any elaborate system of coil bracing, either in shell-type or core-type transformers involves a certain amount of sacrifice in electrical performance and increase in cost. This is, if anything, more marked in the core-type transformer, since the windings in this type are not embraced by the iron as in the shell type. Special mechanical attachments for coil bracing are not generally necessary for transformers for normal service on systems under about 20,000 k.v.a. They are, however, desirable on large transformers, and on large systems, or in cases where the operating conditions are severe, and stresses of several tons per square inch may be met.

7. Inherent Protection against Mechanical Damage on Short-circuit.

With the growth of size of generating stations the question of protection of transformers against mechanical damage due to short-circuits has become of increasing importance. Nowadays, we may have to deal with supply systems up to 300,000 k.v.a. with step-up transformers situated directly on the station bus-bars and distributing transformers situated near to the power station, in the case of industrial districts, and thus with higher short-circuits current than formerly.

These transformers must be of sufficiently robust construction to withstand short-circuit shocks. Mechanical strains may be restricted by limiting the short-circuit current, by introducing a sufficiently high impedance somewhere in the circuit—either as inherent reactance in the transformers themselves, or as external current-limiting reactances. The external reactance is more efficacious, but questions of costs, space and simplicity weigh against this consideration. It is possible by designing the transformer with a suitable amount of inherent reactance, to limit the short-circuit stresses to a safe value. In modern large power transformers the impedance voltage is of the order of 5 to 8 per cent., which limits the short-circuit current to approximately 20 to 12·5 times normal (based on the assumption of a straight-line volt-ampere short-circuit characteristic).

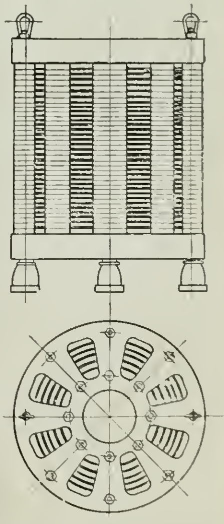

Fig. 5.—Outline of Single-phase Protective Reactance with Concrete Frame.

There are two types of external protective reactance, the ironclad type and the air-core type. The former consists of a choke coil with an iron ore similar to a standard transformer, but with a large air-gap or a number of small air-gaps interposed in the path of the magnetic flux. The air-core type consists of a simply plain coil in air, the inductance of which is designed to give the required choking effect

Either type can be built to give satisfactory service The choice depends mainly on (1) the type of service obtaining, (2) the location and space available.

1. As regards the type of service, the choice reduces itself largely to a question of capital cost ; the relative prices depend on the short-circuit current required in terms of the normal current *i.e.*, the maximum current up to which a straight line volt-ampere characteristic is required.

We may divide the type of service into three classes : (*a*) Bus-bar reactances, (*b*) generator reactances, (*c*) feeder reactances.

(*a*) Bus-bar reactances usually limit the current transference from one section to another to about 4 to 5 times the normal current in each set of bus-bars, corresponding to a voltage choke in the reactance of 25 to 20 per cent. of the line voltage.

(*b*) In generator reactances the current limitation is usually about eight times the normal current, which, allowing for 7·5 per cent. inherent reactance in the generator, requires an additional 5 per cent. external reactance, or a total of 12·5 per cent. reactance.

(*c*) Feeder reactances are generally proportioned for a smaller voltage drop of about 5 per cent., corresponding to a current limitation of 20 times normal.

In each case the volt-ampere characteristic must be approximately a straight line up to the limiting current. This is inherently attained with the air-core type, but considerably influences the design of the ironclad type. Owing to the heavy magnetic fields resulting from the large short-circuit currents, the iron sections in the ironclad type must be greater the higher the limiting current. Hence the cost of such reactances increases with the value of the current limitation for a given normal current. This consideration does not arise in the air-core type, but in point of cost the ironclad type can be designed to compare favourably with the air-core type up to limiting currents of about eight times normal.

2. The location of the reactances with regard to structural or other iron and steel work and electromagnetic instruments is of importance. The ironclad type has the advantage here, as there is no stray field. Air-core reactances should be so installed that there is no ironwork nearer than a distance approximately equal to the overall diameter of the coil. This is often an important factor where space is limited (as is generally the case in older stations, where extensions necessitate the use of such apparatus).

If sufficient space is available, as may be provided when laying out new stations, the air-core type can be installed without possibility of trouble in this direction. It has less liability to fire risk. The ironclad type is totally enclosed and the tank can be earthed, whereas the air-core type is mounted on insulating supports, and the coils are usually exposed at full line voltage, unless completely protected by concrete or porcelain frames.

(*To be cotinnued.*)

Presidential Address of the Hon. Sir Charles A. Parsons, F.R.S., to the British Association.*

In his presidential address to the British Association, Sir Charles Parsons dealt in a general way with developments in engineering prior to the war and developments during the war. The former included a reference to the work of James Watt, who, so long ago as 1784, saw the great importance of high speeds. These speeds, Sir Charles remarked, had now been realised in the steam turbine of the present day. In these there had been many minor improvements, such as the more accurate curvature of the blades to avoid eddy losses in the steam, the raising of the peripheral velocity of the blades so as to have nearly the velocity of the steam impinging upon them, and in details of construction to reduce leakage to a minimum. In turbines of 20,000 H.P. to 30,000 H.P., 82 per cent. of the available energy in the steam was now available as brake horse-power, and with a boiler efficiency of 85 per cent. the thermo-dynamic efficiency from the fuel to the electrical output of the alternator had reached 23 per cent., and might shortly reach 28 per cent., a result rivalling the efficiency of the internal-combustion engine worked by producer gas. During the 20 years immediately preceding the war, turbo-generators had increased in size from 500 kw. to 25,000 kw. and the consumption of steam had fallen from 17 lb. to 10·3 lb. per kilowatt-hour.

Other developments of importance were to be found in the construction of battleships, the production of tungsten steel and other alloys, and investigations of gaseous explosions.

Developments During the War.

During the war many questions of scientific interest had presented themselves, due in some respects to the unprecedented scale on which operations were carried on. For example, in the South African War the total artillery rounds fired weighed approximately 2,800 tons, while during the whole war in France, on the British front alone, the corresponding weight was nearly 3½ million tons. Yet such figures were insignificant when compared with those in respect of a modern naval battle squadron. For example, the "Queen Elizabeth," when firing all her guns, discharged 18 tons of metal, and was capable of repeating this discharge once every minute, thus developing by her guns an average of 127,000 effective horse-power. If all her guns were fired simultaneously they would for the instant be developing energy at the rate of 13,132,000 H.P.

Among the scientific developments during the war probably the most interesting was the extensive application of sound listening devices. Sound ranging had been so developed that it could give the position of an enemy gun to about 50 yds. at 7,000 yds. range. The use of sound under water presented special difficulties. One difficulty that was found, if a hydrophone was dragged through water, or the boat was in rough water, was that the noise from the vessel dragging the hydrophone, or from the water passing the hydrophone, interfered with the sounds one wished to detect. By consultation with biologists, this difficulty was surmounted to a considerable extent. It was realised, for example, that the whale did not suffer in this respect, and examination of the conditions led to the use of towing bodies in the form of fish or porpoises, made of celluloid and filled with water, the hydrophone being fixed within. By these means the required sounds could be detected up to speeds of 14 knots. Considerable progress was also made in the use of high-frequency sound used in the form of concentrated beams, which would be reflected by objects on which they impinged, thus giving rise to echoes. An interesting means for following a desired course in mine fields consisted in the use of an insulated cable laid at the bottom of the sea, earthed at the further end, and through which an alternating current was passed. By means of delicate devices installed on a ship she was able to follow the cable at any speed with precision. This device was first used by the Germans.

With regard to the development of electricity, this had largely been bound up with the development of the steam turbine. At the end of last year electric power stations in the United Kingdom contained plant aggregating 2¾ million kilowatts, 79 per cent. of which was driven by steam turbines. Much discussion had taken place as to the economical size of a generating station, the size of generating units and the size of the area to be supplied. Large power stations permitted some decrease in the cost of production, and if in the future the recovery of by-products from coal should become a practical realisation, the larger power stations would present greater facilities than the smaller ones. On the other hand, there were losses by transmission to be considered. Also the larger generating unit required longer to overhaul or repair; consequently a larger percentage of spare plant was necessary. There was no golden rule to secure cheap electricity.

The Future.

The nations who had exerted the most influence in the war had been those who had developed to the greatest extent their resources, their manufactures and their commerce. Failing, however, some new and unexpected discoveries in science, such as the harnessing of the latent molecular and atomic energy in matter, the great position of England could not be maintained for an indefinite period. At some time, more or less remote, long before the exhaustion of our coal, the population would gradually migrate to those countries where natural sources of energy were the most abundant. England owed her modern greatness to the early development of her coal. This she was using up much more rapidly than most other countries, and long before any near approach to exhaustion, owing to increased costs, it might pay her better to import coal from richer fields of almost limitless extent belonging to foreign countries, and workable at a much lower cost than her own. In some foreign countries the capital cost of mining was comparatively low, and as coal was transportable long distances, and generally speaking electricity was not, it seemed probable that capital would in the immediate future flow in increasing quantities to mining operations in foreign countries rather than to the development of, at any rate, the more difficult and costly water-power schemes. When, however, capital became more plentiful, the lower running costs of water-power would prevail, with the result that water-power would then be rapidly developed. As a possible new source of power, the sinking of shafts to great depths might be considered. In his Address to Section B in 1904 he had discussed the question of sinking a shaft to a depth of 12 miles, the estimated cost being £5,000,000 and the time required about 85 years. The matter had been considered by Prof. F. D. Adams, who had come to the conclusion that in limestone a depth of 15 miles was probably practicable, and that in granite a depth of 30 miles might be reached without the rock giving trouble by being crushed at such depths. The sinking of such a shaft might prove of inestimable value to science, and would throw additional light on the internal constitution of the earth in relation to minerals of high specific gravity. In Italy bore holes had already been sunk which discharged large volumes of high-pressure steam, and this was being utilised to generate about 10,000 H.P. by turbines.

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* Delivered at Bournemouth on September 9th. Abstract.

The Future of Power Transmission by Alternating Current.*

By Dr. M. DOLIVO-DOBROWOLSKY.

Thirty years ago polyphase current displaced direct current for transmission purposes, and the question arises as to whether in the future it only remains to adjust details and dimensions with regard to further extensions on polyphase lines. The author is of opinion that a new struggle will arise between alternate and direct current, in which the latter will emerge victorious. The demand for electric power will increase enormously, partly as the result of the cheapness and convenience of electric motors. Let us now consider that we may have to deal with the transmission of power over much greater distances. Suppose we take the case of something in the neighbourhood of 1,000 km. It seems at first that this would mean an increase of pressure. At present we work with 100,000 volts, and it might be possible to increase this pressure, in so far as transformers and insulators are concerned. But if the transmitting distance is increased, the charging current is increased in the same proportion, even without allowing for any increase in pressure. The charging current may interfere seriously with the efficiency of the scheme. With a given system of high-tension conductors there is a theoretical voltage limit which gives the minimum losses through heating; for too low a voltage the losses from watt-current are too great, and for too high a voltage the losses from the wattless-current are too great. The rudimentary law of power transmission used to assert that the losses in a given conductor were inversely proportional to the square of the pressure, but with very long conductors and very high alternate current pressures, this is a grossly inaccurate statement of the facts. If the frequency were lowered we might have some improvement, but a remedy of this sort is plainly impossible. Let us take an existing power-transmission line with wires of known diameter, separated by given distances. Then, if a transmitting voltage is chosen which makes the watt-current equal to the wattless current, we shall have the scheme of greatest efficiency. For any further increase of pressure will decrease the watt current, while increasing the charging current, with the result that the resultant current will be increased. For purposes of simplification, we neglect the fact that the charging current is not constant throughout the length of the conductor; it would probably be more correct to consider "equivalent" values; it is sufficient to say that there is some limiting voltage, beyond which any increased efficiency is impossible.

Let us now suppose that we desire to make the transmission line twice as long. If we work with the same voltage as before, the charging current will be doubled. It will, therefore, be necessary to lower this pressure, and to increase the watt current; this leads to evident absurdities. We might increase the section of the transmitting conductor; the capacity increases only slowly with the logarithm of the diameter. We might increase the weight of material in the conductors, and yet find it necessary to work with a lower pressure than before, and with greater losses in the conductors. Inductive losses would be more than doubled. The charging current complicates matters obviously; if there were no charging current it would be merely necessary to increase the pressure in the ratio of $\sqrt{2}$ to 1, in order to keep the losses the same as before, if the length of the line were doubled. The author proceeds to give certain elementary mathematical considerations in the shape of formulæ connecting costs with technical data, and from these the same conclusion is deduced. In fact, so soon as the length of the transmission line exceeds certain limits, the charging current becomes the dominating factor. It is possible to compensate for the charging current by choking coils, connected at intervals across the lines, as is done in telegraphic work. But this complication has very obvious objections, and need not here be further considered.

Generally speaking, the combined effect of capacity and induction is to produce a voltage at the end of the conductor, which is not only higher than the voltage in the generating station, but depends very much on the load and power factor. These variations of voltage are very annoying, especially on light loads. The effect of self-induction is more harmful with a heavy charging current. So far as efficiency is concerned, the capacity of the line sets limits through the charging current, but in actual work the limit is set by the combination of capacity with self-induction. The voltage due to self-induction in the conductor seems to be independent of the transmitting voltage, yet it increases with the length of the line, and the resulting current; it also depends on the logarithm of the ratio of the distance between the wires to the diameter of the wire, but this is not variable within wide limits. Thus, we may expect still greater disturbances to result from the self-induction, if distances are increased and loads and currents are correspondingly increased. If there were no charging current to take into account, it would be possible to suppress the effects of self-induction by increasing the working pressure, but this solution, as we have already seen, is not possible.

This is meant to explain in elementary fashion the essential position as to the limitations of alternate current; still, in the author's opinion, alternate currents will be able to transmit power over a few hundred kilometres at pressures up to 200,000 volts, but this is likely to be the most that is possible with ordinary frequencies. With cables, the limits would be much lower. Overhead cables are always the earliest stage of development—*e.g.*, in telephones and telegraphs. Power transmission lines will also disappear overhead, and be placed underground in due course. This will not take place at once. Neither is it desirable that it should do so. Engineers have long since recognised that direct currents are much more suitable for cables than alternate current. The higher the pressure, the more marked is the difference, which has nothing to do with questions of charging current. There is with direct current a steady charge on the dielectric, and there is an absence of the glow discharge, which injures the dielectric. For equal mechanical and electrical strength the thickness of the insulation is much less with direct current. But it is not purely a question of cost. The peak of the alternate-current wave is the determining factor. With direct-current, iron armouring works perfectly, but with alternate current it can only be used with multi-cored cable, and on very high pressures this system of several cores is very disadvantageous. Armoured cables are cheaper to lay; the inductive effects in the lead-covering must not be forgotten with alternate current. Neither can faults be so easily discovered with alternate currents, largely owing to difficulties caused by the charging current. Protective devices like condensers and choking coils produce complications on alternate current; the inductive voltage-drop has to be considered and often the protection is of a very limited character. Alternate-current condensers have often to be made too small on account of the charging current. With direct current, the condenser can be of any size. Neither with direct current is there any difficulty from resonance, harmonics, &c. In other words, the disturbances are less and the protective devices more efficient with direct than with alternate current. It is indeed a fact that the work that has been done and that can still be done with alternate current is truly wonderful, but this must not blind us to the fact that indefinite progress on the same lines is likely to be impossible.

It is therefore necessary to say that, in the author's opinion, the future is likely to see the development of direct-current work with the use of underground cables instead of overhead wires. Direct current has advantages both in respect of transmission over long distances and the use of underground cables. The fact that cables are cheaper for direct than for alternate current seems also to point in the same direction. It seems necessary to recognise first the fact that direct current will be needed to solve the problems of the future, and then to set to work to find the ways and means. This latter part of the question raises many problems that will require much hard work for their solution. But when a solution is found to be imperatively necessary it will doubtless be forthcoming. It is not possible to say in what direction this solution will lie, whether by means of kathode-ray tubes, mercury converters or improved mechanical devices for commutating and converting the current; it may be that the existing type of dynamo can be radically altered and improved. It may be that several paths will lead to the result.

Analysis of Graphite Carbons.—We understand that the Bureau of Mines, U.S.A., has developed at their Pittsburgh station a method of determining the prescence of amorphous carbon in samples of the graphitic variety. While the method is still in the experimental stage, it is hoped that it will render possible a direct quantitative determination of the amorphous constituent, a factor which has hitherto always been computed by indirect means of a somewhat uncertain character.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 1, 1919. Paper read before the Elektrotechnische Verein, November 26, 1918.

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Electricity in the House.

In the times through which we are at present passing, when domestic help continues to be a rare commodity, the desirability of reducing manual labour in the house to a minimum needs but little emphasis. Yet we doubt if the average woman is so adaptable in a matter of this kind as the average man. The latter would willingly adopt mechanical methods on every occasion, but a woman is not so ready to adopt new methods. She is generally much more conservative and sceptical, and is inclined to doubt the value of new methods until they have been well tried by other people.

The position would, no doubt, be different if the housewife could be installed in an entirely new house fitted up with every possible labour-saving device. This, however, is an ideal which we do not find in ordinary life. In fact, one of the chief difficulties is that the older type of house is usually not built on an efficient plan. Not only are new houses arranged more efficiently, but they are usually provided with better types of fittings. It is, however, impossible to convert old houses so as to adapt them to modern ideas except by considerable re-building, and even the adoption of new fittings may cost a considerable amount of money. Consequently, it is the older kind of house that must usually be assumed in considering domestic problems, and it is the shortcomings of such a house that have to be met.

For domestic requirements, electricity is naturally the best servant that can be found. It is so adaptable and can be put to all manner of uses. In cooking, heating, the provision of hot water, dust removal, the preparation of food, and in many other ways, electricity can do what is necessary. It is in fact, ideal in many respects. We are reminded of this fact by a little book entitled "The Ideal Servant-saving House," by an Engineer and his Wife. Some further reference to this book will be found in our Review Column. In the present connection we need only say that the authors call attention to the very many directions in which electrical apparatus may prove very useful in the household. The electric fan in summer and the electric fire in winter have become quite commonplace. The electric cooker as a complete unit has not yet become so thoroughly established as its merits deserve; but as a stepping-stone in this direction the electric grill has attractions which should not be forgotten. It is very useful, very portable and gives a minimum of trouble. The electric oven in combination with a grill is also an extremely useful appliance. Turning to cleaning we have such appliances as vacuum cleaners, boot polishers, electric washing machines and other apparatus varying in complexity according to the requirements. Nor must the electric flat iron be forgotten.

There is, however, a point on which the authors do not touch, and that is the question of first cost. The various implements described are not provided with the house, and consequently the tenant must purchase practically all that he desires, unless he is blessed with an unusually obliging landlord. In making an expenditure any tenant will wish to be quite certain that the investment will prove a satisfactory one. The higher the cost the more he will hesitate to take the plunge. Take, for example, the simple matter of an electric flat-iron. So long as these are charged at such a price as 25s. each, people will certainly hesitate to make use of them, more particularly as more than one iron will be desired in order to ensure continuity of service. If two are ordered at the same time, well and good; but, if one iron is ordered some time after the first one the chance is that the existing adapter will not fit, so another flexible cord must also be provided. If a flat-iron were obtainable at, say, 10s., and not a toy at that, the householder would certainly be much more inclined to go in for them. The same thing applies all round when we consider the various implements that can be used in the household for heating, cleaning and in the preparation of food.

The conclusion, therefore, follows that the manufacturer should strive in every possible way to bring down the cost of electrical apparatus for domestic purposes. The field is undoubtedly large, but so long as there is a great variety in the type of apparatus produced, and so long as renewals are difficult on account of this variety, the price will be high. It is essential that certain lines should be produced in larger quantities, chiefly by repetition work, if the needs of the domestic consumer are to be met and this side of the electrical industry is to develop accordingly.

Review.

The Ideal Servant-saving House. By An Engineer and His Wife. (London: W. & R. Chambers.) Pp. vi.+122. 1s. 6d. net.

This little book will be read with interest, not only by the worried householder, but also by the manufacturer who sees that there is a large field for domestic appliances provided the householder can be educated to their use. The authors deal with more than merely electrical implements; they refer also to gas. The book starts with a consideration of the various problems involved in the heating and ventilation of a house, and in the construction of a house to meet modern requirements in the simplest way. With regard to heating, there is surely a fallacy in the statement that, owing to the refraction of the sun's rays as they pass through the glass of a greenhouse, the heating effect produced inside is much greater than if the rays had merely passed through the air. The heating effect is due to a much simpler cause than this. Leaving aside, however, this little error, useful information is given on how houses may be kept warm without spending so much as is usual on fuel. In the comparison between electricity and gas for heating, we think the authors have unduly favoured gas. This is always a difficult matter, and can be decided much better by actual experience than by any theoretical reasoning based on various assumptions. In dealing with this part of the subject, we notice that the authors use a mistaken term which is much too common, and speak of "watts per hour." In dealing with electrical equipment, the authors describe many useful pieces of apparatus. We think, however, that the equipment described for the kitchen would be much more suitable for restaurants than for private houses, being of considerable size. The first cost of such plant is a consideration to which due attention must be paid if satisfactory headway is to be made.

The authors appear to think that happiness in the house is much increased by abolishing the domestic (*i.e.*, by converting the housewife into a *hausfrau*), and that the cooking of eggs and bacon on the breakfast table instead of in the kitchen has an appetising and charming effect. Although we do not agree with these views, we do not doubt that this little volume will serve a useful purpose, and will help those who have no domestics whether they will or no.

Electric Welding: Its Theory, Practice, Application and Economics.*

By H. S. MARQUAND.

(*Continued from page* 219)

Summary.—In this article the author concludes his description of various methods of preparing welds and gives some further illustrations of various kinds of work that is now undertaken. He then passes on to the economies effected by machine welding, and to the testing and strength of electric welds.

It should be the care of the superintendent to periodically submit specimen welds of individual welders to the standard machine tests for tenacity and elongation, &c., and to encourage healthy competition amongst the operators by exhibiting the best results, and, if possible, to offer some inducement to encourage each welder to attain results above the maximum yet obtained.

The welder himself, or his foreman, can judge fairly accurately the quality of welds by three simple methods. Corrosion, hammering and bending.

The micrographic test or corrosion test can be applied to all metals, providing the specimen to be tested is not less than 3/16 in. in thickness.

This simple test is very interesting and instructive. The welded specimen is cut in half along the line perpendicular to the line of welding. The section through the weld is then highly polished. This is done by filing the cut section with a rough file, and after with a smooth file, and finally with a dead smooth file, then obtaining a high polish by means of very fine emery cloth.

All traces of grease and finger marks must be strictly avoided, and immediately the polishing is complete paint the surface with any suitable etching liquid. It will be found that the structure of the weld will immediately develop, and the corrosive action will be complete in a few minutes when the surface should be quickly but thoroughly washed in running water, and dried with methylated spirits and finally painted with pure clean varnish to preserve the test piece.

The success of this test depends upon a high and uniform polish and absolute freedom from grease; the rest is simple.

It is, perhaps, curious, but none the less true, that neither the cutting of the part welded nor the polishing discloses any defects; on the contrary, it gives one the impression that the weld is perfect. However, as soon as the etching liquid is applied the defects begin to show up.

The etching agent first attacks the oxide, exposes any adhesion, blowholes and eventually discloses the general structure of the weld.

The welder need only examine the test piece to recognise all his defects and can tell whether at the same time he has burned the metal or not.

The etching or corrosive liquids are made up as follows:—

For Iron or Steel: Water, 10 parts; potassium iodide, 2 parts; iodine, 1 part.

For Copper, Brass and Bronzes: Water, 75 parts; nitric acid, 25 parts.

For Aluminium and its Alloys: Water, 10 parts; hydrochloric acid, 90 parts.

The hammer test of mild steel welds will indicate the ductility of the weld and the tenacity; according to the size of the specimen, this test can be more or less severe, and might include a drop test.

Hammering pure and simple is, perhaps, of greatest value for welds of copper and brass. After annealing the weld the metal can be beaten out with a hammer, though from time to time re-heating the weld to prevent hardening. If a weld of copper or brass is perfect, it will be possible to hammer down to extreme limits of thinness without showing cracks.

The bending tests as a rule confirm the tensile tests as regards the ductility of the metal, and hence welders should frequently apply a bending test to samples of their work.

In all cases the added metal should be in the fold of the bend, so that if there is a lack of penetration in the weld the defect will soon be exposed.

The specimen is best bent by means of a steady pressure rather than by shocks, and the angle at which the weld begins to crack should be noted. A sound weld should enable the piece to be bent right over and back again without fracture.

In order to test the relative values of rivetted, electrically arc welded and acetylene welded joints, a set of samples were made up and tested, with the results shown in Table VII. The pieces of steel were $\frac{3}{8}$ in. thick, 8 in. long in the straight section. The welds were made by an operator of average skill only, and therefore the comparisons are true commercial tests.

Table VII.—*Mechanical Tests on Rivetted, Arc Welded and Acetylene Welded Joints.*

Samples and preparation.	Breaking strain.	Length after breaking.	Per cent. efficiency.
	In lbs.		
Original piece of steel plate	58,600	8·80 in.	97·66
Lap joint, electric arc welded ...	54,800	8·94 in.	91·33
Lap joint, rivetted and welded...	54,200	9·22 in.	90·33
Butt joint, electric arc welded ...	47,800	8·28 in.	79·66
Butt joint, acetylene welded ...	36,800	8·23 in.	61·33
Lap joint, rivetted only	35,000	...	58·33

Nominal strength of the steel plates was 60,000 lb. per the square inch.

In practice the joints welded are more often than not reinforced, and consequently an efficiency of over 100 per cent. can easily be obtained.

All welding, in so far as possible, should be tested before being put into service, especially where there is any risk to human life. Fortunately, in actual practice, this can be and is carried out for instance, in steam boilers, air compressors, and any receptical which has to hold pressure. The hydraulic test of $1\frac{1}{2}$ to $2\frac{1}{2}$ normal working pressure when possible to apply is a very safe and satisfactory manner of proving the efficiency of the welding.

However, in such a case as welding of ships' shell plating and general constructional work it is difficult to apply any test of any real value. If the outer surface of the welding is briskly hammered to remove any surface skin, and paraffin washed over its inner surface, any porosity will be soon indicated. Hence, an important work of this kind, only operators thoroughly well trained and eminently reliable should be employed.

Some General Considerations on Arc Welding.

The advent of the great war gave a tremendous impetus to electric arc welding, due largely to the vast quantities of munitions required. For rapid production of munitions welding was soon found to fill the gap in manufacturing processes right well, and authorities turned their close attention to improving and applying arc welding to many industrial requirements where hitherto electric welding had not been thought possible or quite inadequate.

The great success achieved in this field has been the cause of calling the attention of many high authorities to the great possibilities of the application of the process of arc welding to ship construction.

Major James Caldwell, R.N., and his staff were untiring in their efforts to introduce arc welding wherever by its application production could be speeded up. Their efforts have already met with unprecedented success, and a vast amount of splendid work has been done under their initial direction.

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Lloyd's Register of Shipping have now formulated rules regulating the acceptance of arc welding in ship construction, and a schedule of requirements of welders and systems applied to ensure at all times that the workmanship is good and the materials used and system of application are sound and reliable, thus, as it were, protecting the public, the consumer and the welding industry.

It may be of interest to record here that several cross-channel barges have been constructed and launched in which rivetting was entirely eliminated and replaced by electric welding.

So far as the Author is aware, these barges have proved eminently successful, and give promise of great and immediate extension in the use of arc welding in the fabrication and construction of large ships.

A comprehensive series of tests on electrically arc welded joints have now been completed, under the direction of Prof. W. S. Abell, of Lloyd's Registry. The objective of these tests was to determine the relative strength of electrically arc welded and rivetted joints and their respective ability to resist the alternating stresses to which ships are subject.

The results are very satisfactory and are of considerable interest and importance. The results of these official tests agree in the main with those obtained by the Author from time to time, and even better results have been obtained than those shown by Prof. W. S. Abell.

To describe in detail how these and the Author's tests were carried out, and to tabulate all the figures obtained, would require a treatise of considerable bulk. With apologies, therefore, the writer proposes to set out briefly the conclusions officially confirmed.

Table VIII.

	Plain plate.		Longitudinal weld.		Transverse weld.	
Thickness	½″	¾″	½″	¾″	½″	¾″
Elastic limit in tons per square inch	15·0	15·1	18·2	16·4	16·2	14·6

To determine the modulus of elasticity of the material actually forming the weld, specimens were prepared by building up test bars entirely of electro-deposited metal. The Author has found the average value to be in the region of 11,620 tons per square inch. Prof. Abel puts the figure somewhat higher—namely, 11,700 tons per square inch. Prof. Abel also gives the value for wrought iron at 12,500 tons and 13,500 tons for mild steel.

It is now evident that up to the elastic limit the extension in the region of the weld is practically coincident with other portions of the plate, but at stresses beyond the elastic limit the ductility of the weld falls considerably below that of the unwelded portion of the plate. The elongation in 8 in. of a welded specimen only averaging about 12 per cent. against 25 to 30 per cent. for mild steel.

Electrically welded butt joints compare in tensile strength very favourably with solid plating. For mild steel plating welded with ordinary commercial metal electrodes the strength of the welded joint varies from 90 to 97 per cent. of the tensile strength of the unwelded plate, and can, by reinforcing, be well above 100 per cent.

Lap welded joints welded with a full fillet along one caulking edge and a single run of weld on the other edge give an ultimate strength compared with the unwelded material of 70 to 85 per cent. A rivetted lap joint treble rivetted gives 65 to 70 per cent. of the strength of the unperforated plate.

Alternating Stresses.

It is very important to know the behaviour of welded joints under the influence of alternating stresses. For example, ships, and indeed many parts of machinery, are subject to alternating stresses.

For rotating specimens* it is found that a welded bar will withstand not less than 62 per cent. of stress that an unwelded bar can withstand when subjected to a large number of repetitions of alternating stress, while for stationary welded plates subject to alternating stress the figure is higher, being in the nature of 70 per cent.

A lap welded plate can withstand over 60 per cent. of the number of repetitions of alternating stress necessary to fracture a treble rivetted lap joint.

Welded plates can withstand an impact or a crushing strain practically as well as an unwelded plate. This is a useful characteristic in ship constructional work, as a vessel is liable to receive damage from heavy weather.

(To be continued.)

Correspondence.

ELECTRIC POWER IN CHEMICAL WORKS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to the leading article in your journal dated July 25th last, entitled "Electric Power in Chemical Works," permit me to observe that I feel extremely gratified, that the Paper which I prepared very hastily for the annual meeting of the Society of Chemical Industry, this year, induced your interesting remarks.

Unfortunately, owing to an illness from which I have only just recovered, I was unable actually to read the Paper in question, and for the same reason my attention has only just been called to your article.

Will you be good enough, however, to explain somewhat further your, to me, rather surprising assertion, that in this country electricity is cheap at present.

I agree that electricity was cheap before the rise in the cost of coal, &c., and there may be some schemes in this country which are still supplying electricity for power purposes, at a price which is not proportionate to the general cost of coal and labour, but surely this cannot continue indefinitely?

Regarding the use of electricity for chemical factory lighting and motive power, I venture to suggest that you may be underestimating the amount of electrical energy which is, or, at any rate, should be, absorbed in such directions in the majority of chemical works, thereby minimising the effect on the operating costs of such factories, of the price of electricity.

Finally, permit me to remind you that it is a scheme of centralisation, but not necessarily of nationalisation, though the latter is proposed, which should tend to reduce, or shall we say, keep down, the price of electricity.

I am by no means an enthusiast for nationalisation generally.—I am, &c.,

Southsea, Sept. 6. H. Martin.

[With regard to the cost of power we had in mind pre-war rates, as any basis of comparison is not of value at the moment.—Ed. *E.*]

The Gattie Transport Scheme.

The Board of Trade Committee appointed to consider this scheme continued its sittings during the week.

Evidence was given of the refusal of the Treasury to allow the company to raise £100,000 for an experimental station, and Mr. Gattie was cross-examined on the details of the proposed London clearing house, the approaches to it, &c. He contended that, by relieving the railways of terminal work and eliminating shunting, he could do the work at a fraction of the present cost. He had never suggested that it was necessary for all the clearing houses to be put up simultaneously. The first need not necessarily be put up in London, and he named some desirable provincial centres. He would not mind installing the first part of the scheme as a test at the Gladstone Dock, Liverpool, or at a wharf at Gravesend. According to Mr. Harper's report, on a capital expenditure of £14,000,000 on the London goods clearing house, the surplus profit after paying interest on capital, would be £9,295,948 per annum.

Capt. Rattenburg explained the working of the proposed clearing house scheme at Battersea, which, he said, would enable 40 trains to be loaded per hour, compared with 62 wagons at Nine Elms. The cost of truckers, cranes, locomotives and lighting would be £250 a day, equal to ½d. per unit for 120,000 units, or ¾d. per ton handled.

Mr. A. G. Seaman said no engineering difficulty would be involved in the operation of a number of truckers acting simultaneously.

Prof. Hele-Shaw said he considered the machinery in question would do all that was claimed for it. From what he had seen of the appliances, he considered the system a sound mechanical proposition.

Col. R. E. Crompton said the mechanism at Battersea worked smoothly and satisfactorily.

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* Application of electric welding to large structures, by Prof. W. S. Abell, "Proceedings of Institute of Civil Engineers, 1918–19."

Address of Prof. A. Gray, F.R.S., to Section A of the British Association.*

After a reference to the loss which physical science suffered through the deaths of Lord Rayleigh and Prof. Carey Foster, our lack of organisation and preparation for the war is dealt with at some length. Prof. Gray relates how he suggested a scientific organisation for the country in 1915, but although something was done the scheme finally came to a standstill. The address then proceeds to questions of inventions during the war:—

I turn now to another side of scientific work during the war. It was my lot to serve for nearly three years on the Inventions Panel of the Ministry of Munitions, and as the result of that experience I venture to make some observations on the utilisation of scientific knowledge and genius in the production of inventions useful for the public service. We had an enormous multitude of inventions to consider, and the Ministry of Munitions Inventions Department was, so far as I could see, eminently well managed.

Many of the so-called inventions were not inventions at all. Some were not at all new; in other cases an idea only was mooted. Could so-and-so not be done? and so on, and the department was supposed to be grateful for the idea, and to do the rest, besides rewarding the proposer. A favourite notion, which illustrates the diffusion of scientific knowledge among different classes of people, was that of taking a magnet—any magnet—up on an aeroplane, and using it to attract Zeppelins and other aircraft. Others suggested electromagnets fed by machines which would have involved carrying into the air on an aeroplane a fully equipped power-house! Another favourite notion, inspired, no doubt, by a certain sensational type of article in the fiction magazines, was that of rays charged in some way with electricity, or some other mysterious agency, and therefore intensely destructive.

But there was a residium of valuable inventions, which fully justified the existence of the department. These were recommended for further consideration by the various departments of the service, or by General Headquarters. It by no means followed that all that came to this stage received careful further consideration. Everybody was very hard worked, and many were overdriven. And it was by no means certain that when important approved appliances were sent to G.H.Q. a thoroughly well-informed and capable officer would in all cases have the duty of explaining and showing their action. Then, again, we were told that G.H.Q. did not want this or that, and here, as in all human affairs, mental inertia certainly played a considerable part.

The delays that occurred were to some of us at home, who were anxiously dealing with all kinds of contrivances, exceedingly exasperating. Some were undoubtedly unavoidable, but others were, as I have indicated, far otherwise. Deficiency in scientific education was the cause.

I feel bound to allude to another aspect of the inventions business which to my mind was very serious. In doing so, however, I wish it to be clearly understood that I am criticising a system and in no way here referring to particular individuals concerned in its administration. Various inventions which had passed satisfactorily the first examinations by responsible judges were submitted to technical departments at home to be subjected to practical tests. These inventions were, frequently, solutions proposed of problems on which technical officers, of the departments required to conduct the tests, had long been engaged. It was natural, indeed inevitable, that some of these officers should have come to regard the solving of these problems as their own special job, and so did not much welcome the coming of the outside inventor. Then, no doubt, they often felt that they were just on the point of arriving at a solution—a feeling that certainly could not facilitate the avoidance of delay. It was manifestly most unfair to ask them to judge the work of the outside inventor, or to place in their hands details of his proposals.

Thus, I have no hesitation in expressing the opinion that a testing board of practical, well-qualified physicists and other experts, with a properly qualified staff, should be formed for the purpose of carrying out all tests of inventions. No insuperable difficulty would, I believe, be experienced in forming such a board. It should be formed carefully, not by more or less casual nomination of one another by a few persons. Expert knowledge of a subject should be a necessary qualification; the so-called "open mind" of the much-lauded but untrained practical man is not worth having. But on that board neither inside nor outside inventors of the same kind of appliances should have any place

The value of university and college men trained in science has been thoroughly proved in the Artillery, the Engineers, and in their offshoots, the Special Sound Ranging and Survey Corps, though its recognition by the authorities of Whitehall has been scanty and grudging.

The real cause of the prevailing neglect of science, with all its pernicious results, is that almost all our political leaders have received the most favoured and fashionable form of public school education, and are without any scientific education.

As things are, eminence in science is no qualification, it would even seem to be a positive disqualification, for any share in the conduct of the affairs of this great industrial country. The scientific sides of public questions are ignored, nay, in many cases our rulers are unconscious of their existence. I myself once heard it suggested by an eminent statesman that an electrical efficiency of 98 per cent. might by the progress of electrical science be increased fourfold! This, I am afraid, is more or less typical of the highly educated classical man's appreciation of the law of conservation of energy; and he is, save the mark, to be our minister or pro-consul, and the conservator of our national resources.

While scientifically educated men, whether doing special work or acting as officers, have been held of far slighter account in the services than they ought to have been, for physicists as such there has been little or no recognition, except, I believe, when they happened to be ranked as research chemists! How did this happen? Why, the various trades asserted themselves, and the result was a sufficiently long list of "reserved occupations."

Research chemists received their recognition in consequence of the existence of the Institute of Chemistry. I am extremely glad to find that something is now being done to found an Institute of Physics. I hope this movement will be successful, and that it will be thoroughly practical and efficient. I hope its president and council, its members and its associates, will be jealous for science, and especially for physics. It ought to be a thoroughly hard-working body, without any frills, destitute of work value. They have an example in the General Medical Council, which has so effectively cared for the interests of the medical profession.

I am glad that something is being done at last for the organisation of scientific research. This movement has started well in several, if not in all, respects, and I wish it all success. There are, however, one or two dangers to be avoided, and I am not sure—I may be much too timid and suspicious—that they are fully recognised, and that the result will not be too much of a bureaucracy

There is to my mind too much centralisation aimed at. Everything is to be done from London; a body sitting there is to decide the subjects of research and to allocate the grants. There may be a good deal to be said for that in the case of funds obtained in London. But apparently already existing local incentives to research work are to be transferred to London.

There is, it seems to me, another danger to be avoided besides that of undue centralisation in London. In most of the statements I have seen regarding the promotion of research work the emphasis seems to be on industrial research, that is, in applied science. This kind of research includes the investigation of physical and chemical products of various kinds which may be used in arts and manufactures, and its deliberate organised promotion ought to be a commercial affair. I observed, by the way, with some amusement, that according to the proposals of one committee for applied science, which is prepared to give grants and premiums for researches and results, the professor or head of a department, from whom will generally come what are most important, the ideas, is to have no payment. He is supposed to be so well paid by the institution he belongs to as to require no remuneration for his supervision of the committee's researches. And the results are to be the sole property of the committee!

There is in this delightfully calm proposal at least a suggestion of compulsion and of interference with institutions and their staffs, which ought to be well examined. Also some light is thrown on the ideas of such people as managing directors of limited liability companies, who are members of such a committee, as to what might reasonably be expected of men of high attainments and skill, whose emoluments, taken all round, are on the whole miserably insufficient.

I think that it is in danger of being forgotten that, after all, pure science is by far the most important thing. Most of the great applications of science have been the products of discoveries which were made without any notion of such an outcome. Most certainly it is right to encourage research in applied science by all available and legitimate means. But beware of attempting to control or "capture" the laboratories of pure science in the universities and colleges of the country. Let there be also ample provision for the pursuit of science for its own sake; the return will in the future as in the past surpass all expectations.

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* Delivered at Bournemouth. Abstract.

I had intended to say something about scientific education as exemplified by the teaching of physics. I have left myself little time or space for this. In the first place I regard dynamics, especially rotational dynamics, as the foundation of all physics, and it is axiomatic that the foundation of a great structure should be soundly and solidly laid.

The better the student of physics is grounded in the older dynamics, and especially in the dynamics of rotation, the sooner will his way of looking at things begin to become instructive.

With regard to the study of physics, it would, I think, be conducive to progress if it were more generally recognised that dynamics is a physical subject, and only secondarily a mathematical one. I deprecate the teaching, however elementary, which as a beginning contents itself with rectilineal motion. The true meaning of rate of change of a directed quantity, even of velocity and acceleration, is missed, and instead of having laid a foundation for further progress the teacher, when he desires to go beyond the mere elements, has practically to relay his foundations, has in fact to extract imperfect ideas from his pupils' minds and substitute new ones, with the result that a great deal of avoidable perplexity and vexation is produced.

With regard to mathematics, the more the physicist knows the better, and he should continually add to his store by making each physical subject he takes up a starting-point for further acquisition. Some very philistine notions as to mathematics prevail, and are very mischievous. For example, I once heard an eminent practical engineer declare that all the calculus an engineering student required could be learned in an hour or two. This is simply not true, nor is it true, as some exponents of ultra-simplicity seem to suggest, that the professional mathematical teacher wilfully makes his subject difficult in order to preserve its esoteric character. Like the engineer or phyiscist himself, he is not always so simple as he might be; but the plain truth is that no good progressive mathematical study can be carried out without hard and continued application of the mind of the student to the subject.

Address of Prof. J. E. Petavel, F.R.S., to Section G of the British Association.*

I.—Engineering and Science during the War.

To summarise adequately the part played by engineering in the war would be impossible, and I shall restrict myself to an outline of the more outstanding facts. The urgent necessity for a vast output of munitions made centralisation and standardisation essential, and involved a complete revolution in workshop practice. The Ministry of Munitions, created in May, 1915, concentrated first on the production of guns and shells. The maximum expenditure of ammunition was reached one day in October of 1918, when 900,000 shells, weighing 40,000 tons, were fired. The total number of guns manufactured during the war was 20,000, and over 200,000 machine guns had been delivered by November, 1918. Aircraft were ultimately turned out at the rate of 4,000 per month; later the provision of motor transport was in addition placed under its control.

Among the inventions which have had an influence on military operations may be mentioned the tanks, first used in 1916. Sound-ranging introduced the complex methods and delicate instruments of physical research into the trenches, and proved them to be reliable under the most adverse conditions. The Stokes gun superseded all other trench mortars by simplicity of design of manufacture and convenience in handling; 20,000 of these guns were used during the war. On August 4, 1914, the Government assumed control of the railway systems in this country. British engineers have been responsible for transport through France, and large numbers of engines were sent across the Channel, and miles of track were taken up in England and re-laid in France. Road transport was organised and 100,000 new vehicles delivered. A network of narrow-gauge railways was carried up to the trenches, and numerous new roads, railway lines and bridges constructed. Railway construction formed an important factor in Mesopotamia and Palestine; in the latter case the entire water supply had for a long period to be drawn from the Egyptian base through a specially laid pipe-line. Among the notable new departures, the cross-Channel train ferry and the portable steel bridges should be specially mentioned.

Naval warfare consisted largely in measures against the submarine. Among devices for attacking submarines, the depth charge was of great importance. The Paravane was of great assistance in enabling ships to pass safely through mine fields, and was also used in attacking submarines. Sound location proved a most valuable weapon. Strange craft, monitors, &c., were developed for special purposes. Torpedo nets proved ineffective, but mine-sweepers were largely protected by special bulkheads. Ultimately submarines were provided with a heavy gun that could be fired submerged.

Rapid progress was made in aeronautical science and construction. In 1909 Blériot flew the Channel. In 1910 Cody won the British Michelin Cup by a flight of 185 miles. The Royal Flying Corps was formed in 1912 with 72 aeroplanes and two airships. The number of aeroplanes available in 1914 was under 200; the number ultimately required more than 3,000 per month. In 1914 the maximum speed of some 80 miles per hour, a rate of climb at ground level of 300 ft. or 400 ft. per minute; the engines of 6 H.P. to 100 H.P. In 1918 140 miles per hour, a rate of climb of 2,000 ft. per minute; and a power plant developing over 1,300 H.P., were attained. The maximum height attainable had increased from 5,000 ft. to 25,000 ft. The largest bombs in use weighed over a ton, and during the war 8,000 tons of explosives were dropped on the enemy. The labour difficulty was overcome by the introduction of a large proportion of female labour. For a period the supply of magnetos was both inadequate and unsatisfactory, but a total of 8 million horse-power was produced during the last 12 months of the war. Synchronised gun firing through the propeller was first brought into use by the enemy. On the other hand, throughout the war the only stable machines were British. Airships proved to be of great importance in connection with naval work for patrol duty and convoy service; by their means a submarine could be detected and attacked while at a considerable distance below the surface. What is popularly known as an invention, or an idea of revolutionary importance emanating from one person, has played relatively little part in the recent development of aeronautics. Success has been due to systematic investigation and to the combined effort of many scientific workers, trained designers and practical constructors. Several inventions notably influenced the course of the war. The successful manufacture of incendiary bullets put an end to the Zeppelin raids, tracer bullets increased the accuracy of aim, and synchronising gear made it possible to fire through the propeller at the rate of nearly 1,000 rounds per minute. A satisfactory self-sealing petrol tank was manufactured. Wireless telephony and directional wireless were introduced. A reliable turn indicator and improved compass made accurate navigation through clouds possible. Armoured aeroplanes were constructed; special machines were also designed for carrying 37 mm. quick-firing guns for use at the Front and against submarines; these guns fired a 1½ lb. high explosive shell.

The use of airships near the fighting zone or within reach of enemy aeroplanes was impossible owing to the inflammable nature of the gas. The proposal to replace the hydrogen by helium came from a member of the Board of Invention and Research, and in 1915 experiments were started. At the time of the Armistice a supply of 350,000 cubic ft. per week was ensured.

The above outline of engineering activities during the war is incomplete, but illustrates the two features which characterised the period and made victory possible—namely, (1) large production, obtained by organisation, standardisation and co-operation; and (2) rapid progress resulting from the stimulus to research and invention and the immediate application of the results obtained.

II.—Industrial and Economic Reconstruction.

The peace declaration is the opening of a new act in the world's greatest drama, and the events of the next few years will decide the fate of many generations. The world is emerging from a furnace, and the rigid constitution of civilisation, for a moment plastic, will harden in the mould we form. It is our duty to understand the transformation going on, and influence it in the right direction..

The principal feature of the day is the insistent craving for better and easier conditions of life; this is inaccurately expressed by a demand for higher wages and less work. The two aims are far from identical. The total remuneration received by a nation is measured by its production. This law cannot be altered or affected by legislation or revolution; but the share received by a class or an individual is capable of adjustment within certain limits. During a generation the working classes have been told, and have firmly believed, that they receive but a tithe of the value of their work, and that the bulk goes to swell the fortune of the capitalistic class. The actual fact is that, on an average in pre-war days, the share of the capitalist was one-ninth that of the workman. The position with regard to coal is now known to all. For each ton raised 19s. 5½d. goes for labour and a total of 2s. is paid as royalties, owners' profits and owners' compensation. The 13s. rise in the miner's wages cannot be paid out of profits and royalties amounting to a total of 2s. These facts, though clearly established, are not easily credited by the working man. The limitations, however, are clear. The income of the United Kingdom per head of the population was before the war about £50. If, therefore, the State were run on completely communistic lines, and if under these conditions there were no reduction either in the working hours or the output, our wages would average a sovereign a week each, and we could buy our goods at pre-war prices.*

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* Delivered at Bournemouth. Abstract.

Hence a real improvement in material welfare is necessarily associated with increased production. At one time production was directly dependent on muscular effort; it is now mainly influenced by equipment, organisation and skill. Increased production does not necessarily imply harder work or longer hours; it can be secured by improvements in method and machinery, but only with the willing co-operation of all concerned. Before the war the Americans were far ahead of us in standardisation and specialised machinery. The American clock and the Ford car are two well-known examples. During the war we adopted and developed these methods. As a result, although the cost of all materials increased considerably, although the wages more than doubled and the profits were more than adequate, the cost was in many cases reduced. Thus the eighteen pounder shell fell from 22s. to 12s., the Lewis gun from £165 to £62. The importance of standardisation has been fully realised by the manufacturers of this country, and as a result we may hope to see a general reduction in cost.

The economic value of an individual depends exclusively on the nature, quality and quantity of his output, and his remuneration should correspond to his economic value. In this respect our present system is a complete failure. The minimum wage is beneficial in so far as it prevents sweating, but in two other respects its consequences are most unfortunate. Under the operation of this rule the man whose value is a fraction below the minimum is unemployed and economically unemployable. Further, the minimum wage becomes the standard wage, and the better men are inadequately paid. Both causes lead to decreased production.

Among the professional and business classes the remuneration is proportional to the skill and to the effort. Any form of payment by result is viewed with indifference or distrust by the unions, and past experience with piece work explains that attitude. There has been a disposition for employers to make large individual earnings an excuse for cutting rates. Another important but difficult subject is the distinction drawn between skilled and unskilled labour. The experience gained during the war has proved that many operations scheduled as skilled work could be effectively performed by women who had only received a few weeks' special instruction. Just as it is clear that if labourers and skilled men were grouped together at a uniform wage, that wage would necessarily be lower than the present minimum for skilled work, so also the separation of tasks which require but a nominal period of training would increase the rate of remuneration available for the really skilled man. Increased production is at the present moment the most pressing national need, but it will become effective only when for every man increased production becomes the talisman by which *his* paper wages can be turned to gold.

Heating and Cooking Notes.

The Importance of Selling Service as Well as Electrical Energy.

To promote further the use of electricity for heating and cooking purposes, not only has the ignorance of the general public to be overcome, but ways and means have to be found to obviate the disadvantages which at present exist in the form of expense due to additional meters, separate wiring, larger services, &c.

It is estimated that there are at least half a million new houses required to ease the present difficulties in connection with housing. Are these houses to be built ready wired for electric lighting, cooking and heating? They offer an attractive opportunity for supply authorities, and electric lighting, cooking and heating has been justified in practice on the ground of economy, convenience and efficiency. An average eight to ten-roomed house will consume about 300 units per annum for lighting purposes, and, if electric cooking is installed, probably a further 2,000 units would be consumed, and the use of a radiator occasionally during between-seasons and at odd times for short periods in bedrooms, drawing-rooms, &c., would call for another 1,200 units, making a gross annual total of 3,500 units per ten-roomed house. Think what this consumption means in half a million houses and it immediately becomes evident that the domestic load is well worthy of energetic consideration.

The first difficulty to be removed is the conversion of the authorities responsible for housing schemes from old-established ideas to modern ones. They require to be shown that previously old slum houses have merely been replaced by new slum houses of exactly similar type, and it only required the process of time for the new houses to become as dismal as the old.

By building houses on modern lines and giving every possible attention to questions affecting cleanliness and labour saving, there will be a far greater probability that the houses will be kept in decent condition.

Then there comes the question of cost of adding these modern improvements; but, instead of being an additional burden, it can be shown that electricity will permit economies in the building cost which will balance the cost of the installation. With electric light a saving can be effected in the height of the houses, and every foot saved in building height means a considerable reduction in cost. In building on the new housing estates, electricity should be employed from the start by using a sub-station to supply power for building operations, and afterwards the same source can be used to supply the houses with electrical energy. Overhead mains for distribution together with open surface wiring in the houses would considerably reduce expenses. Electrical energy should be charged for in as simple a manner as possible, and separate meter circuits, &c., done away with. By allotting each house a certain number of units at a definite annual charge, payable monthly, and then charging all units consumed in addition at a fixed price, the charging system becomes simple and understandable. The consumer is not confused or annoyed with a charging system he cannot understand.

It requires to be realised by supply authorities that they are selling "service" as well as "juice." For instance, it is much more palatable to the man in the street to pay a little more for his electricity and have his fuses replaced and small repairs done free of charge than to have to pay half a crown every time a fuse blows.

Naturally the cost of maintenance and repairs has to be paid for in some way; but, if your patient won't drink nasty medicine, why not give him a sugar-coated pill? If the cost of hire and hire-purchase schemes for supplying apparatus seem to work out at high figures, why not reduce them and charge a little more for the current consumed, and obtain payment that way? In this manner electrical energy plus service is being sold and satisfaction given. In the old way of selling electrical energy first and charging extra for service, large numbers of consumers were continually annoyed by petty charges, and the supply of additional current-consuming apparatus was hindered. The only way of overcoming the high cost of services to small houses for lighting purposes is to promote the demand for cooking and heating apparatus, and the best way to do this is to make it easy for the public to obtain and use such apparatus.

Even water heating becomes a more possible proposition if adequate use of an efficient thermal storage system is employed. Under such circumstances the water can be heated at night, the heater circuit being controlled by a time switch. During the night the equivalent cost of electrical energy as it is in the off peak period would be less, though it should be charged at the flat rate decided upon and arrived at after considering the average equivalent amount and values of energy used for lighting, heating and cooking. Such a flat rate system is better than a fixed price system per piece of apparatus or per lamp, because the former allows the consumer to instal the most convenient and efficient installation, whilst the latter tends to cause him to use only the bare minimum. The progress of electric supply is quite as much bound up with the future development of the sales policy of the supply authorities as with the manufacturers' activities in providing efficient apparatus at a reasonable price.

A Combined Radiant Electric Boiler and Toaster.

Messrs. Rich & Bundy, of 11a, New-road, Ponder's End, have produced a combined boiler and toaster of neat design and serviceable character. The apparatus consists essentially of an open-type nickel chrome spiral element threaded through eyeletted holes in a series of mica strips, which give support to the element. The spiral and mica strips being mounted in a sheet metal frame. A rack slides under the element, and will carry a slice of bread when it is desired to use the apparatus as a toaster, and at the same time a kettle or other vessel can be placed on the top of element. Thus, toasting and boiling can be carried out at the same time. When toast is not being made the rack can be reversed, and its bottom acts as a deflector to give additional efficiency when the apparatus is used as a boiling plate only. The apparatus is well finished and brightly nickel plated, presenting a very pleasing appearance. The loading of the element is 500 watts.

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* This statement is optimistic in so far as it does not take account of war losses.

Regulations for Wireless Communication With Aircraft.

The Air Ministry has issued an announcement to the following effect: pending the issue of the license by the Postmaster-General, temporary authority for the installation and use of wireless apparatus in aircraft can be obtained by application to the Secretary of the Post Office. For the present the wave-length suggested for wireless telephony is 480 metres. This is the wave-length which the Air Ministry wireless telegraphy stations now use. The Postmaster-General's license will probably contain provisions to the following effect: the sending apparatus installed at any aircraft station shall be capable of using waves of 600 metres interrupted continuous wave, and 900 metres continuous wave; such of the following wave-lengths—namely, 220, 300, 450 and 800 metres interrupted continuous wave, and 200-550 metres, 650-950 metres, 2,000-3,000 metres continuous wave, may also be used for transmission as are authorised by the Postmaster-General.

The use of the wave of 600 metres (hereinafter referred to as the "aircraft ship" wave) shall be confined to the use of the system known as "Interrupted undamped wave or tonic train, or I.C.W.," and the use of 900 metres, hereinafter referred to as the "aircraft normal wave," shall be used only for continuous damped waves or wireless telephony.

Should an aircraft station be also fitted with a supplementary installation on long continuous waves, such installation shall be so constructed as to be capable of using the wave-length of 2,400 metres.

The range of wave-lengths for which the receiving apparatus may be constructed is not limited, but the apparatus must be capable of receiving on 600 metres and 900 metres, and on 2,400 metres when a transmitter working on this latter wave-length is installed: it must also be made to embrace any other wave-length on which a transmitter installed has been authorised to work. The power used shall not exceed 100 watts, exclusive of power employed for heating filaments of vacuum valves.

Overseas Trade.

The report of the Committee appointed to examine the question of Government machinery for dealing with Trade and Commerce was issued on Monday. The Committee do not consider it practicable permanently to place the appointment and control of Consuls under one department and the supervision of their work of collecting commercial intelligence and safeguarding commercial interests under another. An enlargement of the Consular staff and an improvement in its training and status are urgently required. The Committee recommend that Sir A. Steele-Maitland's scheme, which had been approved by the War Cabinet so far as it relates to the development of the Consular service, including the creation of new posts, training, pay and allowances, should be brought into operation as early as possible. The Department of Overseas trade should continue as at present constituted.

It is desirable that the Foreign Office shall take care that it is impressed upon his Majesty's Ministers and Consuls abroad that the Department of Overseas Trade is in fact a part of the Foreign Office, and that they must look to it for instructions and guidance in commercial questions.

The following is a summary of recommendations added to the report: That the Consular Service remain under the control of the Foreign Office. That the proposals in the scheme for the reform and development of the Consular and Diplomatic Service, other than those which relate to the Trade Commissioner, Service and Labour Attachés, be adopted. That the Board of Trade be authorised from time to time to send temporary missions for special purposes to foreign countries. That the Board of Trade be represented on the selection and promotion committees for the Consular and Commercial Diplomatic Service. That the Department of Overseas Trade continue as at present under the joint control of the Foreign Office and the Board of Trade. That the Board of Trade remain responsible for general commercial policy, and that it be the duty of the Department of Overseas Trade to give effect to that policy overseas. That the Consular and Commercial Departments of the Foreign Office be Transferred to the Department of Overseas Trade. That the War Trade Intelligence Department be transferred to the Department of Overseas Trade except as to those branches which may be more conveniently transferred to the Board of Trade. That a standing committee or board be formed for the discussion of matters relating to overseas trade, to consist of the heads of the Board of Trade, Foreign Office and Department of Overseas Trade, with power to call in representatives of other departments, and that such standing committee or board meet at regular and frequent intervals.

Mr. Dudley Docker, in a minority report, says he considers that the system of dual control of the Department of Overseas Trade is at the root of the trouble. He puts forward recommendations: That the work of procuring economic intelligence from foreign countries through the commercial, diplomatic and Consular services, and of analysing such intelligence, must be carried out by the Foreign Office in order to enable that Department to be in a position to formulate the lines upon which our foreign trade policy should be framed. That the Foreign Office must be strengthened by the absorption of the staff of the Department of Overseas Trade, and the introduction of a commercial man of the highest calibre, who should be given a position only second to the Foreign Secretary. That the decisions of the Foreign Office as to the lines upon which our foreign trade policy should be framed should be referred to the Board of Trade to assist that department in formulating the general trade policy of this country. That the salaries and allowances of Consular officers should be made commensurate with the greatly-increased importance which their duties will assume in the future. That the trade commissioners' service shall not be amalgamated with the commercial diplomatic service, but shall be graded equally with it. That the staff of the War Trade Intelligence Department shall be absorbed by the Foreign Office and the Board of Trade, according as the capacity of each individual officer may appear advisable.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewaurn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1919 Specifications.

129.579 Townsend. Electric wave meters. (4/2/19.)
Consists in the combination with a variometer of two condensers of approximately equal capacity and means for connecting them either in parallel or in series.
129.595 Dean & Chloride Electrical Storage Co. Portable electric lamps (28/2/19.)
129,607 Berry & Reid. Electric fires. (31/3/19.)
129,921 Howorth. (Huggins.) Electro-mechanical transmission systems for automobiles. (2/1/19.)
129,934 Ionides. Electric collectors for maintaining contact between relatively movable conductors. (6/2/19.)
129,959 Forrester. (Burgess.) Electric heating apparatus. (10/7/18.) (Divided application on 11,304/18.)
130.279 Walshaw. Insulated joints for electric conductors. (11/2/19.)
130.288 Marriott. Electric furnaces. (3/3/19.)
130,291 Etablissements H. Crochat. Electric motor control systems. (19/11/18.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

July 18, 1919.

18.001 Torrance. Magnetos.
18.003 Picquerez. Electric boiler. (4/10/18, Switzerland.)
18.004 Picquerez. Electric furnaces. (2/9/18, Switzerland.)
18.006 Picquerez. Resistance for electric furnaces. (20/2/19, Switzerland.)
18.016 Electro-Metals, Ltd., & Robertson. Electric furnaces.
18.027 Dale. Apparatus for converting direct current into high frequency alternating current.
18.034 Timmons. Telephone transmitter.

July 21, 1919.

18,087 Sampson. Coin-freed electrical shooting apparatus.
18,127 Palmer. Dry cell batteries.
18,133 Fitzgerald. Electric laundry irons.
18,146 Goldsmid-Abrahams.
18,148 Hewson. Electric ovens.
18,150 Powell & Smith. Automatic electric control of vehicles.
18,166 Relay Automatic Telephone Co. (Betulander.) Line arrangements for automatic telephone exchanges.
18,167 Relay Automatic Telephone Co. (Betulander.) Switching arrangements for automatic telephones.
18,248 Arntzenius. Telephone systems. (19/8/18, Holland.)

July 22, 1919.

18,233 Western Electric Co. Telephone exchange systems. (22/7/18, U.S.)
18,257 Bolitho. Wireless telegraph apparatus operating with relays.
18,254 Smith. Electric signs.

July 23, 1919.

18.284 Cave & Goss. Apparatus for electric transmission of drawing, printed matter, &c.
18,301 Automatic Telephone Mfg. Co. Automatic or semi-automatic telephone systems. (4/11/18, U.S.)
18.305 Burleigh. Dynamo-electric machines.
18,319 Hanson. Wireless transmission of speech.
18,321 Relay Automatic Telephone Co. Thermostatic devices.
18,325 & 18,326 Mancha Storage Battery Loco. Co. Storage battery locomotives. (31/8/18, U.S.)
18,327 Goodman & Clayton-Wright. Electric lamps for motor vehicles.
18.320 Remy Electric Co. Electric ignition apparatus for engines. (19/9/17, U.S.)
18,336 Smeddles. Trollies or current collectors for electric trams, &c.

July 24, 1919.

18,363 Thornton. Electric fuses and switches.
18,409 Lee. Jointing troughings for cables.
18,410 Bitton & Brantom. Atmospheric discharge and disturbing element eliminator for wireless telegraphy.
18,411 Cooper. Dynamos.
18,413 Hartwell. Protecting electric mains against flooding on ships.
18,415 Graham & Rickets. Vacuum tube or electronic discharge apparatus.
18,435 Dubilier Condenser Co. Condensers. (1/8/18, U.S.)
18,436 Dubilier Condenser Co. Insulation testing devices. (26/8/18, U.S.)
18,437 Dubilier Condenser Co. Condenser structure. (7/3/19, U.S.)
18,438 Dubilier Condenser Co. High potential condensers. (7/3/19, U.S.)
18,439 Dubilier Condenser Co. Condenser plates. (11/4/19, U.S.)
18,445 Slaney. High tension insulators.
18,458 Western Electric Co. Electric signalling systems.
18,462 Cole. Electric switch lock.

July 25, 1919.

18,467 Worthington. Using waste water from mines or sunken ships for obtaining electric power.
18,476 Barry. Increasing power of overhead transmission lines.
18,492 Scott-Taggart. Negative and positive resistance vacuum-tube devices.
18,496 Gregory. Electric circuit breakers.
18,505 Chambers. Production of electrical oscillations for radio-telegraphy or telephony.

Commercial Topics.

Electrical Progress in Japan.

According to recent statistics there are now 715 electrical utility undertakings in Japan, including 625 electric supply stations plants, 42 electric railways and 48 companies operating both power plants and tramways. This is an increase of 40 companies over last year, and is clear evidence of the growing popularity of electricity supply for power and lighting in the progressive Empire of the East. Japan has an abundance of water power, and good progress is being made with the systematic survey of waterfalls which is being made in order to develop hydro-electric power.

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The Government Credit Scheme for Exports.

We have already given particulars of the Government scheme for providing long term credits for exporters, and it is now announced that the Export Credits Department at 10, Basinghall-street, London, E.C. 2, will consider applications for advances up to 80 per cent. of the cost of the goods, plus freight and insurance, for goods sold to—

Finland, the Baltic Provinces (Latvia, Esthonia and Lithuania), Poland Czecho-Slovakia, Jugo-Slavia and the areas in Russia to which the scheme for insurance against abnormal commercial risks applies, subject to the conditions abstracted in our issue of the 29th ult. (p. 232).

Apparently the scheme applies to all classes of goods and manufactures, and as there should be a very good demand for electrical plant and supplies, we hope that electrical manufacturers and exporters will bestir themselves and take advantage of it. Mr. L. A. Davis, deputy foreign manager of Barclay's Bank, Ltd., has been appointed manager of the new Department.

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Recent Legislation.

Those who believe in legislation as a cure for industrial unrest and social evils must surely be satisfied with the record of the first half of the Parliamentary session, for the legislative output of this period surpassed all previous records. There are many, however, and we are among them, who attach more importance to good, prudent administration, more especially when legislation is drafted in haste and ushered through the Houses of Parliament without full consideration. We are afraid that some of the recent legislation, more especially the Profiteering Act, is so crude that it is doubtful if it will serve the purpose for which it was passed. Nevertheless, the work of the current Session must have an important effect upon the social fabric, and many of the measures have considerable interest for our readers.

In the first place, the Transport Act creates a Ministry of Transport for the co-ordination of the various transport services of the country, and electrical engineers are already anticipating the adoption of electric traction on all urban railways, the construction of new lines and other improvements. The Ministry may also acquire the municipal undertakings under certain conditions, and it is possible that it will also have control of electricity supply. The Housing Act should enable a great and beneficent reform in housing conditions to be effected, and electric supply authorities and wiring contractors would be well advised to watch local developments so that all the new houses are wired for electricity supply. By the Ministry of Health Act the Local Government Board was transformed into the Ministry of Health. The Ministry performs important functions in regard to the borrowing powers of local authorities under the Electric Lighting Acts, and we believe that these functions might very well be transferred to the Government Department which will have the administration of the powers conferred by the Electricity (Supply) Bill. Hitherto municipal electrical undertakings have been brought into contact with the Board of Trade, the Home Office and the Local Government Board, and the elimination of the successors of the last-named would simplify matters.

In the next place there are several minor Acts of some importance to the electrical industry. The Courts (Emergency Powers) Act, 1919, which amends and extends the scope of the 1917 Act, enables the courts to suspend or annul, or (with the consent of the parties) amend contracts (including those confirmed by Statute on Provisional Order). In order to obtain relief the court will have to be satisfied that "owing to the prevention or restriction of, or the delay in, the supply or delivery of materials, or the diversion or insufficiency of labour, or the shortage of shipping, or the alteration of trade conditions occasioned by the present war, the contract cannot be enforced according to its terms without serious hardship."

The Profiteering Act, which became law on Aug. 19th need not worry electrical engineers. It is of doubtful value, but it authorises the Board of Trade to make orders applying the Act to any article or class of articles declared by the Board to be articles of a kind in common use by the public, or material, machinery or accessories used in the production of such articles. The Board has decided that the provisions of the Act shall be administered by means of Committees or Tribunals, and for this purpose it is proposed to establish three grades of Committees or Tribunals, Central, Local and Appeal.

The Merchant Shipping (Wireless Telegraphy) Act makes it compulsory for ships of 1,600 tons and over to be provided with a wireless telegraph installation. Under the National Health Insurance Act employers must now insure all employees, whose salaries are under £250 a year. There are also the Expiring Law Continuance, the Acquisition of Land and the Coal Mines Acts which have interest for some of our readers. It will thus be seen that, apart from the Electricity Supply, the Patents and Trade Marks Bills, which are still under consideration, the legislative record of the session is a long and interesting one and should bring much new business to electrical manufacturers and contractors.

Electricity Supply.

A company is being formed for the erection of electricity supply works at Newtonbarry, co. Wexford.

Burton-on-Trent has secured authority to borrow £13,500 for additional mains, services and transformers.

In order to meet the growing demand for electric current in Beauly, an additional oil-driven set has recently been installed.

It has been decided to instal electric motors at Saitcliffe Mill, Accrington, which contains 15,000 spindles and 375 looms.

The Slough & Datchet Electric Supply Company is extending its mains to Farnham Common, Farnham Royal and Stoke Poges.

The salary of the engineer and manager of the Leeds electricity department, Mr. C. N. Hefford, has been increased from £1,000 to £1,260 per annum.

Londonderry is suffering from a water famine, and, owing to the failure of the water supply, the electricity station was closed from the 2nd until the 9th inst., when the full supply of current was resumed.

An inquiry was held on Wednesday into the application of Manchester Corporation for sanction to borrow £1,042,000 for the new generating station at Barton.

We are glad to see that the necessity of making electricity available for the new houses which are to be built at Aston is not being overlooked by the Wrexham Housing Committee, which has asked the Electricity Committee to make arrangements for a supply.

The Midland Electric Light & Power Company, of Leamington, proposes to apply for a provisional order for the supply of electricity in certain areas in Warwickshire, including Atherstone, but the District Council of the latter area will oppose the application unless the company can give a guarantee that supply will be available within two years.

Walsall Corporation on Monday authorised an application being made to the Ministry of Health for sanction to borrow £11,970, which is required in consequence of increased cost of labour and materials in erection of the new power station at Birchills, and a further £44,000, also required for the electric supply undertaking, including £21,000 for an extension of mains into the Cannock urban area.

York City Council has sanctioned the purchase of the weir and mill on the River Derwent, at Stamford Bridge, for the purpose of erecting a hydro-electric station. Proposals are also under consideration for the erection of electricity works at Linton Locks, some 15 miles above the city, and at Naburn Locks, 6 miles below York. The new step is being taken in order to economise in the use of coal.

The accounts of Belfast electricity department for the year ended March 31, 1919, show revenue £164,807 (compared with £152,737 in the previous year), total costs £127,925 (£107,041), and gross profit £36,882 (£45,696). After providing for dividends on stock, redemption contributions, income tax, &c., the net balance was £3,486. Total costs, exclusive of capital charges, were 1·658d. (1·305d.) per unit sold. Units generated were 20,743,198 (22,083,990) and sold 18,514,748 (19,688,372). Maximum simultaneous load was 9,917 kw. (10,051 kw.), and load factor 21·3 (22·4) per cent.

The report of the Dundee city electrical engineer, Mr. Harry Richardson on the utilisation of the Tummel Valley water for generating electrical energy is now ready. Mr. Richardson estimates the cost of the first stage of the water power scheme from Loch Tummel at £1.250.000, and that electricity could be supplied more cheaply than by a steam plant extension scheme. He also states that the scheme could easily supply any ordinary demands for power on route without depreciating the interest of Dundee.

A Ministry of Health inquiry was held last week into the application of Eastbourne Corporation for sanction to a loan of £7.278 for a new boiler for the electricity works. Mr. Brydges, borough electrical engineer, said the Government subsidy on steel, &c., having been withdrawn, the cost of the boiler and fixing it would be increased to about £8,537. Mr. Hooper, the Inspector, suggested that an amended application be made for £8,000, and that the balance be paid out of reserve.

The borough electrical engineer of Wolverhampton (Mr. S. T. Allen) calls our attention to the fact that our statement, on p. 103 of our July 25 issue, that Wolverhampton Corporation had agreed to take over the whole of the electric supply in the Heath Town district, is rather misleading. The facts are that Wolverhampton Corporation, having a large surplus of plant at present, have entered into an arrangement to supply the Midland Electric Corporation for Power Distribution, for the time being with a bulk supply, sufficient to deal with the Heath Town district.

A proposal to borrow £42,650 for the installation of a 5,000 kw. set, to increase the generating powers of the undertaking has been approved by the Wigan Town Council. Negotiations are taking place for a supply of about 2,800 kw. and the 5,000 set will hardly cover the demand. Ald. Grimshaw stated to the Council that out of 114 electrical departments throughout the country, in their own group Wigan stood 14th in point of efficiency, and out of 20 stations in the vicinity they occupied fourth place. Within two years they would probably have the most efficient station in Lancashire.

The Clyde Harbour Trust has decided to convert the pumps at the graving docks from steam to electric power. During the current financial year £60,000 is to be expended on the electrification of the machinery at Prince's Dock and the graving docks, the lighting of Prince's Dock, the provision of pneumatic plant and electric power at the graving docks, and the completion of the three 8-ton cranes for Rothesay Dock. The change from steam to electric pumping is being carried out on reports from engineers, who estimate the capital expenditure involved at £17,300, and the total annual saving at £3,700.

The accounts of the Oldham Corporation electricity department for the year ended March 25, 1919, show revenue £89,367 (compared with £79,833 in previous year), working and general expenses £56,870 (£47,907), gross profit was £32,497 (£31,926), and after providing for capital charges and £248 for expenditure on meters, the net profit was £8,325 (£7,572). Maximum demand was 6,130 kw. (6,101 kw.) for lighting and power and 1,450 kw. (1,650 kw.) for traction. Units generated 18,550,564 (18,896,189) and sold 14,774,817 (15,183,088). Mr. F. L. Ogden, borough electrical engineer, says, in his report, the replacement of c.i. pipes and armoured cables, laid direct in the ground, by fibre pipes laid in concrete had been continued. The applications by the Councils of Crompton, Lees and Royston for provisional orders to authorise the supply of electrical energy in those districts has been deferred pending the decision of Parliament on the Electricity Bill.

Electric Traction.

Leeds Corporation has increased the salary of the tramways manager and commercial manager, Mr. J. B. Hamilton, from £2,000 to £2,300 per annum.

In an omnibus bill to be promoted by Wallasey Corporation power will be sought to extend the tramway system, to own and operate motor omnibuses, &c.

The Board of Trade has extended for one year from Aug. 15 the period limited by the Derby Corporation Act, 1913, for the completion of the tramways authorised by that Act.

Dundee Council decided last week to increase the charge for current supplied to the Dundee, Broughty Ferry & District Tramways Company from 1·25d. to 1·75d. per unit, plus 10 per cent.

Lanark County Council has received an offer by the Lanarkshire Tramways Company for £463,050, plus the value of stock of coal, motors, &c., and compensation to directors and officials for loss of office.

The Board of Trade have offered to arrange a meeting to discuss the objection of Paisley Trades and Labour Council to the proposed increase of fares on the cars of the Paisley District Tramways Company.

Ashton-under-Lyne Corporation, who are taking over the tramways of the Oldham, Ashton & Hyde Electric Tramways Companies in their district, intend to double the line from Ashton to Bardsley, where it joins the Oldham section.

Worcester City Council has commenced an action against Worcester Electric Traction Company for the recovery of increased charges claimed by the Council for the supply of current to the company. The company decline to pay the increased charge unless the Council agree to the company doing their own repairs to the permanent way.

The Belfast tramway department's accounts for the year ended March 31, 1919, show revenue £406,300, working expenses £257,162, and gross profit £149,137. After providing for dividends on stock, interest, income tax, redemption contributions, reserve (£11,545), depreciation and renewals fund (£17,000), &c., the balance carried forward was £29,231. Car-miles run were 5,254,482. Income per car-mile was 18·56d., and working expenses were 11·75d.

The Minister of Transport (Sir Eric Geddes) has invited the County Councils of London, Middlesex, Kent, Surrey, Essex and Hertfordshire to appoint a representative on a special committee which he is about to appoint to deal with the LONDON TRAFFIC PROBLEM as far as the powers of the Ministry permit. At present the Transport Ministry has no powers to deal with tramways or omnibuses, and the question whether or not an attempt shall be made to obtain further powers will be one for the new committee to consider.

Oldham Corporation tramway accounts for the year ended March 25, 1919, show revenue £184,029 (against £151,411 in previous year), working expenses £124,336 (£106,937), rent of leased lines £3,811 (£4,010), interest £8,489 (£8,964), amounts paid to sinking fund, £19,019 (£18,643), income tax £8,227 (£5,876), and net balance £20,144 (£6,978). Revenue per car-mile was 21·093d. (17·132d.) and working expenses, including power, were 14·251d. (12·099d.). Passengers carried were 31,229,035 (28,703,371), and car-miles run 2,093,946 (2,121,092). The revenue earned by the motor-omnibuses (not included in the above figures) was £716 (£599), and as working expenses were £1,627, and income tax £4, there was a deficit of £914 Average revenue per 'bus-mile was 11·187d. (11·162d.), and working expenses were 25·397d. (28,082d.

The dispute between Torquay Corporation and the local tramways company as to the price to be paid for traction current is to be referred to a Board of Trade arbitrator.

On Friday, Sir Robert Horne, Minister of Labour, met representatives of the Municipal Tramways' Association, the Tramways and Light Railways' Association and the Transport Workers' Federation at the Ministry of Labour, when the question of the reference to arbitration of the Federation's claim for an ADVANCE OF WAGES TO TRAMWAY WORKERS was discussed. It was agreed that the Minister should prefer the claim to the Interim Court of Arbitration. The owners of the tramways undertakings contended that the Court should hear the case in the districts, but the Federation declined to waive their point that the claim must be dealt with on a national basis. Sir Robert Horne said the question of the arrangements for the hearing was a matter within the discretion of the Court of Arbitration. It was arranged that the Court should be asked to grant a preliminary hearing on Monday, Sept. 15.

Miscellaneous.

The SERVICE OF DEFERRED TELEGRAMS between the United Kingdom and Canada over the British Imperial cable has been resumed this week. A Government deferred service is also again in operation to Australasia and the British West Indies.

We recently announced that arrangements were being made for laying a Submarine Telegraph Cable between Yokohama and San Francisco, and H.M. Commercial Secretary at Yokohama now reports that the formation of a new company entitled Nichibei Kaitei Densen Kabushiki Kaisha (the Japan-America Cable Co.) for laying the cable.

An inquest was held on the 3rd inst. upon a workman who recently received a fatal electric shock at Cerebos salt works, near West Hartlepool. The evidence showed that deceased put his hands on some electric light wires that ran along above the window frame, and was afterwards heard to shout. Another employee, who ran to him and touched him, said he received an electric shock that bowled him over. He was going to him again when deceased fell. The electrician at the works said the wires would not be dangerous unless there was a leakage, and that anybody clutching at them quickly would be likely to cause such a leakage. A verdict of accidental death was returned.

An interesting feature of the forthcoming Shipping, Engineering and Machinery Exhibition, to be held at Olympia from Sept. 25 till Oct. 17, will be the assemblage of water softening and purifying plants at work. We are informed that such a comprehensive exhibit of pure water producing plant has not previously been shown at any exhibition. The art of water treatment has made astonishing progress during the war, due largely to the urgent necessity which arose for completely effective treatment, not only for the water supplied to the armies, but also of the water used in the manufacture of many munitions of war. The authorities of some of our principal cities have plans in preparation for the improvement of their water supplies by the methods which proved so successful under the severe conditions of the war.

One of the most important features of the measures for RESETTLING EX-SERVICE MEN IN CIVIL LIFE is the Government scheme whereby ex-officers and other ranks of good education may be assisted to take up or resume training for business and professional careers. In the phase of the work dealt with by the Appointments Department of the Ministry of Labour, training is arranged for in offices and work, &c., and the co-operation of employers is, therefore, essential to success. Many employers have responded to the appeal which has been made to them with the greatest willingness, and although the scheme has only been working fully for a comparatively short time, over 3,500 students are now in training. Engineering is a profession which is greatly sought by candidates, and at Aug 22 there were 602 students training in the various branches of the profession. The number of applicants is, however, greatly in excess of the number of training vacancies available, and employers who can help by offering to train suitable candidates are urgently requested to communicate with the nearest district office of the Appointments Department. In cases where it is proved necessary, grants are made to students to assist in payment of their fees, &c.

The accounts of the Hull municipal telephones department for the year ended March 31, 1919, show receipts £59,444 and expenditure £41,396, leaving gross profit £18,048. Interest required £6,629, loan instalments £10,556 and income tax £1,966, the net result being a deficit of £1,105. The manager (Mr. T. Holme) says, in his report it was anticipated a year ago that the accounts would show loss of several thousands of pounds, but practically no "ceases" have taken place in connection with the new tariff, and the result is more satisfactory. The increased tariff yielded £600 in the past year, and is estimated to yield an additional £9,400 in the current year. Rates, taxes and royalties absorb 20 per cent. of the gross income. The system comprises 11,596 stations and 38,463 miles of wires, of which 32,775 miles are underground. The City Architect is preparing plans for an automatic exchange, to be equipped with the Western Electric machine switching system, for 1,000 lines in Pearson Park. It is also intended to provide automatic equipment for 1,000 subscribers at the central exchange.

Educational.

A final appeal is being made for the War Memorial Fund of King's College, London. The Memorial Committee propose to purchase an athletic ground for the Colleg and the present appeal is for the balance of the purchase money (£4,000, and £6,000 for laying out the ground and building a pavilion. The secretary of King's College (Mr. S. T. Shovelton, M.A.) is honorary treasurer of the fund.

At the Northampton Polytechnic Institute, St. John-street, London, E.C.1, evening technical courses in all branches of mechanical and electrical engineering will commence on Sept. 22, and full time sessional day ocurses in engineering and technical optics will commence on Sept. 29. The laboratories are well equipped, and the electrical apparatus provides for specialisation in a.c. and c.c. work, radio-telegraphy and telephony, and electrical testing.

At the Royal Technical College, Glasgow, enrolment for the day courses commences on Sept. 23. The courses of instruction extend over three years and qualify for graduation in Glasgow University. The diploma of the college is granted to students who complete satisfactorily the prescribed courses, and the associateship to those who satisfy certain additional requirements. Instruction is given in civil, mechanical, electrical and mining engineering, chemistry, metallurgy, naval architecture, &c. The evening classes in science and technology are carried on not only in Glasgow, but at numerous centres throughout the west of Scotland.

Tenders Invited and Accepted.

Keighley Guardians want tenders for supply of electrical sundries. Particulars from the Clerk until Sept. 17.

Atherton Urban Council invites tenders (by Sept. 18) for one boiler plate cubicle equipped with instruments, bus bars, sweating sockets, &c. Tenders to the Clerk.

Brighton Guardians require tenders by 10 a.m. Sept. 16 for three month's supply of Electrical Fittings, &c. Forms of tender from the Clerk, Prince's-street, Brighton.

Southend Corporation require tenders for the supply of about 150 tons of Sandberg Tramrails. Specifications from the Borough Engineer and tenders to Town Clerk by Sept. 15.

Westminster Guardians want tenders by noon Sept. 17 for the supply of electric lamps, fittings, &c. Forms of tender from the Clerk, Princes-row, Buckingham Palace-road, London, S.W.1.

The West Ham Guardians require tenders by 10 a.m. Sept. 25 for six months' supply of electrical fittings, ironmongery, oils, colours, &c. Forms of tender from the Clerk, Board Room, Union-road, Leytonstone.

Portsmouth Tramways Committee invite tenders for supply of 3,000 tons steel girder tram-rails, 180 tons fish-plates, 40 tons fish-bolts and 85 tons w.-i. tie-bars. Specifications from the Engineer and tenders to the Town Clerk by Sept. 16.

Manchester Electricity Committee require tenders by 10 a.m. Sept. 23 for the supply and erection of two 250 k.v.a. and two 500 k.v.a. three-phase static transformers. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester. Particulars from the Chief Engineer and Manager.

Bradford Corporation require tenders by 10 a.m. Oct. 9 for the supply and erection of (contract R.117) two 1,500 kw. rotary converters (R. 118), induced draught plant and chimney (R. 119), three economisers. Specifications, &c., from Mr. Thos. Roles, city electrical engineer and manager.

West Ham Council require tenders by Sept 23 for supply and erection of (1) one 10,000 kw. turbo-alternator, (2) one 10,000 kw. surface condensing plant, and (3) two water-tube boilers, superheaters and stokers. Specification, &c., from Mr. Fredk. W. Purse, engineer and manager, 84 and 86, Romford-road, Stratford, E. 15.

Grimsby Corporation invite tenders for the supply and erection of two 1,000 kw. converters and c.c. and a.c. l.t. switchgear, e.h.t. switchgear and cables ; coal and ash-handling plant and a 30-ton electrically-driven travelling crane. Specifications from the borough electrical engineer, Lieut.-Col. W. A. Vignoles, and tenders by Sept. 25

The Lahore Electric Supply Company, Ltd., Lahore (India), invite tenders for two 1,000 kw. and two 500 kw. three-phase turbo-alternators, main and auxiliary control gear, crane, transformers, &c. ; water-tube boilers, overhead coal bunkers, conveyer, mechanical stokers, feed pump pumps, economiser, condensing plant, piping, sub-station plant (10 motor-generator sets, 10 balancers, control gear, &c.), overhead and underground h.t. ring feeder main and l.t. distributor mains. Specifications from the General Manager.

King's Lynn Council has placed orders with E. Green & Son for an economiser, and with W. Boby & Son for water-softening plant.

Tuam Town Commissioners have accepted the tender of the Tuam Electric Light & Power Company for lighting the town, at £110 per annum.

Sunderland Electricity Committee has accepted the tenders of Ferranti, Ltd., for house service meters, and Armstrong, Addison & Company, for creosoted wood capping.

Heston and Isleworth Urban Council has accepted the tender of the General Electric Company (at £7,925) for the supply of a 500 kw. rotary converter and transformer and cable work.

Bradford Council have accepted the following tenders : Babcock & Wilcox, Ltd., three water-tube boilers, superheaters, stokers, &c. ; Peter Brotherhood, Ltd., one cooling tower and chimney for existing cooling stack.

Johannesburg Municipal Council has ordered supplies of metal filament lamps from the Griffin Engineering Company, Hubert Davies & Company, the British General Electric Co., South African General Electric Company, Robertson & Moss, and British Westinghouse Co.

Cape Town Corporation has placed an order with the General Electric Company of America for electrical plant at £28,278. Several tenders were received from British firms, and the difference of price in favour of America was not considered material. The plant was, however, urgently required, and British tenderers were unable to offer as early delivery as their American competitors.

Appointments Vacant and Filled.

A tramways manager is required for the tramways in the boroughs of Stockton and Thornaby-on-Tees. Applications to the Town Clerk, Borough Hall, Stockton-on-Tees, by Sept. 27.

The London County Council requires a rolling-stock engineer, a permanent way engineer, an assistant electrical engineer, a traffic operation superintendent, a traffic statistics assistant, a publicity assistant and two sub-station superintendents. Applications to Clerk by 4 p.m. Sept. 25.

The East Ham Education Council invite applications for the posts of instructors of telegraphy and telephony. Forms of application from the Principal, Technical College, East Ham, E.6.

A meter superintendent is required for the electricity department of Dundee Corporation. Applications to the City Electrical Engineer.

The Yorkshire Electric Power Company require a control engineer to assist in the control of the company's system outside the generating stations. Applications to Box 34, G.P.O., Dewsbury.

A lecturer and demonstrator in physics is required for the South Western Polytechnic Institute, Chelsea, London, S.W.3. Salary £225 to £315, rising to £440 per annum. Applications by Sept. 13.

Lecturers in physics and metallurgy are required at the Sir John Cass Technical Institute. Salary £315, rising to £440 per annum. Applications to the Principal, Jewry-street, Aldgate, London, E.C.3, by Sept. 13.

A chief lecturer in electrical engineering is required at West Ham Municipal Technical Institute. Salary £250—£10—£400 per annum. Applications to the Principal, Romford-road, Stratford, E. 15.

A senior lecturer in electrical engineering is required for the South Wales and Monmouthshire School of Mines, Treforest. Salary £450–£600. Further particulars from the Principal and applications by Sept. 23.

A wiring superintendent is required in the London County Council tramways dept. Pay 80s. rising to 90s. a week, with temporary war wages of 20 per cent. plus £90 a year. Applications to the General Manager, 23, Belvedere-road, Lambeth, S.E. 1, by Sept. 29.

The Civil Service Commissioners announce that an examination will begin on the 28th prox. for filling vacancies as Assistant Examiners in the Patent Office. The examination will be confined in the main to candidates who have served in H.M. Forces, and will consist of a qualifying examination followed by interview by a Selection Board. The subjects of the qualifying examination are English composition, précis writing, general knowledge and *one* of the following : General chemistry, electricity and magnetism, mechanics and mechanism. The limits of age are 20-30, Initial salary, £150 a year together with a war bonus. Copies of the regulations and forms of application may be obtained from the Secretary, Civil Service Commission, Burlington-gardens, London, W. 1. The last day for making application is Sept. 18.

Mr. G. B. Dent, of Northampton, has been appointed charge engineer at Torquay at £220 per annum.

Mr. J. N. Martin, of Newcastle West, has been appointed engineer to the new electric supply undertaking of the Nenagh Gas Company.

The Governors of the Loughborough Technical College have made the following appointments as from the commencement of the autumn session : Lecturer in mathematics, Mr. T. Stuart, M.A., D.Sc., formerly professor in mathematics, University of Hong Kong ; lecturer in mechanical engineering, Mr. G. Mavor, formerly lecturer in mechanical engineering at the Gillingham Technical Institute. The Governors, after interviewing several candidates for the position of lecturer in electrical engineering, have decided to re-advertise the appointment at a higher commencing salary—*i.e.*, £350, rising by increments of £25 to £400.

Business Items.

The Board of Trade Timber Supply Department, Scotland, have some electric lighting plant for sale. Offers to the Executive Officer, Timber Supply Department, 1, Queen-street, Edinburgh, by Sept. 20.

Tenders are invited for two parcels of tungsten wire which is being sold by order of the Prize Court. Forms of tender, &c., from the brokers (Messrs. Morrison, Kekewich & Company), 270, Gresham House, Old Broad-street, E.C.2, and tenders to the Admiralty Marshal, Royal Courts of Justice, Strand, London, W.C.2, by noon Sept. 22.

The London Electric Stores, wholesale suppliers and exporters of electrical plant and stores, of Fulwood House, High Holborn, London, W.C.1, have recently issued a list giving prices and particulars of their d.c. and a.c. motors, starters, &c. Quick delivery is promised, and all parts are interchangeable.

Messrs. H. S. B. Brindley and E. T. Elbourne have opened offices at 110, Victoria-street, London, S.W.1, where they will practice as consulting engineers, especially in regard to factory reorganisation, with particular reference to production, efficiency and co-ordination with labour.

A stock list has been issued by Messrs. Higgs Bros., Sand Pits, Birmingham, giving particulars of the electric motors and dynamos manufactured by them. The firm, who intend to develop the list into a magazine, will send copies on request.

The Remco Carbon Company, of Gravesend, has recently issued its catalogue of Remco resistances, carbons, &c. Remco is a non-metallic material resembling artificial stone ; it can be made in block from of great mechanical adaptability and moulded to any shape. Elements have been standardised for wireless telegraphy and telephony, motor starters, regulators, dimmers, &c., so that any desired resistance can be built up. We are informed that large quantities of these resistances were used for war work, especially in connection with wireless telegraphy.

The General Electric Company, Ltd., 67, Queen Victoria-street, London, E.C.4, have recently issued a revised list of the "Freezor" fan section of their catalogue, so as to bring it into line with prevailing conditions. We have recently given some particulars of this fan. The company are holding stocks, and are able to give immediate delivery of the more standard lines, whilst their manufacturing facilities for the production of the remainder are being speeded up.

Birmingham electric supply department has for sale a new rubber and canvas conveyor belt, 443 ft. long and 24 in. wide. Offers to the Secretary, 14, Dale End, Birmingham.

Mr. E. Balinford, formerly assistant to the superintendent of the station construction dept. of the Yorkshire Electric Power Company, has joined the staff of Messrs. Thorp & Atkinson, consulting engineers, Leeds.

Companies' Reports, &c.

A dividend of 2 per cent. has been declared by the AMERICAN TELEPHONE & TELEGRAPH COMPANY for the past quarter.

The directors of the CLYDE VALLEY ELECTRICAL POWER COMPANY recommend an interim dividend of 2 per cent. actual on the ordinary shares.

The directors of STOTHERT & PITT, LTD. propose to pay a dividend of 12½ per cent. £4,000 is being placed to reserve, and after provision for writing off premises and for pension fund and war memorial, £12,959 is carried forward.

The directors of the MADRAS ELECTRIC TRAMWAYS (1904), LTD., have declared the following interim dividends in respect of the current year, namely: On the preference shares 6 per cent. per annum (less tax), and on the ordinary shares 8 per cent. per annum, tax free.

The accounts of the KALGOORLIE ELECTRIC TRAMWAYS, LTD. for 1918 show that after providing for interest and sinking fund on "A" debenture stock and charging interest on the "B" debenture stock, the debit balance of £30,519 brought down was further increased to £36,519.

The report of the directors of the BRAZILIAN TRACTION, LIGHT & POWER COMPANY, LTD., for 1918 shows revenue under contracts with subsidiary companies (the Rio de Janeiro Tramways, Light & Power Company, the San Paulo Tramway, Light & Power Company and the San Paulo Electric Company) $6,122,412, and after adding interest on investments and deducting general and legal expenses and interest, &c., on loans, amortisation reserve and four dividends of 1½ per cent. each on preference shares, a surplus of $4,569,672 is carried forward. The gross earnings of the subsidiary companies were $101,894,163 (compared with $92,200,309 in 1917).

At the half-yearly meeting of the BISHOP'S STORTFORD, HARLOW & EPPING GAS & ELECTRICITY COMPANY the chairman (Mr. E. L. Burton) announced that the company was ready to commence the supply of electricity, as the technical assistant had returned to his work after putting in several years of service with the Naval Forces. He feared they would be compelled to charge at least 1s. per unit. They expected to be in a position shortly to make a definite statement on the subject. He said "the directors realised that electricity was not the necessity that gas was and with both gas and electricity up in price, there was not much temptation to those not keen on electricity to take it."

The report of the VICTORIA FALLS & TRANSVAAL POWER COMPANY for 1918 states that, after providing for interest, premium and expenses on debentures (£229,715) and for depreciation and income tax, &c. (£410,844) the net profit is £224,128, and with £97,691 brought forward the total is £321,819. The directors have transferred £50,000 to reserve, and declared two dividends, each of 3 per cent. (less tax) on the preference shares for the year, leaving £186,318. On June last the directors declared a dividend of 5 per cent. on the ordinary shares, and as the preference shares are entitled to share pro rata with the ordinary shares in the surplus profits distributed until the preferece shares have received a total dividend of 10 per cent, for the year in respect of which the distribution is made, the directors declared a further and final dividend of 4 per cent. (less tax) on the preference shares. These dividends absorbed £92,624, leaving £93,693, which will be carried forward.

New Companies.

ACME ELECTRIC TRACTION COMPANY, LTD. (158,400).—Private company. Reg. Sept. 1, capital £20,000 in £1 shares, to take over business carried on at Acme Works, 688, 700 & 702, Seven Sisters-road, Tottenham, N., as the Acme Electric Traction Company, and to carry on the business of armature winders, winders of all electrical apparatus, electrical and mechanical engineers, &c. First directors: F. W. Francombe, J. G. Francombe and A. Hutchings. Reg. office, 700 & 702, Seven Sisters-road, Tottenham, N.

CLARK'S NEO-ELECTRIC DEVICES, LTD. (158,199).—Private company, reg. Aug. 23, capital £1,012 10s. in 1,000 ordinary shares of £1 each and 250 deferred shares of 1s. each, to carry on the business of civil, mechanical, electrical, hydraulic and general engineers, &c. Reg. office: 9, St. Helens-place, E.C.

CRAVENS, LTD. (158,475).—Private company. Reg. Sept. 3, capital £10,000 in £1 shares, to carry on the business of contractors for construction and equipment of railways and tramways, manufacturers of rolling stock, plant, machinery, rails, signalling apparatus, &c. Solicitors, Walbrook & Hosken, 4, St. Paul's Churchyard, E.C.

CUTHBERT JONES CURTIS & COMPANY, LTD. (158,159).—Private company, reg. Aug. 22, capital £5,000 in £1 shares. Objects: to take over the business carried on by C. Jones and J. Curtis, as power engineers and contractors, at 2, Mount-street, Manchester, as "Cuthbert Jones Curtis & Company." First directors are Cuthbert Jones, J. Curtis, J. W. Baron and J. T. Parker.

FAIRLESS ENGINEERING SUPPLIES COMPANY, LTD. (158,316).—Private company, reg. Aug. 28, capital £8,000 in £1 shares, to take over the business of engineers carried on by G. P. Fairless and W. T. Hill at Stockton and Thornaby as the "Engineering Supplies Company," and to carry on the business of mechanical and electrical engineers, manufacturers of machinery, tool makers, &c. First directors are G. P. Fairless (managing) and W. T. Hill (both permanent). Secretary, G. P. Fairless.

HOBART MFG. COMPANY, LTD. (158,412).—Private company. Reg. Sept. 1, capital £75,000 in £1 shares, to take over business carried on by Hobart Mfg. Company at Hobart House, Charterhouse-street, E.C., and to carry on business of manufacturers of and dealers in electrical food-preparing machinery and accessories, &c. First directors: J. M. Spencer and F. H. Wright. Reg. office, 401-3, Birkbeck-chambers, W.C. (1).

J. A. COOMES & COMPANY, LTD. (158,508).—Private company. Reg. Sept. 4, capital £2,000 in 1,400 ordinary shares of £1 each and 6,000 deferred shares of 2s. each. To carry on the business of mechanical and electrical engineers and scientific instrument makers. First directors: A. W. Ettridge (chairman), J. A. Coomes and J. E. Kershaw. Reg. office, 95, Plashet-grove, East Ham, E.6.

J. A. STEVENS, LTD. (158,314).—Private company. Reg. Sept. 1, capital £1,000 in £1 shares, to carry on business of mechanical and electrical engineers, manufacturers of and dealers in railway, tramway, electric, magnetic, galvanic and other apparatus, &c. Solicitor, F Purchase, 14, Regent-street, S.W.

A. LIPPOLD, LTD. (158,466).—Private company. Reg. Sept. 3, capital £1,000 in £1 shares, to carry on the business of consulting, civil, mechanical, electrical, constructional, ventilating, heating and general engineers, &c. First directors: A. A. Lippold and D. B. Jones. Reg. office, 1A, Montford-place, Kennington-road, S.E.11.

T. W. JEFFERSON, LTD. (158,550.)—Private company; reg. Sept. 5, capital £10,000 in £1 shares, to take over business of electrical engineers and contractors carried on as "T. W. Jefferson," at Birkenhead. First managing director, T. W. Jefferson.

VICKERS-CHINA, LTD. (158,463).—Private company. Reg. Sept. 2, capital £10,000 in £1 shares, to carry on the business of steel, iron, brass and metal manufacturers and dealers, shipbuilders, electrical engineers, &c. Reg. office, Vickers House, Broadway, Westminster, S.W.

WARD & COMPANY (DEWSBURY), LTD. (158,233.)—Private company, reg. Aug. 25, capital £10,000 in £1 shares, to carry on the business of motor, mechanical, electrical and general engineers, &c. First directors are H. Ward, J. H. Ward and C. E. Wood. Secretary, C. E. Wood. Reg. office: Brewery-lane, Thornhill Lees, Dewsbury.

Prices of Metals, Chemicals, &c.

		TUESDAY, Sept. 9. Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£109 0 0	—	£1
Electrolytic bars ...	,,	£120 0 0	—	—
H.C. wire, basis ...	per lb.	1s. 3$\frac{15}{16}$d.	—	—
Sheet	per lb.	1s. 3⅝d.	$\frac{1}{16}$d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	per lb.	1s. 7$\frac{15}{16}$d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 10⅞d.	$\frac{1}{16}$d.	—
Sheet, basis	,,	1s. 2⅜d.	—	—
Wire, basis	,,	1s. 2¼d.	—	—
Pig Iron—				
Cleveland warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	£33 10 0	—	—
Lead Pig—				
English	,,	26 5 0	5s. 0d.	—
Foreign or colonial	,,	25 2 6	2s. 6d.	—
Tin—Ingot	,,	283 0 0	7 0 0	—
Wire, basis	per lb.	0 3 6	1d.	—

Salammoniac.—Per cwt. 80s. and 75s.
Sulphur (Flowers).—Per ton £23.
,, (Roll Brimstone).—Per ton £21.
Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £43.
Boric Acid (Crystals).—Per ton, £72.
Carbon Bisulphide.—Per ton £55.
Sodium Bichromate.—Per lb. 11d.
Sodium Chlorate.—Per lb. 6¾d.

Shellac.—485s. October delivery 475s.

Rubber.—Para fine, 2s. 5¾d.; plantation 1st. latex 2s. 1¾d. lb

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W.T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Sept. 9, 1882.]

MR. PENDER.—Mr. John Pender, M.P., is now on a visit to the United States. The fact of his having paid a visit to Mr. Jay Gould has, of course, given rise to all kinds of absurd rumours.

PILSON, JOEL & GENERAL ELECTRIC LIGHT COMPANY.—The first ordinary meeting of this company will be held at Cannon-street Hotel, E.C., on the 11th inst., at 2 p.m., after which an extraordinary meeting will be held to pass resolutions altering the articles of association.

THE METEOROLOGICAL STATIONS AT THE POLES.—It is stated that the new Norwegian meteorological station at Bosekop, on the Alten Fiord, established in accordance with the arrangements of the International Polar Commission, commenced operations on the 18th of August. Great magnetic perturbations are said to have been observed during the night.

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Notes.

Municipal versus Company Supply.

IT might not be waste of time if the various parties interested in the Electricity Supply Bill would make use of this summer interval of leisure between the sittings of Committee B to moralise for a moment on the ten days' sittings which have taken place. One very apparent feature in the series of sittings was the increasing warmth displayed in the speeches of the members. The proceedings started off in a calm and judicial tone, as befitted the matter in hand, but after proceeding some little time the warmth of feeling seemed to rise in a kind of geometrical progression, until in the last day or so it had reached its apogee in something very much like direct personalities. This warmth of feeling coincided with an increasing emphasis of demarcation between two parties, namely the Company and Municipal sections. It is immensely to be regretted that what should be now an obsolete controversy has been imported into the present deliberations. There seemed no need whatever for the present Bill to be discussed under these battered party watchwords. In no case has it been a question between a company and a municipality. The municipalities and companies are both in the same box and both subsumed under a national scheme which regards all the undertakings indifferently from this point of view. The Company (distributing) undertakings under the scheme will remain Company, and the Municipal will remain Municipal, and there is nothing in the Bill to set them by the ears. A minute's moralising, therefore, in the present lull would not be amiss if it checks this futile and out-of-date antagonism. There are a good many important points still to be settled on the Bill, and certainly each party might do worse than reflect whether some change of tone, if not of policy, might not conduce to their mutual benefit. Further, when the Bill is passed and the practical schemes are actually afoot, municipalities and companies must perforce in many cases go into harness together as a "joint electricity authority," and if this present antagonism continues it will not augur very well for the smooth formation of such subordinate schemes. In the present instance the actual belligerents are, of course, members of Parliament; yet some little warmth has been reflected from the outside. Both sides have undoubtedly contributed their quota, but certain of the municipalities, perhaps, lead the way in one or two of their reports where the engineers, perhaps somewhat incautiously and unnecessarily, entered into the region of abstract politics. However, in the forthcoming session it is to be hoped that the decision on each question considered, whether it affects municipalities or companies will be arrived at by common consent and not by party tussle.

The Electrical Development Association.

THE usual counterpart to the formation of any institution that is to be of value is the demand for financial support, and generally this is required on a large scale if the results are to be of value. Those who are asked to help in this burden usually ask themselves whether they will gain any direct benefit. This is probably the case at the present time with the Electrical Development Association, which is now formally inviting supply undertakings (both private and municipal), manufacturers and contractors, to become members of the Association and to subscribe to its funds. When, however, the question of direct benefit is raised by the hesitating potential subscriber, we feel that he is making a mistake. Although he may not see an immediate direct benefit, there is certain to be an indirect advantage to him by the stimulus which must follow the energetic efforts of a suitable organisation like the Electrical Development Association. We therefore suggest that all who are invited to subscribe should look upon the broad issues rather than upon the narrow benefits. We are glad to hear that, although only a beginning has so far been made, the replies have been numerous and satisfactory. Those who are in a state of hesitation should communicate with the director, Mr. J. W. BEAUCHAMP, who we feel sure will deal with such questions in a sympathetic manner, and will doubtless show why the new Association should be loyally supported.

Trades Union Congress.

As was to be expected, there was a great deal of straight talking at the Trades Union Congress last week, and as a result it may, we think, be said that the labour situation is in some respects more satisfactory. There were, of course, two points which overshadowed all others under discussion—namely, nationalisation and "direct action." Very naturally, both policies suggested by these two terms are popular with a large proportion of trade unionists, more particularly those of the younger generation. Under these circumstances, it requires very considerable courage for responsible leaders who disagree with such methods to speak in opposition to them. The far easier course is one of silence. Mr. HAVELOCK WILSON was the only leader who had the courage to speak against nationalisation. He emphasised the hopelessness of progress in such an industry if managed by the State. Nevertheless, there was an overwhelming majority in favour of this policy, and we do not doubt that the demand will be continued, not merely in regard to the coal mining industry, which is the immediate objective, but also with regard to many other industries. Unfortunately, it is difficult to bring forward arguments which carry conviction to the rank and file in a question of this kind. This is much more easy when it comes to a policy such as "direct action," or the use of force to secure what is considered desirable by a certain minority. Here the fatal effects may be demonstrated more easily, and thus we have strong speeches by Mr. TOM SHAW on Bolshevism and by Mr. J. R. CLYNES upon the danger of the Labour party endorsing such methods when they may in the near future have the government of the country in their hands. Nevertheless, the question was merely shelved, which must be considered as a weak conclusion to such a debate and a virtual triumph for those who advocate this fatal policy.

The Patent Office Library.

Now that the war is over we sincerely hope that the authorities will, as soon as possible, restore the pre-war period during which the library could be visited—namely, from 10 a.m. to 10 p.m. We understand that a belated concession is now to be made by extending the closing hour to 8 p.m., instead of 5 p.m., the time at which the library has closed during the war. We have always considered that the curtailing of the hours available for work at this library, even during the war, was a mistaken measure of economy. The Patent Office Library is in some respects unique in the variety of publications available, and (before the war) in the fact that it was available during the evening hours, the only period when most people in a position to profit by the library are free to spend time therein. The matter is discussed by a correspondent in "Engineering." He points out one, at first sight, curious but really quite easily explained fact—namely, that in pre-war days there was usually a temporary rush just about 6 p.m., followed by a period when the library was almost deserted until 8 p.m. From 8 p.m. to 10 p.m. the attendance again increased. The natural explanation would be that many people take their evening meal in the 6 to 8 period; but the later hours are most valuable for evening study. It seems likely, therefore, that after the extension from 5 p.m. to 8 p.m. is introduced the attendance from 6 to 8 p.m. may be found relatively small, and it is possible that the authorities will then draw the conclusion that the extension was uneconomical, and will point to this small attendance as justifying their action in closing the library after 5 p.m. This view would, however, ignore the fact that the valuable period—8 to 10 p.m.—has been omitted. Apart from this, we do not think that mere numerical attendance is a good criterion of the usefulness of a library of this kind. One can never tell how the seed of invention and discovery may develop, and who knows but that the authorities, by excluding some student or scientist during evening hours may cause him to miss the essential link in some process of discovery, and so lose the nation a valuable invention!

Railway Electrification in France.—The French Ministry of Public Works is considering the question of adopting electric traction on the French railways. In the preliminary report of the Commission recently sent to America to study railway electrification the use of the h.t.d.c. system, as employed on the Chicago, Milwaukee and St. Paul—at 3,000 volts—is recommended. The Chicago-St. Paul railway is a 440-mile standard line, handling heavy fast passenger trains and general traffic, the yards having also been converted.

Steel Structures.—In "Steel Structures," the quarterly journal of the British Engineers' Association for July, some striking examples are given of the use of steel frameworks in buildings for export. Among the buildings so treated are bungalows and warehouses, one of the latter being an imposing structure of great height, itself intended for iron and steel storage. The exceptional height is here necessitated by the great headroom for locomotive jib cranes used in handling steel inside the building. Other extensive operations in building and repairing steel bridges are also illustrated. It is natural to find that the tendency towards standardisation, which is now general, is having a great influence on steel constructions.

Federation of Technical and Scientific Professional Associations.—A meeting of the Federation of Technical & Scientific Associations was held in London on the 6th inst., to which kindred Associations had been invited to send representatives. Fourteen Associations were present, representing the interests of about 50,000 professional officers and servants. The meeting was presided over by Mr. A. C. J. Charlier, the president of the Federation. The draft proposals for the constitution of the Federation were considered. It was agreed that all duly qualified bodies as shall accept the constitution and adhere to the Federation by the date of the next meeting, viz., October 18, 1919, shall be considered original members of the Federation. It was also decided to form Group Committees for each professional interest represented to advise the Federal Council. At the conclusion of the meeting the representatives of the British Association of Chemists announced their intention to join the Federation, and Mr. N. Wyld intimated that the Society of Technical Engineers would probably become members.

Electrical Equipment of Textile Mills.—The "Electrical World" mentions an interesting instance of the tendency towards the complete conversion of textile mills to electrical equipment. This mill, at Cohoes, in the State of New York, started 80 years ago. Yet the old motive power equipment remained substantially the same until 1911, when improved water wheels were added, two of them coupled to electric generators, and a steam-electric auxiliary was added to help in times of low water. Four years later, however, the Cohoes Power Company installed a 30,000 kw. hydro-electric plant, and the water wheels were then abandoned, and the whole equipment run from purchased power. Up-to-date driving from 100 H.P. motors was introduced, and a power factor of 85 per cent. (very good for induction motors) was attained. It is interesting to see an old water-power mill passing first to electric drive in part, and then taking the further step of relying exclusively on transmitted power. One by one the old mills that used to cluster round water-powers have abandoned the older practice, and electric drive is now becoming general.

Effect of Pressure on the Intensity of Sound from Organ Pipes.—In the "Physical Review" Miss B. F. Love and Miss M. K. Dawson describes some interesting experiments upon organ pipes and other wind-blown instruments, the chief problem attacked being the relation between the blowing pressure and the intensity and pitch of the sound. The intensities of sound emitted by a tone-variator and an organ pipe were measured by a Rayleigh resonator, the blowing pressure being recorded on a water manometer. The experiments showed that the intensity of sound is apparently directly proportional to the blowing pressure. It appears also that the pitch rises somewhat with increased pressure, which suggests the desirability of calibrating such instruments for a given pressure and adhering to the range of pressures decided upon. The general results appear to be in harmony with theoretical considerations and confirm the impression that only a portion of the energy of the air emerges in the form of sound, though the proportion usefully employed is not stated. Such researches have obvious practical importance for the design of wind-instruments, and there seems room for much further experiment on these lines.

Representation of Colour in Lantern Slides.—Of all the methods of illustrating lectures lantern slides are the most usual and popular, and for black and white work leave little to be desired. The preparation of lantern slides in colour is, however, difficult. By hand-painting one can only secure the crudest washes, while if natural colour photography is employed there are various difficulties, such as the interference of the grain with very fine line work and the loss in brilliancy through absorption. A method of colouring, described by Mr. A. E. Bawtree before the Physical Society, and summarised in the most recent issue of its "Proceedings," therefore deserves notice. It is based on the production of the image in a fine colloid film on glass, and a range of dyes and mordants has been selected by the aid of which practically any shade of colour can be obtained. In addition images in different colours can be superimposed, and coloured mosaics can be produced to illustrate additive colours in optical experiments. Another possible application of the processes seems to possess special interest. If a screen of lines ruled in alternate red and green of, say, 250 lines to the square inch have projected upon it by means of a lens an image of a screen of similar ruling but in alternate black and white, the former screen will appear to change colour with a very small movement of the latter of, say, 1/250 in. Thus a small lateral movement can be demonstrated before quite a large audience. It is suggested that the method would be very useful in illustrating very small pressures and elongations, such as the effect of hydrostatic pressure or the behaviour of a rod under tension or compression or under the action of heat.

Effect of Yellow Light on the Eye.—There has long existed an impression that light from the red and yellow end of the spectrum is more agreeable to the eye than the blue and green rays, or at any rate that illuminants which are relatively rich in the yellow and orange rays are more agreeable than those which have a somewhat greenish or blueish tint. Thus, the light of the oil lamp is still preferred by some to that of a metal filament lamp, and the light of the latter to that of the still whiter gas-filled lamp. But how far there is any justification for this impression, or whether it is merely a whim based on preference for what is familiar, it is hard to say. It is interesting to note that some experiments of Dr. Feree and Miss Rand, summarised in recent "Transactions" of the American Illuminating Engineering Society, rather support this preference for yellow light. Their experiments apparently showed that the "efficiency of the eye" during a three-hour test diminished more rapidly with light from the metal filament lamp than when a kerosene oil lamp was used, the intensity of illumination being the same in both cases. More recent experiments on a series of incandescent mantles with graded uria content and yielding light of progressively warmer tint led to a similar result. The crux of such experiments, however, is the method of defining the "efficiency of the eye." The methods used by the authors is based on observation of the ratio of time during which type steadily observed appears respectively clear and blurred, and we imagine that the interpretation of this phenomenon would furnish ground for some discussion by physiologists.

The Standardisation of Lighting Methods.—The "Illuminating Engineer" comments upon the natural tendency towards the standardisation of lighting methods: a tendency which has been favoured in the United States by the development of "codes" of lighting in New York, New Jersey, Pennsylvania and elsewhere. For such work we agree that there is much to be said for standardisation. It is, for example, helpful to be able to predict the illumination which can be anticipated with a certain arrangement of lamps, equipped with a standard type of reflector, but the accuracy of such determinations is, of course, dependent upon close adherence by the manufacturers to the standards proposed. Attention has been drawn, for example, to the variations in polar curves caused by differences in the relative position of lamp filament and reflector. As the lighting expert, in all his calculations, primarily rests his assumptions on the polar curve, it is vital that this should be trustworthy. For industrial work standardisation has, perhaps, as good a chance as any. We think, however, that it should be recognised that standards of illumination for different operations are necessarily subject to revision. While illumination photometry has yielded much useful information on this point we are hardly as yet in a position to lay down hard and fast standards. Recent experience gives indications that an increase in illumination may lead to improvements in output, even when carried far beyond customary values. There is, in fact, a tendency for such standards to be continually raised as efficiency and economy in lighting improve, and experience seems to show that hitherto values have been controlled more by considerations of economy than by a final judgment of the amount of illumination really needed by the work. Hence the need for revision from time to time.

Absolute Measurement of Sound.—This fascinating problem has received a considerable amount of attention from various workers in the United States, and the account of the researches of Mr. A. G. Webster, summarised in a recent issue of the "Proceedings" of the American Institute of Electrical Engineers, certainly adds to our knowledge of the subject. The problem resolves itself into two: The provision of a standard source of sound (the "phone") and of an apparatus for satisfactorily measuring its intensity (the "Phonometer"). The author explains how his standard source was constructed with a tunable diaphragm, the tone being adjusted by altering the volume resonator and the tension of the attaching wires. The material for the membrane in phone and phonometer received much study. Paper is unsatisfactory, because of lack of permanence; with metal the tension is unduly altered by thermal expansion; and with thin glass temperature also affected the pitch. Mica seems to have given the best results. It is interesting to note that quartz is the substance recommended for tuning forks. The operation of a diaphragm depends on its mass, stiffness and damping, and the latter, in particular, was subjected to exhaustive experiment, and was ultimately vastly reduced. In the early experiments observations were made on paper diaphragms with a glass plane mirror attached, and the fringes of Newton's rings produced by contact with a lens were observed. Ultimately the Michelson interferometer was substituted, thus avoiding the inconvenient lens. The lateral displacement was observed through the objective of a telescope attached to a tuning fork. The device thus appears highly complicated; but the author appears to have reached his aim of expressing results absolutely in terms of amplitude of pressure variation measured in dynes per square centimetre, and of expressing sound output directly in watts. One curious complexity met with in sound measurements is the fact that there is invariably some degree of reflection from surrounding objects. Thus, it is stated that in some experiments the coefficient of reflection for grass and gravel surfaces attained 95 per cent. The whole question is of great scientific interest, and its practical bearing has already been demonstrated by experiments on fog sirens, &c.

Arrangements for the Week.

FRIDAY, Sept. 19th (to day).

IRON AND STEEL INSTITUTE.

10 a.m. Papers to be read on "Synthetic Cast Iron," by Mr. C. A. Keller; "The Fluxing Action of Iron Oxides on Acid Furnace Structures," by Mr. J. H. Whiteley and Mr. A. F. Hallimond; and "On the Woody Structure of the Fractures of Transverse Test Pieces from Special Steels," by Mr. J. J. Cohade.

2.30 p.m. Papers to be read: "Nickel-Chrome Forgings," by Messrs. J. H. Andrew, J. N. Greenwood and G. W. Green; "Brittleness in Nickel-Chrome and other Steels," by Mr. F. Rogers· "Temper Brittleness of Nickel-Chrome Steel," by Mr. R. H. Greaves; "Experiments with Nickel-Steels," by Mr. N. Hudson; and "On the Cause of Irreversibility in Nickel-Steels," by Mr. K. Honda and Mr. H. Takagi.

The Three-Electrode Thermionic Valve as an Alternating Current Generator.*

By Prof. C. L. FORTESCUE.

1. Introductory.

This Paper deals mainly with work done during the war in the W/T Department of H.M. Signal School, at Portsmouth, which constitutes the instructional and experimental centre for all matters pertaining to Naval Wireless Telegraphy. The Paper has been prepared in collaboration with the Superintendent of Signal Schools and his staff, has been submitted to the Admiralty, and is now published with the Board's approval.

Thermionic waves were used in the Naval Service for the generation of high-frequency currents of small amplitude for reception by the "heterodyne," or beat method in 1914. De Forest's "audion" valves were used, and the circuits were made up from existing Naval Service apparatus. Later sets used for the same purpose were made by the Marconi Company, the valves employed being those designed by Capt. H. J. Round. In both cases the maximum high-frequency current was in the neighbourhood of 50 milliamperes.

During the spring of 1915 experiments were carried out with a transmitting valve of Capt. Round's design. This valve was of the same general construction as those used with the small heterodyne sets. The filament consisted of a fine platinum wire coated with lime; the grid was made of nickel wire gauze; and a nickel positive electrode was supported by its natural springyness against the glass walls of the tube. The vacuum was not high and no appreciable bombardment of the electrodes was carried out during the exhausting process; this being impossible owing to the large positive electrode being in contact with the glass walls of the tube. With this tube a high-frequency power of from 40 to 50 watts could be obtained. Experiments under actual signalling conditions were carried out, and some surprisingly long ranges were obtained. On one occasion one of H.M. Destroyers received comfortably readable signals when off the coast of Northumberland, and when the high-frequency current in the aerial in H.M. "Vernon" at Portsmouth was only 0·6 amperes.

Considerable difficulties were, however, experienced on account of the lack of proper heat treatment of the valve in the course of the exhaustion, and the valves were not regarded as being sufficiently reliable to enable them to be used in ship installations.

At about this time the French too were experimenting with valve transmission, with a view to the development of wireless telephony.

Towards the end of 1915 some transmitting valves of the "Oscillion" type were obtained from America by the Admiralty. These valves were exhausted to a higher degree than the Marconi valves and gave correspondingly better results. But the uncertainty of the supply and the still far from perfect results obtained made it evident that the requirements of a Naval W/T set using transmitting valves could not yet be met.

In the spring of 1916 a "Pliotron" valve, made by the American General Electric Company, was purchased by the Admiralty for experimental work. This valve, which was similar in construction to those described in the "General Electric Review," of May, 1915, and September, 1916, had been very thoroughly exhausted. It was normally worked with the tungsten positive electrode at a bright red, or even yellow heat, and but for one small defect was probably the equal of any valve made up to the end of 1918. High-frequency currents of from 8 to 10 amperes were obtained in an aerial of about 5 ohms resistance, and with only about 2,000 volts available for the supply to the positive electrode. Had a higher voltage supply been available there is little doubt but that the high-frequency power generated could have been doubled.

On the only trial carried out for maximum range under signalling conditions, communication was established between H.M.S. "Vernon" at Portsmouth and H.M. W/T Station at Gibraltar. This was in June, 1916, and at the time was second in range obtained with an oscillating valve only to the famous wireless telephone trial between Arlington, U.S.A., and the Eiffel Tower.

It was recognised that although the Pliotron valves as then developed could not be manufactured on a scale sufficiently large to meet naval requirements; the elements of successful development were present and exhaustive trials and experiments were continued by the experimental W/T staff of H.M.S. "Vernon." The results of these experiments together with the information already published in the technical and scientific journals (principally American) enabled a fairly complete theory of the action of both the circuits and the transmitting valves to be worked out. This theory has formed the basis of all the subsequent designs.

Early in 1917 the first attempts were made to manufacture transmitting valves in this country to meet naval requirements. This attempt was undertaken by the General Electric Company at their lamp works at Hammersmith, in collaboration with the naval experimental W/T staff.

Previous to this, although the advantages of valve transmission were fully realised, there had been no demand for additional lines of communication, the requirements of which could not be met by the existing arc or spark installations; nor was there any demand for the replacement of the latter by valve transmitters. Consequently, although the necessary conditions were investigated as fully as possible, no earlier steps were taken to start British firms on the manufacture of the larger valves, their staffs being already fully engaged on war work.

By a fortunate coincidence, however, the construction of these valves just preceded an urgent demand from the Grand Fleet for a valve transmitting set. The designs were worked out and eight sets were put in hand in the W/T workshops in H.M.S. "Vernon." The first two of the sets were dispatched to the Grant Fleet on the night of Good Friday, 1917, within six weeks of the demand for the sets arising. Some two months elapsed during which lengthy trials were carried out. On the strength of these trials it was decided to fit similar sets in a considerable number of ships. Contracts were placed with various instrument-making firms, and within one month the first of these sets was on its way North, not complete in every detail certainly, but sufficiently complete for satisfactory service.

Meanwhile, numerous experiments were conducted by the W/T staff of the Admiral Commanding Reserves with Marconi valves installed in W/T stations located round the coast of the British Isles. These experiments gave useful information and showed that results could be obtained even with valves that were only partially exhausted. In particular they demonstrated the advantage of working with high voltages for the supply to the positive electrode.

The success of the first valve transmitting sets in the Grand Fleet led quickly to the demand for other sets of greater power. In the autumn of 1917 a larger set was designed to work from the power supply of existing spark apparatus. The trials of this set were carried out during the winter of 1917-1918, the details of the design being finished early in 1918. The apparatus was being fitted in ships as it became available throughout the whole of the summer of last year. To a great measure the success of this set was due to the type of aerial tuning inductance employed. This coil was designed by the W/T staff at Portsmouth primarily for use with Poulsen arc sets. The work previously carried out by this staff in connection with the design of inductances may be said, in fact, to have contributed more to the success of the valve sets than any other single item except, perhaps, the design of the valves themselves.

Whilst the parts of this more powerful set were being manufactured, yet higher power sets were being experimented with for use on board ship and in the Admiralty Shore Stations. Outputs and ranges almost equal to those of the smaller Poulsen arcs were obtained, and the many advantages of the valve transmitter pointed to the certainty of it replacing the arc in the near future for all purposes except in the very highest powered land stations.

Valve-transmitting sets also had their application in the other Services—the Army and the Air Force. The direction and the nature of these applications have already been described by Colonel Cusins, R.E., and by Major Erskine-Murray before the Wireless Section of the Institute of Electrical Engineers.

A similar development was, of course, also taking place in France and in America. Valves of very considerable power were being experimented with in France in 1917 under the direction of General Ferrié. In America the development was more in the direction of quantity production of relatively small power tubes for short range telegraphy and telephony work.

Wireless telegraphy and telephony do not constitute the only spheres of utility of the three-electrode valve as an alternating-current generator. For laboratory and testing purposes it is rapidly taking the place of all other sources of alternating current where frequencies above about 200 cycles per second are required.

The successful application of the valve transmitters to naval wireless was largely due to the valuable assistance of the following permanent and temporary members of the Naval Experimental W/T staff, viz., Messrs. W. A. Appleton, B. S. Gossling, H. A. Madge, H. Morris-Airey and C. M. Sleeman of Capt. J. A. Slee, C.B.E.,

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* Paper read before the British Association.

R.N., formerly on the staff of the Admiral Commanding Coastguard and Reserves; of Capt. H. J. Round, M.C., formerly attached to Army Signals, and of Dr. G. B. Bryan, the Assistant Professor of Physics, R.N. College, Greenwich.

2. The Action of the Three-Electrode Valve as an Alternating Current Generator.

The conditions necessary for a three-electrode valve to act as a generator of alternating currents have been investigated by others besides the workers at H.M. Signal School, Portsmouth, notably, Hazeltine* in the "Proc." Inst. Radio Engineers, has given a very complete investigation of the requirements. Vallauri† has also worked out the critical condition for a few particular cases. Recently, Eccles has shown before the Physical Society of London, a method of investigating the problem by a graphical method.

In the great majority of cases the valve is used in conjunction with an inductance and a capacity. In an electrical system, inductance plays the same part as inertia in a mechanical system. Capacity, on the other hand, is the analogue of the springyness or elasticity of a spiral spring or similar structure. A heavy weight suspended from a spring has properties closely analogous to a combination of an inductance and a condenser in an electrical circuit. A still closer analogy is that shown in Fig. 1.

The figure represents a spring controlled piston capable of moving in a cylinder. The two sides of the cylinder are connected together by a considerable length of large diameter piping, and the whole system is full of water. Normally the two springs *SS* maintain the piston in a central position. But as shown in the figure the piston is displaced from its normal position and is held there by means of the catch *Z*. If now *Z* is withdrawn the springs will tend to return the piston to the mid position. The piston will not take up this position instantaneously, however, because it has weight and therefore, inertia. But more important at the moment, the piston cannot reach the normal position except by moving a considerable quantity of water round through the piping from one side of the cylinder to the other. This water also has inertia. The actual result is that on the withdrawal of the catch *Z*, the piston starts moving towards the mid-position under the force exerted by the springs. The rate of movement of the piston and the water will gradually increase (so long as the pipes are of large diameter and give rise to relatively little friction), and when at last the piston does reach its normal mid-position, it and all the water in the pipes may have attained to quite a high speed. As a result of this velocity the inertia comes into play again and both water and piston overshoot the mid-position, coming to rest at a point considerably to the left of the centre in Fig. 1. The process is then reversed. The piston moves back to the right, over-runs the mid-position, finally coming to rest again somewhere near the position from which it was originally released by the withdrawal of the catch *Z*.

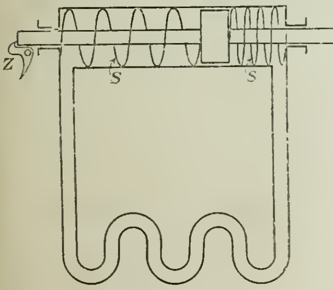

Fig. 1.

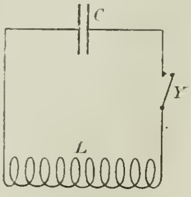

Fig. 2.

This process of oscillating to and fro may go on several times before the piston and the water ultimately come to rest. Each successive excursion to the left or right will be less than the preceding one, owing to the friction of the piston in the cylinder and of the water in the pipes.

The time required for the piston to make one excursion out to the left and to return again to rest on the right will depend upon two things, viz.:—

(*a*) The quantity of water which has to be transferred from one side of the piston to the other for a given restoring force from the springs.

(*b*) The inertia effect of the water in the pipe; which is dependent upon the length of the pipe and the velocity of the water in the pipe relative to the velocity of the piston.

An increase of either of these two factors will delay the movements of the piston.

The time required for the piston to move from a position of rest on the right, out to the left and back again to the right is, however, independent of the distance moved to the right and left. With the greater amplitudes the springs are more compressed and so exert correspondingly greater forces. These forces give correspondingly greater accelerations to the water with the result that the time required for one cycle is the same for the large amplitude as for the small one. This interval of time is known as the "Natural Period" of the system. The period will differ with different systems, being greater with large diameter pistons and weak springs and with long connecting pipes.

Hydraulic engineers will realise that it would be difficult to construct a piece of apparatus of this kind in such a way that it would make more than a very few oscillations. This fact, however, is not relevant to the use of the model as an illustration of the action of the inductance capacity electrical circuit.

An electrical condenser consists of a number of flat conductive plates separated from one another by thin layers of non-conducting material. Some condensers are "fixed," *i.e.*, are arranged so that the number of plates and the thickness of the insulating medium between them is always the same. These condensers have a constant capacity for storing up electrical charge. Other condensers, again, are constructed so that the number of plates in use, or their distance apart, or both, can be varied. Such condensers have variable capacity for storing up electric charge. The conducting plates are usually of copper or zinc, or alloys of these metals. The thin layer of insulating material may consist of glass or ebonite, or mica or air.

An inductance consists of a conducting wire wound up into a spiral of a large number of turns, along which a current of electricity can be passed.

An inductance *L* connected up to a condenser *C* is shown diagrammatically in Fig. 2.

Such an arrangement has electrical properties analogous to the mechanical properties of the model shown in Fig. 1. The switch *Y* corresponds to the catch *Z* of Fig. 1. If this switch *Y* is open, there are various means by which a charge of electricity can be given to the condenser *C*. This corresponds to displacing the piston of Fig. 1 to the right and holding it there by the catch *Z*. The stationary charge in the condenser consists of an excess of electrons on one plate of the condenser, usually known as the negative plate.

If the switch *Y* is closed the condenser discharges through the circuit of the inductance. This discharge takes the form of a stream of the excess electrons from the one plate of the condenser to the other. The inductance acts to this stream of electrons exactly as the inertia of the water affects the movement of the piston in Fig. 1. The starting up of the stream is delayed, and then when neutral conditions are realised, the stream of electrons over-runs and the condenser is charged up in the reverse direction. Ultimately, the electrons are all brought to rest with the condenser charged oppositely to the initial charge. The process then reverses itself, and may be repeated many times, just as in the case of the mechanical model of Fig. 1.

This electrical circuit has also a natural period, *i.e.*, a definite time is required for a surge of the electrons from one plate to the other, and back again. Increasing either the capacity of the condenser or the inductance of the circuit, or both, will cause a corresponding increase in the length of the natural period. As in the mechanical model the period is independent of the magnitude of the stream of electrons surging to and fro.

There are, however, two differences between the mechanical and electrical cases, more of a numerical nature than of principles involved.

In the first case there is no difficulty whatever in constructing capacities and condensers so that as many as 20 or more complete oscillations are gone through before the amplitude falls to, say, 1/10th of the original value. Then, secondly, the whole scale of time is different for the two cases. The electrons are so small and nimble as compared to the ponderous molecules of water that their rates of movement are very much greater. Where with the mechanical model it would be expected that the piston would move to and fro at the rate of one complete oscillation in something of the order of a few seconds, the oscillations in the electrical case may take place in a similar number of millionths of a second. It is, in fact, inconvenient with the electrical arrangement to provide for oscillations at a rate of less than 100 a second.

The movements to and fro of the piston of Fig. 1 do not constitute an analogy to an alternating current. They only go on for a few oscillations and then the piston comes to rest for good. These movements are analogous to what is known as a "damped oscillation" in the electrical circuit.

(*To be continued.*)

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* "Proc." Inst. Radio Engineers, April, 1918.

† "L'Elettrotecknica,' Jan. 25th and Feb. 5th, 1917.

Large Power Transformers.*

By A. G. ELLIS and J. L. THOMPSON.

(Continued from p.278)

Summary.—The authors first refer to the progress towards increased size of modern stations generating units and transformers, and the tendency to higher pressures. Limiting sizes of transformers as effected by handling and cooling are discussed, and prices per kilovolt-ampere in relation to output, voltage and cooling are presented. The condition affecting choice of types and relative advantages of shell and core transformers are next dealt with. Subsequently safety factors, transformers for interlinking and the operation and care of transformers (switching in and out, drying out, &c.) receive attention. The final section of the Paper discusses the influence of war conditions.

8. SAFETY FACTORS.

1. *Electrical Safety Factors.*—The safety factor of the insulation on the windings is an indeterminate quantity in such portions as may be subjected to uncontrollable electrical strains. The greater part of the winding is not subjected to such conditions, and here the safety factor may be approximately determined.

In the former case, so far as can be predetermined from experience, an ample safety factor is provided for, by means of reinforcement of the insulation between turns. For normal conditions where the factors are pre-determinable the following data are of interest :—

Insulation Between Turns.—Table I. gives representative values of the average voltage per turn for core and shell-type transformers. The figures relate to 50-period designs, and vary roughly in proportion to the frequency. The actual insulation used on conductors (apart from the specially reinforced turns) is generally of such material and thicknesses as will withstand for mechanical and electrical reasons, the breakdown voltages between adjacent turns given in Table II.

Table II.—*Voltage and Safety Factor Between Adjacent Turns.*

Normal volts per turn.	Approximate breakdown voltage between turns.	Operating safety factor.	Factory safety factor for over-potential test voltage = 2 × normal voltage.
5–10	4,500	900–450	450–225
10–25	7,000	700–280	350–140
25–60	10,000	400–166	200–83

The average operating safety factor (based on the normal working voltage) is thus from 166 to 900.

Usually transformers are submitted to an over potential test of 2 to $2\frac{1}{2}$ times normal voltage for a period of one minute. Hence the factory safety factor (based on the test voltage) is of the order 83 to 450.

Table III *Voltage and Safety Factor Between Coil Sections.*

Normal volts between coil sections.	Approximate breakdown voltage between coil sections	Operating safety factor.	Factory safety factor for over-potential test voltage = 2 × normal voltage.
500	20,000	40·0	20·0
1,000	35,000	35·0	17·5
3,000	45,000	15·0	7·5
6,000	55,000	9·2	4·6
12,000	70,000	5·8	2·9

Insulation Between Coil Sections.—It is possible to insulate up to almost any voltage between coil sections by means of solid insulation, but this method has its limitations. In coils of radial depth greater than about $\frac{3}{4}$ in. to 1 in. experience shows that it is difficult to get rid of the heat and maintain uniform temperature in the winding if the conductors and insulation form a solid congested mass. It becomes necessary to introduce ventilating ducts for the cooling medium to circulate.

Similar considerations to the above lead to the data given in Table III. for the safety factor between adjacent coil sections.

INSULATION BETWEEN HIGH-TENSION AND LOW-TENSION WINDINGS AND BETWEEN WINDINGS AND FRAME.

Table IV. shows the average breakdown voltage for the insulation usually employed between high-tension and low-tension windings and between windings and frame.

Similar data for insulation between windings and the inside surface of the tank give a safety factor to earth through the coil of from 5 to 3 for the operating safety factor, and $2\frac{1}{2}$ to $1\frac{1}{2}$ for the factory safety factor, based on a disruptive strength of dry oil of 15,000 volts between needle points $\frac{1}{8}$ in. apart at 15°C.

Table IV.

Working pressure, kv.	Approximate breakdown pressure, kv.	Operating safety factor.	Test pressure, kv.*	Factory safety factor.
22	40	18·20	5·4	7·40
66	60	9·10	14·2	4·25
11	80	7·25	23·0	3·50
22	110	5·00	45·0	2·45
33	140	4·25	47·0	2·10
55	200	3·65	111·0	1·80

Terminals.—The creeping distance over the surface of porcelain terminal insulators should be so proportioned as to allow an operating safety factor of about 3 and a factory safety factor of about $1\frac{1}{2}$; that is, the flash-over voltage of such insulators should be about three times the working voltage, or $1\frac{1}{2}$ times the test voltage of the transformers.

If some of the above values appear to allow a large margin of safety, it must be remembered that there is a possibility of the safety factor becoming considerably reduced after some time in operation. Safety factors allowed for oil and terminal insulators are much lower than for the other insulation in the transformer, since any deterioration can here be readily detected and remedied at the periodic inspection.

2. *Mechanical Safety Factors.*—The mechanical parts of a transformer subjected to stresses from the windings are proportioned for the usual safety factors employed in machine design, figured on the maximum possible stresses which may occur. The same applies to parts subjected to stress during lifting, handling and transport.

3. *Thermal Safety Factors.*—In well-designed transformers the maximum temperature occurring at any point on the winding should not exceed the average temperature in the windings by more than about 5°C. Where the windings are not well-ventilated or heavy sections are employed this excess may reach 15°C. or even more.

Table V. gives the maximum permissible temperatures according to the B.E.S.A. Report and the possible maximum hot-spot temperatures encountered.

Table V.—*Maximum Temperatures for Insulating Materials in Transformers.*

—	B.E.S.A. permissible max. temp. (50 deg. rating on air temp. 40°C.)	Maximum possible hot-spot temperature.
Cotton, silk, paper and similar materials..	95	110
Asbestos, mica and similar materials.	115	140
Oil	90	90

9. INTERLINKING OF STATIONS.

Recent developments in the interlinking of power systems arising from questions of supply economics have given rise to conditions demanding special consideration.

The service conditions differ from those of ordinary sub-station step-down transformers.

1. Both primary and secondary voltages are usually high and the interlinking transformers must be insulated accordingly.

2. Special means of voltage adjustments are required to compensate for the voltage drop in the lines, as the load may be transferred either way, transferring the voltage drop from one side to the other.

3. The minimum size of transformer is determined by the size of the stations and the synchronising power necessary to keep them in step.

4. The transformers must be of specially robust construction, as they operate with a large amount of power on both primary and secondary sides.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

* B.E.S.A. standard test voltage = 1,000 volts + 2 × normal voltage (*see* Report No. 72 of 1917, par. 82).

Regarding (2), the usual means of obtaining the requisite regulation consist either of tappings on either or both sides of the transformer for, say, 2½ and 5 per cent. above and below normal voltage, or of some form of voltage regulator if a wide range or frequent adjustment is required. Fig. 6, *a*, *b*, *c* and *d*, show the systems which may be employed.

Connection and Phase Angles.—In the case of two-phase or three-phase systems interlinked at one point the connections of the interlinking transformer, whether star-star, delta-star, &c., are of no consequence unless there are more than two stations interlinked. In this case there are two possibilities—viz., a ring connection or a star connection.

In the ring connection the interlinking transformers will simply transform from the voltage of one station to the voltage of the next, and any one station can supply power to, or draw power from only two others, whatever the total number of stations in the ring.

The question of phase relation enters here, as the connections of the interlinking transformers must be so chosen that the phase angle is correct at all points in the ring when completed.

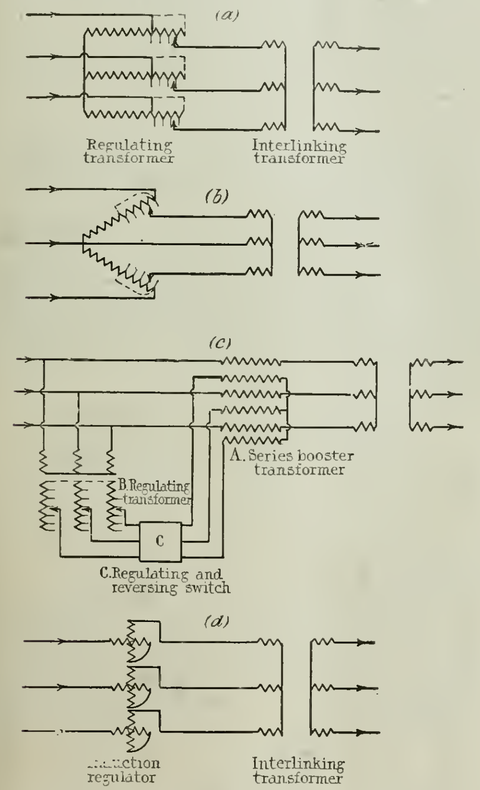

FIG. 6.—SYSTEMS OF VOLTAGE REGULATION FOR INTERLINKING TRANSFORMERS.

In the star connection, which is generally preferable, each station will transform up to the same voltage on a common interlinking feeder or 'bus bar, which may or may not form a ring. In this case any one station can, if desired, supply power to or draw power from all or any of the other stations interlinked.

If the interlinking feeder is connected in a ring it will be necessary, in order to equalise the load distribution, to install an induction regulator or adjustable reactance at one or more points.

The use of auto-transformers for interlinking systems of about equal voltages, though apparently attractive from the point of view of reduced capital cost, is not generally to be recommended. The reasons for this are as follows: (1) The danger of abnormal pressure-rises on the lower voltage system in the event of one line on the higher voltage side going to earth. (2) The difficulty of obtaining a satisfactory earthing point should both systems require earthing. (If two systems are interlinked through double-wound transformers, the neutrals of the generators in both stations can be earthed.) (3) In an auto-transformer if one system has an earthed neutral it is impossible to operate the other system unearthed should this be desired. (4) Auto-transformers have generally a lower reactance than double-wound transformers, and are thus less capable of withstanding short-circuits. Auto-transformers can, however, be specially designed for higher reactance if required, and providing the requirements of (2) and (3) are met, auto-transformers might be used for systems where the voltages of the two systems do not differ by more than 20 per cent.

10. TRANSFORMERS FOR ROTARY CONVERTERS.

Transformers for use with rotary converters in many cases require special electrical characteristics not met with in standard power transformers. Where the voltage on the direct-current side of the converter is obtained by means of static or synchronising boosters, the main transformers are of identical design and construction with standard power transformers. When the direct-current voltage regulation is obtained by means of field regulation, the transformer must be provided with sufficient internal reactance, which may range from 5 to 30 per cent. of the full voltage according to the design of the rotary converter and the range of voltage variation desired. This high internal reactance can be obtained either by a finer or coarser sub-division of the primary and secondary coils, or by means of magnetic shunts placed in the path of the leakage field between the primary and secondary windings of the transformer. With shell transformers the coil grouping can be easily varied, and internal reactance voltages of from 8 to 10 per cent. for a 500 k.v.a., up to 12 to 15 per cent. for a 1,000 k.v.a. transformer, can be obtained. Above these values magnetic shunts have to be used to attain the extra reactance. With core-type transformers the reactance required is readily obtainable up to any required value by means of the coil grouping and suitable spacing of the primary and secondary windings. This method, however, has many disadvantages, namely, expense of manufacture, high eddy-current losses in the copper and core, and difficulties in insulating the sandwich windings. It was first superseded by magnetic shunts consisting of a sheet or sheets of iron arranged concentrically between high-tension and low-tension windings. This diminished the cost of construction, but the losses remained much the same. There was also another difficulty. The

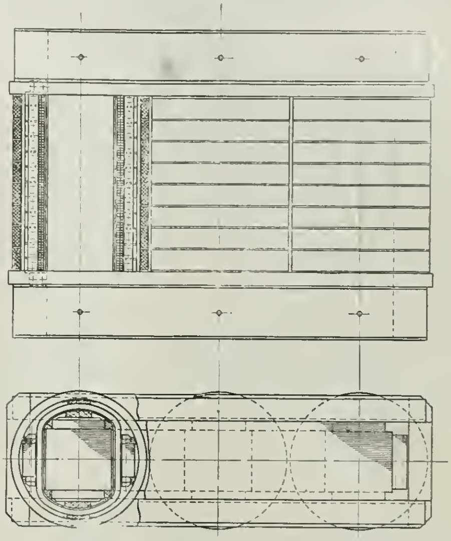

FIG. 7.—HIGH-REACTANCE TRANSFORMER FOR ROTARY CONVERTER.

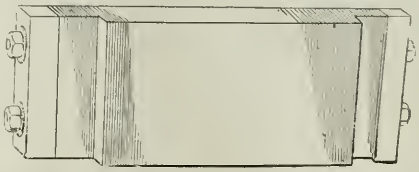

FIG. 8.—PACKET OF IRON FOR MAGNETIC SHUNT FOR HIGH-REACTANCE TRANSFORMER.

commutation of the rotary converter was affected in many cases by the presence of third and ninth harmonics in the secondary voltage, and consequently in the converter armature. This trouble was finally traced to the saturation of the magnetic shunts introduced into the transformer. To avoid this it became essential that the shunts should not be saturated—*i.e.*, that the characteristic of the reactance volts with load should be a straight line up to the maximum load required. These new requirements led to a new type of magnetic shunt of multiple-gap construction which was designed by the authors, and has been widely used.

This type of construction is illustrated in Figs. 7 and 8 for one side of the core of a 1,650 k.v.a. transformer. While transformers with high internal reactance have not yet been built for larger outputs than 2,200 k.v.a., it is quite possible to do so up to any required size, the limiting output being that of the rotary converter.

(*To be concluded*)

A Trigger Relay Utilising Three-Electrode Thermionic Vacuum Tubes.*

By W. H. ECCLES and F. W. JORDAN.

In a well-known method of using a triode for the amplification of wireless signals an inductive coil is placed in the filament-to-anode circuit and another coil magnetically coupled with this is introduced into the filament-to-grid circuit. This "back-coupling," as it is sometimes conveniently called, if it is arranged in the right sense, greatly exalts the magnification produced by the tube in any alternating E.M.F. applied to the grid; for the induced E.M.F. passed back to the grid is in correct phase relation to add directly to the original alternating E.M.F. applied there If instead of using inductive retroaction of this kind we attempt to use resistance back-coupling, then the retroactive E.M.F. applied to the grid is exactly opposite in phase to the original alternating E.M.F., and the amplifying action of the triode is reduced. Since, however, one triode can produce opposition in phase in the manner indicated it is clear that two or any even number of similar triode-circuits arranged in cascade can produce agreement in phase. Hence we conclude that retroactive amplification can be obtained by effecting a back-coupling to the first grid from the second, fourth, and so on, anode circuit of a set of triodes arranged in an ohmically-coupled cascade.

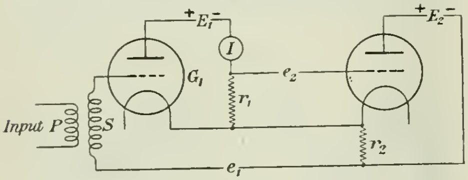

FIG. 1.
(Filament Battery not shown.)

It is possible to take advantage of the fact above stated for obtaining various types of continuously-acting relay, but the purpose of the present communication is to describe what may be called a one-stroke relay which, when operated by a small triggering electrical impulse, undergoes great changes in regard to its electrical equilibrium and then remains in the new condition until re-set.

In what follows, the circuit comprising the space in the tube between anode and filament, the external conductors and the source of E.M.F., will be called the anode circuit, and the current flowing in it the anode current. The circuit comprising the space in the tube between the grid and the filament, external conductors and a source of E.M.F., will be called the grid circuit, and the current flowing in it the grid current.

The operation of the relay is most easily explained when two tubes, each with resistances and battery in its plate circuit and with a resistance and battery in its grid circuit, are used and interconnected in the manner shown in Fig. 1.

The electrical stimulus from outside which it is desired to detect and magnify is applied in the grid circuit in the first tube so as to make the grid transiently more positive in potential relative to the filament. This causes an increase of current in the plate circuit of the first tube and consequently an increase of the P.D. between the terminals of the plate circuit resistance. This increased P.D. is transferred to the grid circuit of the second tube in such a manner that the grid becomes more negative than before relative to its filament. Consequently the plate current of the second tube decreases and the P.D. between the terminals of its plate circuit resistance decreases also. This decrease of P.D. is now transferred to the grid circuit of the first tube in such a manner that it tends to make the grid more positive relative to the filament. The result of these processes is that a positive stimulus from outside given to the grid of the first tube initiates a chain of changes which results finally in the plate current of the first tube attaining the highest value possible under the E.M.F. of its battery and the plate current of the second tube falling to its lowest possible value. This condition, therefore, persists after the disappearance of the initial stimulus. In the initial condition with the two-tube arrangement just described, the plate current of the first tube is made very small and that of the second tube large; after the reception of the outside stimulus on the grid of the first tube the final condition is a large plate current in the first tube and a small plate current in the second tube. Either the decreases or the increases of plate current can be used for indicating. In order to restore the initial conditions it is easy to interrupt for an instant the linkage between the tubes, or to stop the operation of one or both of the tubes, as, for instance, by dimming its filament.

The external stimulus is led into the primary *P* of transformer *PS*, of which the secondary is connected to grid G_1. The plate circuit of this first tube contains the indicating instrument *I*, such as an ammeter or a moving tongue relay. The resistance r_1 in the plate circuit of the first tube has its terminals connected to the filament and grid of the second tube. Similarly, the resistance r_2 in the plate circuit of the second tube has its terminals connected to the filament and the grid of the first tube. The plate circuits contain batteries E_1, E_2, and the grid circuits batteries e_1, e_2. The following values are typical and show the performance of the relay:—

$E_1=78$ volts. $E_2=74$ volts.
$r_1=22{,}000$ ohms. $r_2=12{,}000$ ohms.
$e_1=31$ volts. $e_2=17{\cdot}5$ volts.

The change in the indication of an ammeter at *I* is from 0—2·5 microamperes.

The sensitiveness of the arrangement depends on the transformer *PS* to some extent. Using a telephone transformer of the kind made for Army C Mk. III. Amplifier with 20 ohms resistance in the primary and with the primary connected to a Brown telephone of 60 ohms resistance, the relay is operated with certainty by snapping the thumb and finger at a distance of 5 ft. from the telephone.

Fig. 2 shows another mode of interconnection of two tubes. The stimulus from outside is introduced to the grid of the first tube through a transformer, as before, and the indicating instrument is again placed in the plate circuit of the first tube. The two plate circuits are in parallel with a common battery *E*, and the connections are such that the changes of P.D. between the anode and the filament of the first tube are imposed between the filament and grid of the second tube, and the changes of P.D. between the anode and filament of the second tube are imposed between the filament and grid of the first. In order to help to maintain the grids' advantageous potentials, grid leak resistances are connected as indicated.

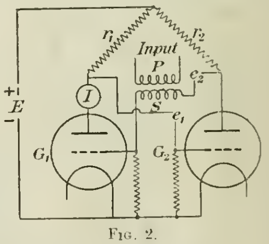

FIG. 2.
(Filament Battery not shown.)

The following numerical values are typical dimensions:—

$E=80$ volts.
$r_1=r_2=100{,}000$ ohms.
$e_1=e_2=40$ volts.

The sensitiveness of this relay could be made greater than that of Fig. 1, when these large resistances are used.

The devices just described were the subject of a patent, numbered 10,290, 1918, taken out by the Admiralty, and the description is now published by permission.

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* Paper read before the British Association.

A Method of Using Two Triode Valves in Parallel for Generating Oscillations.[*]

By W. H. ECCLES and F. W. JORDAN.

In the typical method of using a three-electrode tube or "triode" for generating electrical oscillations, the connections are as shown in Fig. 1. The oscillations in the closed inductance-capacity circuit, sometimes called a flywheel circuit, are sustained by unidirectional pulses of current through the anode circuit, that is, through that external circuit of the tube which begins at a terminal of the filament and ends at the anode. This circuit includes a high voltage battery, which is the ultimate source of the energy of the oscillations. The unidirectional pulses are produced in correct time phase by the action of the oscillations themselves on the grid circuit by means of the coupling between the coil in the closed circuit and a coil in the grid circuit.

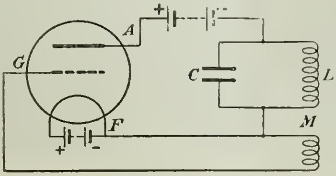

Fig. 1.

When two or more triodes are used they are in the prevailing practice connected in parallel. It is known that unless special care is taken in selecting the tubes and in adjusting their normal grid voltages this connection does not in general give an output double that of a single tube. Moreover, if the coupling is made too close, as is often the case, the variations of the grid voltage may be so great as to carry the representative point in the characteristic diagram on to the straight horizontal parts of the curves, with the consequence that harmonics are produced, accompanied by a lack of symmetry in the oscillations generated.

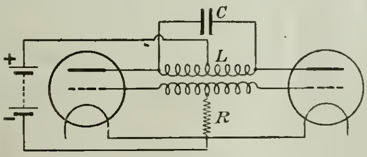

Fig. 2.

More symmetrical oscillations could be obtained if the flywheel circuit were acted upon by a triode and high-voltage battery symmetrically in every half period. The improvement to be described consists in arranging two tubes so as to fulfil the last stated condition. One way of doing this is to join the grids of the two tubes by a coil which is linked by means of its mutual inductance to the oscillating circuit. This method of joining the grids is shown in Figs. 2 and 3. This mode of connection causes the potential of each grid, and therefore the resistance of each tube, to vary in opposite directions, that is, causes the resistance of one tube to increase, while that of the other diminishes—with a definite phase relation to the oscillations.

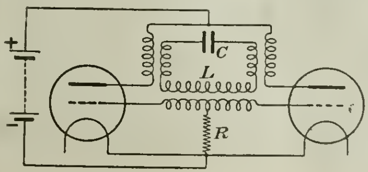

Fig. 3.

In Fig. 2 the anode circuits of the tubes are in parallel and are connected in series with a high-voltage battery. They are associated with the flywheel circuit so that increase of one anode current applies to the flywheel circuit a stimulus in one direction, and increase of the other anode current applies a stimulus in the other direction. In the result the variations of both anode currents are effected in correct phase relation to maintain the oscillations of the flywheel circuit, an impulse being applied first by one tube and then by the other in successive half periods.

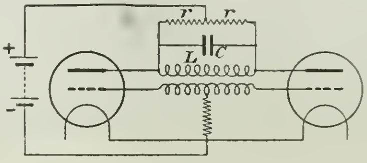

Fig. 4.

In Fig. 2 the coupling between the two anode circuits and the oscillatory circuit is direct. Fig. 3 shows a method in which the anode current acts by mutual inductance on the oscillatory circuit. In both Figures R is a large resistance which acts as a grid leak and should be chosen so as to keep the grids at a voltage found advantageous by trial. A method in which resistance coupling is employed is indicated in Fig. 4. This has its advantages in certain laboratory applications. In Fig. 5 a method employing condenser coupling is shown. Here again R indicates a grid leak. The condensers C_1 and C_2 need not be of any particular capacitance; they are chosen by trial and their variation has very little effect upon the frequency of the oscillations.

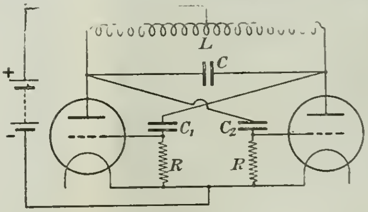

Fig. 5.

It is clear that instead of using two triodes, the symmetrical action could be obtained by using one tube possessing, for example, a single plate, two grids and two filaments, or alternatively a single filament, two grids and two plates.

It is found that these cross-coupled circuits oscillate more freely than single circuits. They can be operated, for example, by using 4 or 5 volts only in the anode circuit with ordinary receiving B.T.-H. triode valves.

The devices just described were the subject of a patent, number 6,090, 1918, taken out by the Admiralty, and the description is now published by permission.

Transformer Ratings with Oil Removed.—An interesting point in connection with oil-cooled transformers is raised by Mr. H. E. Weightman in the "Electrical World." It is stated that the National Electrical Code does not allow oil-filled transformers in buildings which are not stations or substations. Accordingly when it is necessary to instal an oil-cooled transformer in a building which is not of fireproof construction, the oil must be removed. This naturally means that the permissible rating is reduced, the diminution being about 40 per cent. for transformers up to 10 k.v.a. output. Thus a 5 k.v.a. transformer of the oil-cooled type can be used only as a 3 k.v.a. transformer in these circumstances. The point is one that is apt to be overlooked and is of some importance, showing that the design of the transformer house may have direct bearing on efficiency and first cost.

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[*] Paper read before the British Association.

Electric Welding: Its Theory, Practice, Application and Economics.*

By H. S. MARQUAND.

(*Continued from page* 282.)

Summary.—In this article the author concludes his description of various methods of preparing welds and gives some further illustrations of various kinds of work that is now undertaken. He then passes on to the economies effected by machine welding, and to the testing and strength of electric welds.

SOME CONCEPTIONS OF ARC PHENOMENA.

In order to obtain uniform and consistant welding under widely different conditions of operation, it will be necessary to have a very much more accurate and a broader knowledge of what actually is happening when a weld is made by means of an electric arc, and the laws governing that operation.

The problems presented by all welding are particularly within the province for solution of the engineer, the chemist and the metallurgist. So far as present investigation carries us, the engineer has paid the most attention to the subject, and, indeed, has almost come to the limit of his powers to develop the process further along scientific lines. The chemist and the metallurgist, on the other hand, have only touched the fringe of investigation.

The engineer has perfected machinery for carrying out arc welding operations, has thoroughly investigated what can be accomplished with our present knowledge, pointed out the successes and limitations of the processes and pointed out a profitable line of development. The problems are now ripe for solution by the chemist and the metallugist.

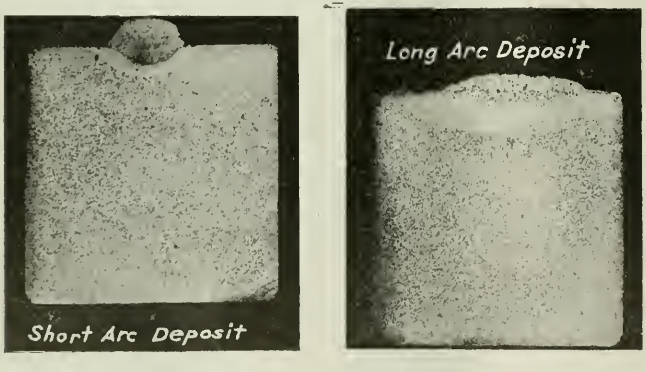

FIG. 82. FIG. 83.

SECTIONS TAKEN THROUGH DEPOSITS FORMED WITH A SHORT AND A LONG ARC.

Without doubt, the understanding of and adherance to a few fairly obvious and fundamental requirements will result, not only in good and consistant welding, but will facilitate successful and economical operation of the various systems. It is often wise, moreover, to appreciate the limitations of a system and to be able to judge of the advisability of its application, having regard to the requirements of the finished product.

CHARACTERISTICS OF THE METAL ARC.

When the arc is struck with the metal electrode, this arc is found to have a highly luminous centre core of iron vapour, surrounded by a flame most probably entirely consisting of gaseous oxides. Simultaneously chemical combinations occur due to the extremely high temperature prevailing in the arc stream, and at the positive and negative poles between the vapourised metals and the atmospheric gases.

These reactions continue until the arc core is completely enveloped by a flame of incandescent gaseous compounds.

Now, as a result of the high temperature of these vapours, assisted by local air currents draughts are created which tend to remove this protecting screen round the arc core as rapidly as it is formed. Thus, the welder has to manipulate his electrode so as to continually secure the maximum protection of the arc flame and the deposited metal. This protection can fortunately be secured by maintaining a short $\frac{1}{8}''-\frac{3}{16}''$ length of arc as far as possible unbroken, and the proper inclination of the electrode to compensate for draught currents.

Figs. 82 and 83 are interesting. They show sections taken through deposits formed with a short (20 volt) and a long (35 volt) arc. Fig. 84 shows the corresponding surface views of the deposited metal.

Comparing Fig. 82 with Fig. 83, it will be seen that there is a distinct superiority in fusion, concentration and economy of deposited electrode, freedom from porosity, and reduction in area of thermal disturbance by the use of the short arc. It is impossible adequately to control the long arc flame, and in consequence to protect the deposited metal from oxidation. Fig. 84, on the right, shows excessive porosity, due to the introduction of oxide and blow holes.

Porosity results usually, as we have previously explained, from frequent striking and interrupting of the arc.

It may be here said that a short arc can be maintained with a high or low potential system. With the former systems less skill is required, and possibly a better continuity of arc circuit is obtained.

Certainly, on a low potential system, a greater degree of skill is required to maintain a steady continuous arc; but when this skill has been acquired the operator is compelled to keep a short arc. A reactance coil in series with the arc circuit considerably facilitates the maintaining of a uniform and continuous arc, while at the same time it very materially assists in keeping the current in the arc constant, and levels up the current and voltage peaks. The effect of reactance in the arc circuit is clearly indicated by reference to Fig. 85.

It is clearly necessary as far as possible to keep the current in the arc circuit maintained at a reasonably constant value, because the rate of fusion is a function of the current and for all practical purposes is independent of the arc voltage.

FUSION.

The fusion obtained at the surface and in the body of the metal is very largely determined by the scarf angle, arc current, arc length, as well as by diameter of electrode used.

Sections through welds are seen in Fig. 86. The right-hand specimen was scarfed to an angle of 60 deg., and the two halves practically abutted. As a result, as can be seen, the bottom of the weld proved to be inaccessible to the welder; arc contact was uncertain, and the surface merely covered by molten metal formed above. By separating the parts to be joined one eighth of an inch and scarfing to 90 deg. satisfactory fusion was obtained, shown by the weld on the left of Fig. 86.

We have already given tables showing the effect of diameter of electrodes and value of current on different sections of plating.

It has often been asked whether the shank of the metal welded is affected by the heat of the arc during the time occupied in completing the weld, and to what extent is this influence detrimental to the original plate.

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* All rights reserved.

The author has, in order to ascertain the extent of the effect of the applied heat, as well as to examine the micro-structure of the weld, made from time to time a series of micro-photographs of the juncture of the original and the added metal, to show the changes which take place in the structure of the material.

We know now from close and repeated examination of these photographs that the original material is only disturbed by the heat to a total extent of about $\frac{1}{16}$ of an inch. Indeed, in thin plates, this distance of disturbance is much less. In a good weld there is little or no evidence of oxidation. A perfect juncture is obtained between the plate and the added welding material. The material in the weld has the appearance of being almost pure iron.

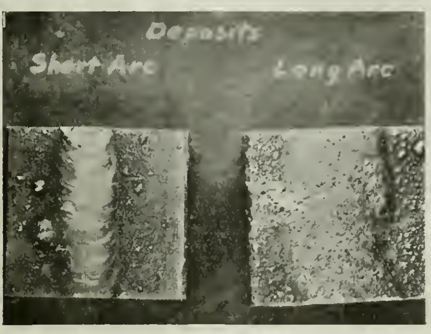

Fig. 84.—Showing Surface Views of Deposited Metals. (*See* Figs. 82 and 83.)

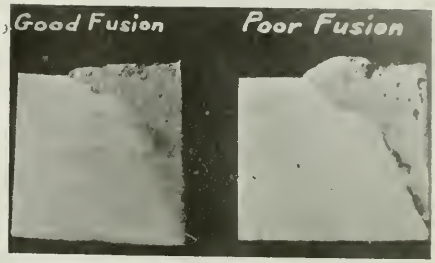

Fig. 86.—Cross-Section through Fused Metal, showing Shank Metal and Fused Metal half-way through Weld.

Note.—The shank metal is seen to the left and the deposited metal to the right in each photograph. Good fusion is shown in the left-hand photograph and poor fusion in the right-hand one.

Table IX.—*Chemical Analysis of Metallic Electrodes used in Arc Welding and the Metal Deposited in the Weld after Passing through the Arc.*

Type of electrode.	Composition.				
Special flux coatings	C.	Mn.	Si.	S.	P.
Original mild steel plate	0·160	0·500	0·025	0·034	0·028
Quasi arc A.	0·091	0·46	...	0·021	0·050
Deposit	0·03	0·021	0·058	0·037	0·038
Double arc	0·085	0·35	...	0·054	0·108
Deposit	0·045	0·068	0·045	0·035	0·056
Equipment and engineering	0·115	0·505	...	0·081	0·0162
Deposit	0·065	0·15	0·036	0·056	0·100
Scott Anderson	0·057	0·32	...	0·026	0·014
Deposit	0·084	0·07	0·039	0·06	0·333
Jones	0·224	0·25	0·001	0·026	0·024
Deposit	0·052	0·17	0·029	0·046	0·038
Quasi arc B.	0·136	0·350	0·110	0·030	0·015
Deposit	0·030	0·037	0·020	0·031	0·02
Quasi arc C.	0·123	0·58	0·045	0·46	0·006
Deposit	0·053	0·19	0·039	0·048	0·04
Special coated	0·048	0·008	0·065	0·010	0·082
Deposit	0·046	0·04	0·031	0·033	0·066
Bare Electrodes :—					
Original mild steel plate	0·125	0·563	0·041	0·061	0·043
Roebling	0·16	0·56	0·016	0·024	0·032
Deposit	0·05	0·18	0·011	0·036	0·031
Norway iron	0·049	0·021	0·08	0·007	0·025
Deposit	0·049	0·018	0·011	0·015	0·020
Swedish iron	0·05	0·16	...	trace	0·05
Deposit	0·042	0·14	...	0·003	0·041
Cold rolled steel	0·11	0·72	0·011	0·123	0·087
Deposit	0·05	0·11	0·011	0·072	0·086
Hot rolled steel	0·17	0·50	0·011	0·045	0·012
Deposit	0·14	0·14	0·011	0·039	0·012

Chemical analysis of the deposited metal seems to confirm this latter observation. In Table IX. analysis of a few characteristic electrodes is given, as well as the metal deposited after passing through the arc. As a whole, the action is one of refining of the iron. The action of the atmospheric gases appears to refine the vapourised metal, decreasing particularly the carbon and manganese constituents.

Some deposits show a slight increase in deposits of sulphur and phosphorous and silicon. This may be attributed to their absorption by the hot filler metal from the shank metal. The inclusion of sulphur and phosphorus is to be regretted as the resultant weld is made hard and brittle in consequence.

A very close examination of the micro-photographs of the weld metal has frequently disclosed short straight lines, which

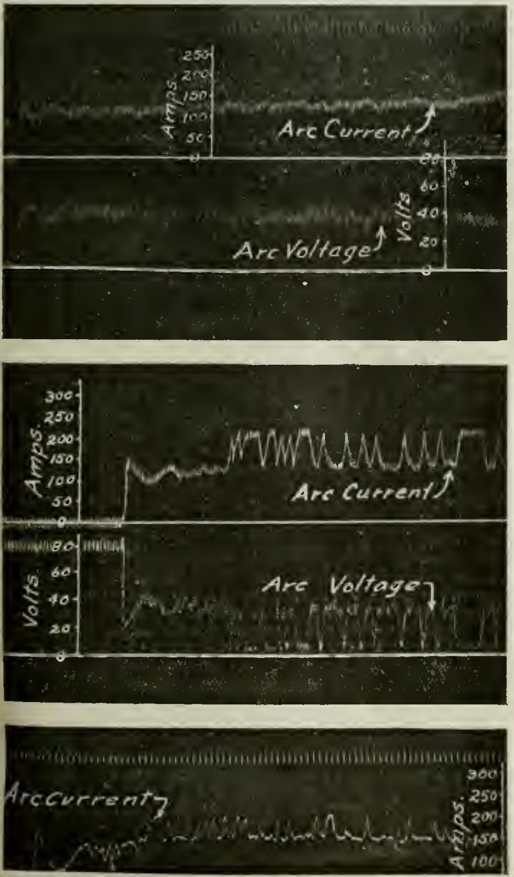

Fig. 85.—Showing the effect of Reactance in the Arc Circuit on a Fixed Potential System.

indicate the presence of nitrogen ; and a careful chemical examination has proven nitrogen to be present to an amount which, though not very largely absolutely, is yet 10 times as great as in the solid plate.

Nitrogen has the effect of rendering steel strong with respect to tensile strength, but brittle.

This inclusion of nitrogen in the weld is very difficult to prevent, yet, strange to say, the fact of its presence and influence has almost been entirely lost sight of, and little or no real investigation as yet has been made upon this point. The author is of opinion that the matter is worthy of very close examination, which might result in some valuable knowledge.

(To be concluded.)

On the Reciprocal Relations of Chemistry and Engineering.*

By Prof. Dr. H. GROSSMANN.

1. The German nation has always been distinguished by a pronounced tendency to form societies. Although it is a slight exaggeration to say that three Germans who chance to meet in any corner of the world must immediately form a society, there is undoubtedly no lack of societies in Germany. A great deal of activity has always been manifest in these societies, which, even during the war, was not hampered to any great extent.

2. As regards technical circles, the great majority of societies have always led an existence fairly remote from publicity, as the various professional groups very rarely inter-penetrate. Engineers, electrical engineers, chemists, architects, medical men, &c., in Germany have a considerable number of large and small societies, which, in their turn, have sub-groups according to professional standpoints or local considerations. It may be asserted, however, without fear of general contradiction, that only comparatively rarely do engineers belong to a chemical society or chemists to an engineering society. There is no doubt that, owing to this, many opportunities have been lost, both the individual and the majority, not only in the direction of obtaining scientific, technical, or industrial stimulus from one's colleagues. The Union of Technical Men has, therefore, quite properly endeavoured to put an end to this seclusion of individual branches of technology, at least as regards industrial and political life, and at the same time it must take special steps to bring the chemists and engineers into closer contact than has previously been maintained.

3. How is it possible to explain the fact that, in Germany, despite the brilliant technical achievements of the past, the chemists and engineers have hitherto generally held aloof, and do so even now to some extent ? This is probably due mainly to the fact that chemists and engineers have learnt to think differently at the technical colleges, so that members of the two professions are only with difficulty able to meet on common ground. The chemists' language of formula, especially in organic chemistry, is a sealed book to the engineer, and just as little are the majority of chemists able to follow engineering specifications with the desired facility, these specifications being based on drawings which are only easily intelligible to the expert. This also explains why the average chemist but rarely reads engineering journals, and why the engineer has no inclination to study purely chemical publications, the reason being that the method of presenting the matter in both cases is only adapted to special professional circles.

4. Must this state of affairs always persist ? The experiences of the war have shown it to be imperative that these mutual relations should be made more intimate as soon as possible, and that the number of engineers capable of thinking in terms of chemistry and of chemists with an engineering training should increase, as a considerable number of such men will be required for industrial developments in the coming period.

5. Much more attention has been given to these problems in England than in Germany, and discussions on the engineering chemist and the best methods of training him have also been very forceful in England during the war. On March 6, 1917, a whole evening was given up to the discussion of this question by the Faraday Society of London, and it must be recognised that these proceedings attained a very high level throughout. It is not possible here to give a full account of this discussion, but I would refer specially in this connection to the translation of a fairly long report of the discussions, which appeared in the "Dokumenten zu England's Handelskrieg" (documents bearing on England's commercial war) in the form of a supplement to the journal "Die Chemische Industrie." It appears, *inter alia*, from this report, that a number of English colleges, *i.e.*, the City and Guilds College at Finsbury, and the Imperial College, have taken up the training of chemical engineers. At the last-named college a special department was formed in 1912 for chemical technology, in which the students are made acquainted in a practical manner with technical works equipment, filter presses, distillation apparatus, reaction towers, milling equipment, &c. Students are also required to draw up plans for the production, on a manufacturing scale, of simple compounds, and to study the individual processes on a fairly large scale. The students also deal specially with the design of factory plant, and the preparation of estimates.

6. In the proceedings in England already referred to, it was generally recognised that chemical engineers, *i.e.*, engineers capable of thinking as chemists as well, are an absolute necessity, *e.g.*, for fuel economy and fuel utilisation—which questions can only be dealt with by the engineer-chemist and the chemically trained engineer. Prof. Donnan, who, moreover, has drawn up a noteworthy programme for the training of the future engineer-chemist and chemical engineer, has quite rightly pointed out that chemical engineering offers the widest and most promising field for the development of engineering science, and for this reason he has called for the establishment of new schools for chemical engineering.

7. There is no doubt from what has been said that it is very advisable that this important question of the training of engineer-chemists, who form the naturing connecting link between chemistry and engineering, should be energetically tackled in Germany, and that the universities and technical colleges should interest themselves in the matter to a much greater extent than they have done in the past, by virtue of the training they receive, engineer-chemists and chemical engineers will be safeguarded in the best possible way from becoming too one-sided—a quality which is fatal in the long run, and which unfortunately is too often met with at present, much to the harm of industry as a whole. There will be no lack of problems for solution in the future, which will call for this combination of chemical and engineering science, as the need for working as rationally as possible both from the technical and economic standpoint, will render such a combination necessary to an extent scarcely ever thought of even in Germany.

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* Translated from the German.

Technical Applications of Schoop's Process of Spraying Metals.*

By W. KASPERONICZ.

Dr. Lach has already described methods by which electric heaters can be made by the application of Schoop's method of spraying metals. (See "Elektrotechnische Zeitschrift," p. 270, 1915.) In the meantime other applications of Schoop's method to electrical work have been discovered, some of which are described in the present article. The metal, which is to be sprayed, has usually been heated in a gas burner, but there are certain difficulties when hydrogen or oxygen are used ; the apparatus in this case becomes complicated, and the cost of the process is increased on account of the expense of the gas. It has now been found possible to fuse the metal electrically. But this task was not easy ; it was a question of melting with regularity small quantities of metal, and the heat was sometimes sufficient to melt the whole apparatus, or at least to injure it to such an extent that it became useless. The electrical process is as follows : Two metallic wires are connected to the electric circuit ; a driving mechanism is arranged so that the ends of the wires are brought in contact and fused by the short circuit. A small arc is formed, which causes a further fusion of the wires. The wire is continually fed forward, and the fused metal is instantly atomised by a current of compressed air, and thrown in any desired direction. This process is interesting from the technical standpoint ; the short circuit is converted into an arc in a quite simple fashion by the use of direct current and a considerable speed in the feeding mechanism controlling the position of the wires. The metal is fused with great regularity. When working at a considerable speed with direct current, the short circuit almost disappears in the arc ; the short circuit becomes damped by the steady arc. This process works well, but attempts are being made to use one wire only. Still there are difficulties that the metal, when on the point of fusion, may come in contact with the walls of the vessel or with some other conducting body. In such a case one would have a metallurgical process ; but it is hoped to be able to develop a method on these lines to a successful issue. It is likely, if successful, to be mainly useful in connection with easily fusible metals and alloys.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 3, 1919.

By the help of this process it is possible to cover bodies with a thin conducting metallic coating. Bodies like celluloid, paper, wood glass, porcelain and other insulators can be covered in this way. Thus glass plates and glass cylinders can be covered in this way for the purpose of being used in electrical condensers. A lead coating can be used as a protection against Röntgen rays.

Good contacts and connections can be made by the spraying process. If two surfaces are to be connected, they should be covered with a sprayed coating before bringing the surfaces in contact An obvious case arises in the preparation of carbon electrodes, especailly for heavy currents ; heavy losses might arise at the point of contact and gradually destroy the electrode. An electrolytic deposit of copper has the disadvantage that the electrolyte penetrates into the substance of the electrode. But by the spraying process it is easy to cover the surface of the electrode with an adherent coating of zinc, aluminium, copper or some other metal. The process is employed in many factories in preparing carbons for the electric furnace, or for electrochemical purposes, or for use as carbon brushes on dynamos and motors. Brushes are also prepared by using layers of paper, which are covered with sprayed metal.

The process can sometimes be used to facilitate soldering. Thus in squirrel-cages with aluminium windings, the wires or rods can be coated with copper before soldering ; in various other ways the connection between the aluminium rods and the short-circuiting rings can be simplified. For bonding the rails of a tramway line, it is often sufficient to deposit a coating of zinc on the rails and on the inner surface of the fish-plates before bolting them up. We then have a contact which is not liable to deterioration through rust ; the resistance of such a joint is not likely to be great. Insulators have also been covered with metallic deposits at suitable points in order to produce a uniform distribution of the electric field, and to prevent congestion of the lines of force. In order to provide an adherent film of no doubtful quality the surface of the porcelain may be slightly roughened, or unglazed porcelain may be used. A proposal has been made to construct light accumulators by spraying films of lead on asbestos fibre or other substances ; the process can be so conducted as to provide a loosely woven active layer on the surface. If this method should be found to be successful a great decrease in the weight of the accumulator would be the result. The process of preparing electric heating bodies by spraying the metal on a refractory substance has already, as aforesaid, been described by Lach. By means of the "electric pistol," which is used in the ordinary apparatus, it has been found possible to deposit films of refractory metals like tungsten and molybdenum. The arc which arises under these conditions has been studied by Prof. H. D. Korda and the author, and is found to contain a large amount of ultra-violet rays. (See "Schweizer Chemiker Zeitung," p. 84, 1918.)

An Electrically Driven Tube Mill.

Electrical plant was recently installed by the General Electric Company, Ltd., at the tube works of the Talbot Stead Tube Company, of Birchills, near Walsall. The principal feature is the direct driving of two Pilger mills by a motor running at the speed of the mill and driving without a flywheel. This is the first time that electric motors have been so used in Great Britain for Pilger mill driving ; in fact, it is believed to be the first time that a Pilger mill has been electrically driven at all. In a Pilger mill there is a severe shock once every revolution, extending over about one-third of a revolution, when the rolls grip the tube. Accordingly, special attention had to be paid to the design of the motors. Continuous-current machines were adopted, the voltage on which they run being 440. The normal full load of each is 188 H.P. at 100 to 200 revs. per min. The speed drop between no load and full load is guaranteed to be not more than 10 per cent. at 100 revs. per min. and not more than 20 per cent. at 200 revs. per min. The motor is able to stand up to a peak load of 400 H.P. for one minute at any speed within its working range. In addition to being fitted with interpoles, complete compensation is provided, so that full output can be obtained at the most suitable speed for the size of tube in the mill.

The special features which had to be introduced into the design in order to enable the motor satisfactorily to withstand the heavy shocks thrown upon it due to the absence of a flywheel include the provision of a very heavy shaft and low centre bearings. The beds are also sunk in the ground, and the spider carrying the commutator is carried on an extension of the armature spider, to which it is fastened with two heavy keys. Briefly, the whole design is as robust as possible. One of the motors is seen in Fig. 1.

Before the billets reach the Pilger mill they are passed through a piercer driven by a 300 H.P. three-phase induction motor of the three-bearing type, driving the piercer flywheel through a rope drive. A duplicate motor with a similar drive is used for the rolling mill, which finishes the tubes to gauge. With both motors it was considered desirable to allow for a certain amount of slip, and an automatic slip regulator of the eddy-current control type was installed. This automatic regulator is also used for starting. Power is obtained from the three-phase 6,600-volt 50-cycle mains of Walsall Corporation. This is transformed down, and, where possible, transmitted to various constant-speed motors ; but continuous current is required for the Pilger mills, and to obtain this a 500 kw. rotary converter (shown in Fig. 2) has been installed. This is a six-phase interpole machine of the standard self-synchronising type. In the illustration is also seen the necessary switchgear for the rotary and for the Pilger motors. On the starting panels to the right of the board there is a Salford circuit-breaker at the top, a double-pole switch for isolating the motor, and a multiple starter below. This starter is provided with a mechanical interlock to ensure that the switches are closed in the correct sequence. The starting resistances, of the c.i. grid type, are mounted at the back of the board. An interesting point in connection with the installation is that the starting of the motors is in the hands of the operator in the rotary sub-station, which is a considerable distance from the mill. Should the circuit-breaker open due to an overload, a bell is rung in the sub-station, and the attendant immediately closes the breaker. However, if the stoppage is intentional and for safety, there is push-button apparatus in various parts of the shop, a red light is shown on the switchboard, and the attendant is thus informed that he should not close the breaker until he receives the necessary instructions. In addition to the driving of the mills, electric motors are extensively used at these works for driving hot saws, compressors and other auxiliary machinery.

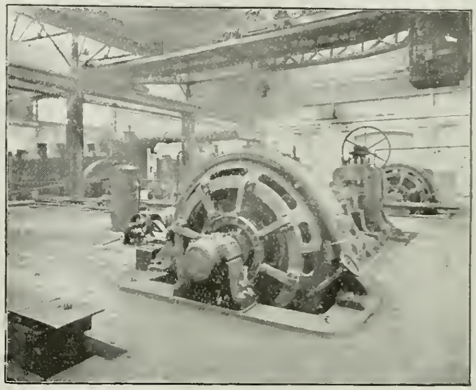

Fig. 1.—188 H.P. "Witton" Motor Driving the Pilger Mill.

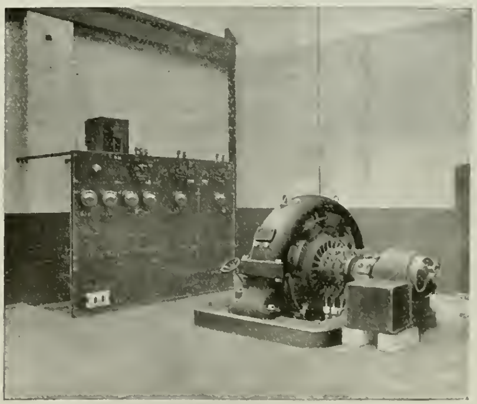

Fig. 2.—500 kw. "Witton" Rotary Converter and G.E.C. Switchgear in Sub-station.

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The British Association.

We think both the physicist and the electrical engineer will have experienced some disappointment over the meeting of the British Association which took place at Bournemouth last week. There was a lack of interest and of variety, except along certain popular lines. We must admit, however, that there are extenuating circumstances. After five years of a world war this meeting could hardly be expected to reveal any great scientific progress, except along certain practical applications. For the last five years, both in the industrial and the scientific world—excepting where national needs have demanded it—research has been practically at a standstill. Reports of the great progress made in the applications of science to the nation's requirements during the war thus formed a large proportion of the Papers and addresses. This was generally anticipated, and, though it may have attracted the layman, it did not deter the academic scientist from attending.

The Presidential Address, and many of the addresses of presidents of sections, disclosed details concerning progress in the scientific effort that has been applied to war service, details that completed and confirmed the general impressions held by the bulk of the audiences, and which were not always of a pleasing nature. Prof. **Gray** was particularly scathing in his indictment of the permanent officials of the War Office for their tardy recognition of the utility of scientists, and was anxious to have some machinery by which the Government could at any crisis obtain the men most competent to advise. This our readers will have seen from the abstract which appeared in our last issue.

Aviation and wireless telegraphy, in which subjects we have gained much new knowledge, received considerable attention; but the readers of such Papers confined themselves to general and elementary facts, because the development of these subjects has been restricted to war departments.

Although it was no doubt inevitable that a great deal of the programme should have been filled with descriptions of efforts made during the war, we think it will be felt that, apart from such descriptive matter, which does not lend itself to much discussion, there must have been endless interesting points and difficulties, possibly on side lines, in connection with this war work which might have been discussed with advantage at this meeting. There seems to have been little attempt to get back to ordinary lines, and if anyone compares this year's programme with that of any pre-war meeting they will be struck with the lack of variety and of subjects which are of general interest to the physicist and the engineer. It is a curious fact that not a single Paper in electrical engineering or on applied electricity (apart from wireless telegraphy) was read this year, and yet we are at the moment passing through a period of great evolution in electricity supply.

Although we do not agree altogether with the leading article which appeared in "The Times" on Monday, we think there is something in the criticism put forward by our contemporary, that purely scientific matters might have been more prominent. On the other hand, it must be remembered that the British Association is a body for the advancement of science among the people quite as much as among those of scientific education. Consequently, it is not a body to which original work is taken of the highest quality. One reason for this, possibly, is that it has no medium of publication for Papers in the ordinary sense of the word. There is a yearly volume which contains valuable reports, but which otherwise only contains abstracts of the Papers that are read; consequently, some other medium of publication must be sought, and this is generally found in the various technical and scientific journals.

We prefer the still small voice of science rather than the sensational heralding of scientific achievements in war, however necessary these may have been. But when it comes to the question of gaining the ear of the nation, and still more of the Government, we do not agree with our contemporary that either of these "will listen more readily to science at its best." The honours that have gone to men of science, speaking in the broadest sense, have been few and far between compared with those bestowed on men who have been able to deal in the spectacular. It must surely be admitted, with regret, that the Government (which is what usually counts) and equally the nation (which usually does not count) will be much more readily captivated by, say, a levitated (and impossible) railway than by a solid advance which does not appeal so readily to the imagination.

The British Association has done much useful work in the past, and there is no reason why it should not carry out correspondingly useful work in the future; but we hope that a definite attempt will be made next year to return to more balanced lines as far as the programme is concerned.

Electricity from Wind-power.

By M. J. E. TILNEY.

In these days when economy in power production is being preached on all sides, and with schemes involving the use of vast quantities of coal and gas for generating electricity being proposed by the Government, it may not be inopportune to put forward a claim for the consideration of the use of wind-power for isolated plants, suitable for supplying the needs of villages and individual houses.

Articles have at times appeared in the pages of the technical press describing individual attempts in this direction, and as far back as May, 1907, one finds details of plants installed which are described by Mr. Horsnail, but no one seems to have followed the matter up to any extent, and in 99 cases out of 100 any private house plant erected in the past 10 years has preferred either suction gas or petrol or crude oil engine drives to the undoubtedly more economical scheme of utilising the forces of nature.

The first objection with which one is met is that the wind is so variable in its force that it cannot be relied upon. The fact of its being variable is undoubtedly true, but a close examination of the records of the Meteorological Office for many widely-scattered districts of this country shows that, while the force of the wind varies over wide limits, it very seldom falls below such a pressure as will provide quite a considerable amount of power.

Of course, storage is essential, but so also is it essential in the case of the gas or oil plants mentioned above, and the factor which must determine the possibility of using wind-power on a commercial basis will be the comparison between the average daily requirements, and the average daily power available according to the Meteorological records for the district.

Mr. Horsnail in his interesting articles of 12 years ago dealt with a house having 100 21-c.p. lamps, but probably a much larger field is open for houses with only 100 10-watt lamps, of which a large number are scattered over the country in the form of farms, and the more moderate-sized country house, with fourteen or fifteen rooms.

For such a house, if lighting only is in question, an extremely small plant can be installed. It is seldom if ever advisable to install a tower lower than 30 ft. high, or a wheel of less than 14 ft. in diameter, because the saving in cost between a 14 ft. and a 12 ft. wheel is inconsiderable, and anything below a 30-ft. tower is subject to air eddies that undoubtedly reduce the efficiency.

The question then arises as to what power should be available from such a wind engine, and this is a matter which can be determined with some degree of accuracy from the records referred to above, which are available for a very large number of stations throughout the country.

As a general rule it will be found that there are very few days indeed throughout the year in which a breeze of 10 miles per hour and above, is not available for several hours per day, and a wheel 14 ft. in diameter will place at our disposal rather over 7 B.T.U. in the 24 hours, with a 10 mile an hour breeze, and should this rise even to a small extent during the day, the power will be increased in a very much greater ratio than the increase of wind velocity.

The records which the writer has used do not differentiate between a wind velocity of 10-20 miles per hour, so that in all probability the available power would be nearer 18 B.T.U. than the figure given aboveof 7 B.T.U. per 24 hours.

Houses such as it is proposed to consider would not require, even in the darkest months of the year, more than about 4 B.T.U. per day, the maximum lighting load being probably in the nature of 500 watts, so that any balance provided by the wind engine will be available for other purposes, and cooking and heating at once come into consideration.

If it is decided to use any balance in the first place for cooking, it will be well to consider what will be the requirements of such a house, and from the writer's personal experience he would be disposed to suggest that for a 14-roomed house with, say, six people, from 10 to 12 units per day for cooking in winter and rather less in summer, will be a very full allowance, so that the power available from our small wind engine would practically always be ample to supply not only the light, but also the power required for cooking, and in times of calm the lighting supply can easily be safeguarded by transferring the cooking to the ordinary kitchen range.

By increasing the height of the tower to 40 ft. and the diameter of the wheel installed to 16 ft. a very much larger margin of power can be obtained, and in all probability for such a house as we are considering a certain amount of electric heating could be indulged in during the winter months, for one finds that during the six winter months even including the calm period noted by Mr. Horsnail, which appears to be fairly widespread over the country, there is usually an average of seven hours per day when the wind velocity will be well into force 5, which with the 14-ft. wheel even would give us in those 7 hours about 12 B.T.U. as a minimum, and with the 16-ft. wheel about half as much again.

In all these figures allowance has been made for loss in the storage battery, but this will not be applicable to the whole of the power generated, because in practice a very considerable proportion of the power will be used direct, particularly where cooking and heating apparatus is installed.

In the case of a small plant using a battery of 120 ampere-hours capacity, the units generated by the wheel were metered, and also the units actually used in the house, and the overall efficiency for a full years run came out as high as 80 per cent.

The wind engine and battery floated together on the line, and it was quite apparent by watching the instruments that the wind engine supplied direct to the house its maximum capacity for the wind velocity at the times of observation, the balance only being taken from the battery if the load was too great for the engine.

In deciding upon the size of the plant, considerable care must of course be taken to balance the various units, and it will be found wise to install a dynamo which might at first appear slightly too small for the wind engine power available. This will be readily understood when it is considered that for quite two-thirds of the year the plant will be running below the maximum possible, and it is better to overload the dynamo somewhat in maximum velocities rather than have unproductive capital expenditure, and an unduly heavy unit.

Again, a mistake may be made in the size of the battery which can more easily be of too large a capacity than too small, as ones instinct is to provide the maximum storage capacity without realising that the best efficiency will be got by calculating on the charging capacity of the dynamo at considerably below the maximum wind velocity

Some adjustment of the governor of the wind engine is very certain to be found necessary after the plant is put to work so as to ensure (1) that the best use is made of the average prevalent wind velocity, and (2) that the battery is not overcharged systematically.

The extra charging that the battery may get in the case of a gale will probably not do it any harm, but the thing to guard against is systematic over charging at a low rate which causes rapid loss of capacity.

The figures given by Mr. Horsnail for the costs of running such plants certainly do not err on the low side. Wind engines of the type suitable for this work have been running for years on other work without costing more than £2 or £3 altogether for repairs. Such painting as is necessary is a very inexpensive job, particularly if one of the modern sprayers is used for the purpose. Battery renewals and depreciation must, of course, be allowed on a substantial basis.

The writer hesitates to give any figures for plant at the present time, because prices are quite different to what they were 5 years ago, when the last of the installations with which he has been concerned was erected, but something far below the figure of £500 given by Mr. Horsnail should amply cover a complete installation of a 14 to 15-roomed country house or farm, including the wiring and cooking and some heating apparatus.

On high ground, in localities where the records show high average wind forces, quite an ambitious scheme might be indulged in, and it will of course be evident that where the house is placed within comparatively easy reach of the sea, owing to the higher average velocities in such districts, ample provision should be made for utilising all the natural power available.

In this country probably the disc type of mill will find most favour, though in Denmark and Holland the perhaps more picturesque arm type seems to give good results.

Of course, there will be objections to the adoption of these wind engines on aesthetic grounds, but we have as a nation got to be a good deal more careful of our coal resources than has been the case in the past, and while it is not suggested that people should erect wind engines on the tops of their houses in towns, it certainly is suggested that no country house suitably situated should neglect to use such power as may be available, and that farms where electricity would undoubtedly be of great use for many purposes, including perhaps the electrification of crops, should certainly consider them as a necessary adjunct to the general farm equipment.

It is not suggested that the adoption of a windpower policy should materially affect the proposed super-power schemes, but it might undoubtedly, if co-ordinated with those schemes, effect a considerable saving in the matter of supplying districts and villages lying off the line of the main trunk supplies, and so bring us nearer to the universal electrical age which so many are already prophesying.

If Government gave even the smallest encouragement to the idea, there is reason to think that good results would be obtained, but it must not be left to unqualified men to advise on the erection, or frequent failures by the adoption of unsuitable sites or plant would result.

Notes on the Meeting of the British Association.

The meeting of the British Association at Bournemouth was held last week under conditions which may be described as ideal, and the number of visitors that were attracted to the meeting was considerable, amounting to 1,500, though this cannot be regarded as in any sense a record. The Presidential Address was delivered by the Hon. Sir Charles A. Parsons in the evening of Tuesday, while the Sectional Addresses were delivered in the morning. Abstracts of the Presidential Address and of Prof. A. Gray's address to Section A, and Prof. J. E. Petavel's address to Section G, were given in our last issue.

It may be said in a general way that the Papers read before Sections A and G were not as interesting to the average physicist or to the electrical engineer as was generally the case in pre-war days. In fact, in Section G there was nothing of direct electrical interest beyond certain Papers on wireless telegraphy and kindred subjects, and possibly Prof. Thornton's Paper on Heat Insulators. The proceedings of this Section were otherwise taken up by subjects of military engineering interest.

Prof. Gray's Presidential Address to Section A was immediately followed by the report of the Committee on Radio-telegraphic Investigations. This will be found in another column, together with some notes contributed by Prof. W. H. Eccles on observations which were taken during the recent eclipse.

Wednesday, September 10th.

Discussion on Thermionic Valves.

The proceedings in Section A on Wednesday consisted mainly in a discussion on thermionic valves.

Prof. W. H. Eccles, in opening the discussion, remarked that the three-electrode vacuum tube had produced a revolution in radio telegraphy in the last few years. Previously, spark transmission and crystal detection of radio signals were used. Now, high power stations for long-distance transmission generally generated continuous waves, and at the receiving station beat reception by means of three-electrode valves was becoming more general. Reception of much weaker signals was now possible, and the range of a transmitter had been extended enormously beyond what it was in 1913 by employing the three-electrode valve. Magnification of the signal, probably 100,000 fold, was now possible by means of a receiver employing valves.

The valve had another use as a producer of high-frequency oscillations and for modulating high-frequency oscillations, as, for example, in wireless telephony. Dr. Eccles proceeded to describe the parts of a valve, and showed photographs of a French valve and an American army valve.

Electrons were emitted from the filament and passed through the control electrode (grid) to the anode. By reason of their small mass the electrons showed no tardiness in responding to changes of potential impressed upon the grid, and the anode current faithfully recorded changes in the potential of the grid. The filament was usually of tungsten, but metal filaments coated with oxides, such as lime, had been used. The valve was a magnifier—*i.e.*, a P.D. of 1 volt applied to the grid might have the same effect upon the anode as a potential of 20 volts applied to the anode circuit. The first three-electrode valve was made by De Forest; but many brains had been involved in bringing the valve to its present condition.

Using as a means of detection an amplifier in conjunction with a vibration galvanometer, alternations of amplitude of 10^{-10} volts applied to the grid at a frequency of 10–20 per second could be observed by the galvanometer. It thus ought to be possible to transmit signals across the Atlantic with insulated cables having exposed ends dipping in the sea at places 50 miles apart with a transmitting current of about 20 amperes.

Fig. 1 showed how the valve could be used as a generator of oscillations. The following mechanically operated circuit (Fig. 2) was of use in explaining the action. M_1 M_2 were two electromagnets placed near the limbs of a tuning fork, T. If by chance any change took place in the current through electromagnet M_2, the tuning fork was attracted, and, both limbs moving together, an E.M.F. was induced in the coils of the electromagnet M_1, which E.M.F. affected the potential of the grid. The magnet M_1 could be so arranged that the change of potential of the grid tended to increase the original change in the anode current, and under such circumstances the tuning fork would vibrate with proper adjustment of the magnets M_1 and M_2. This Dr. Eccles demonstrated. If the filament was dulled by lowering the filament current, then the oscillations died away. A condition could be reached where the oscillations were just not possible. If then a small current of the same frequency as the tuning fork was applied to the anode circuit through the transformer shown in the diagram, then the oscillations would gradually build up, and the tuning fork would begin to vibrate. This method was only applicable when the stimulus was of the same frequency as the fork.

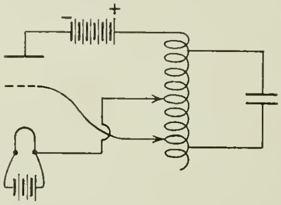

Fig. 1.

Dr. Eccles then described the auto-heterodyne method of reception. The magnification by this method was extremely large, possibly of the order of 100,000. An interesting application of this circuit was mentioned. A beat of one per second was obtained. Then, without changing any other part of the circuit, coal gas was used as dielectric for the condenser instead of air. The beats noted were three per second, and the change in the capacity of the condenser, and hence the dielectric constant of coal gas relatively to air, could be calculated. By this method a change in capacity of $\frac{1}{1000}$ cm. could be detected.

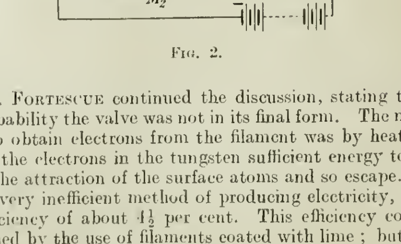

Fig. 2.

Prof. Fortescue continued the discussion, stating that in all probability the valve was not in its final form. The method used to obtain electrons from the filament was by heating it, giving the electrons in the tungsten sufficient energy to overcome the attraction of the surface atoms and so escape. This was a very inefficient method of producing electricity, having an efficiency of about $4\frac{1}{2}$ per cent. This efficiency could be increased by the use of filaments coated with lime; but these, for some reason at present unknown, ceased to have the power of emitting electrons after use. Another disadvantage of the thermal method of producing the electron emission from a filament was that the velocities with which the filaments emitted varied considerably, the energy being distributed among the emitted electrons according to Maxwell's law. It would thus be advisable to search for some method of producing electron emission without heating the filament.

Another difficulty in the manufacture of valves was that of removing the last traces of gas from the bulb. Gas was occluded in the glass and the interior metal parts. The gas might be in solid solution in the crystals of the metal, or in the interstices between the crystals. How it was retained was doubtful. The method of removing the gas was to submit the metal parts during evacuation to a higher temperature than they would be subjected to during normal use. The gases that appeared in a valve had been examined in two ways: Firstly spectroscopically, and secondly by measuring the potential at which a sudden change in the anode current occurred as the anode voltage was increased, the grid being connected to the anode. This indicated the voltage at which ionisation occurred.

Another unexplained phenomenon which occurred was that when a higher anode voltage was used than normally, a valve tended to harden; but with very low anode voltages a tendency to soften was noticed.

Another drawback was the fragility of the glass envelope. Glass also had the disadvantage that chemical action took place at the points where the metal stems passed through the glass. Further, the bulb could not be heated to a very high temperature during exhaustion, because it was liable to collapse. De Forest had patented a valve in which the metal anode was itself the case, but it was improbable that the seals indicated would permit a good vacuum to be maintained.

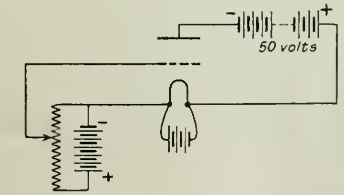

FIG. 3.

Mr. B. S. GOSSLING traced the experience of an electron in its path from the filament through the grid mesh to the anode. Manufacture of valves during the war had improved considerably, so that valves with very similar electrical properties could be made on commercial scales.

Major R. WHIDDINGTON mentioned a few applications of the valve to problems in physics, and indicated how the permeability of a gas could be measured by using a method similar to that described by Dr. Eccles for measuring the dielectric constant of a gas.

Major Whiddington then read a Paper on "Self Oscillation in Valves," in which he stated that oscillations had been obtained in a circuit without employing inductance and capacity. The circuit used is shown in Fig. 3. A soft valve was necessary. The phenomena depended upon intermittent emission of electrons from the filament. An electron leaving the filament took a definite time to traverse the distance from filament to grid. If the electron could there ionise, the positive then formed would take another definite time to pass to the filament. Major Whiddington assumed a cloud of electrons leaving the filament and producing a cloud of positive ions which returned to the filament, and created by bombardment a further cloud of electrons, so maintaining the process. The periodic time was the sum of the times taken by the electron to reach the grid, and that of the positive ions to pass from grid to filament.

Thursday, September 11th.

On Thursday, the centre of interest shifted rather to the Economic and Educational Sections. Dr. H. M. Vernon, whose work on industrial fatigue is well known, opened a discussion on Lord Leverhulme's idea that works should be run on two shifts, each of only six hours. He dealt largely with the effect of decreased hours on rate of output, and his conclusion was not favourable to the six-hour shift. Probably the eight-hour shift did not cause more than a moderate amount of fatigue, the real trouble being due to monotony and boredom.

Mr. P. S. FLORENCE stated that investigations on this subject had been carried out by the National Research Council, of America, and their main report would be issued shortly. Rhythmical movement had been shown to be important, and an eight-hour day was generally favoured.

There was considerable discussion on continuation schools. In this connection Mr. A. P. M. Fleming drew attention to the great importance of works schools. Not only were they good technically, but they ultimately led to more harmonious relations between the management and the workers.

In Section A, Prof. Horton and Miss A. C. Davies read a Paper on "The Ionisation of Argon and Helium by Electron Collisions." The authors described how electrons emitted by a hot filament produced two effects in a gas at low pressure. One effect was the well-known one of ionisation; the other effect occurred when the bombarding electron did not possess enough energy to ionise, but did disturb the electrons of the gas atom to such an extent that short-wave radiation was emitted. They measured the potential through which an electron must fall to perform these operations, and found that for helium the resonance and ionising potentials were respectively 20·5 and 25·5 volts. For argon the values were 11·5 and 16·1 volts respectively.

In the discussion on this Paper Mr. Goucher agreed in the main with Dr. Horton, but stated that with helium he always got an ionisation effect with the radiation effect at 20·5 volts.

Friday, September 12th.

On Friday, in Section G, Capt J. Robinson read a Paper on "Directional Wireless with Special Applications to Aircraft," which we hope to publish next week. In the discussion on this Paper Prof. Fortescue requested more information with regard to the deviation of bearings obtained by loops used in Capt. Robinson's scheme from the true direction. These deviations were assumed to be of atmospheric origin. Prof. Ewing stated that the location of Zeppelins by wireless surveying was probably in operation by us before the Germans themselves used it in directing the course of their raiding aircraft. This was followed by a Paper by Prof. C. L. Fortescue on "The Three Electrode Thermionic Valve as an Alternating Current Generator," of which we publish the first portion in another column. Two Papers were also read by Prof. W. H. Eccles and F. W. Jordan on "A New Arrangement for Generating Oscillations by Using Thermionic Valves," and "A Trigger Relay Operated by Thermionic Valves." These two Papers will be found on another page.

Dr. W. A. Herdman, F.R.S., has been appointed President of the Association for the year 1920-21, when a meeting will be held at Cardiff. The names of Prof. A. Fowler, Prof. A. W. Kirkealdy, Dr. W. H. R. Rivers and Dr. E. H. Griffiths have been added to the Council. In response to a deputation inviting the Association to hold its meeting in 1921 in Edinburgh, the invitation was unanimously and gratefully accepted. Prof. J. Perry was re-appointed general treasurer.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, of receipt of published price, plus postage.]

"Electricity in the Service of Man." By R. Mullineux Walmsley, D.Sc. (London: Cassell & Company.) Vol. II., Section II. Pp. vii. +691. 10s. 6d.

"The Study of the Weather." By E. H. Chapman. (Cambridge: University Press.) Pp. xii. +131. 3s. 6d. net.

"An Enquiry Concerning the Principles of Natural Knowledge." By A. N. Whitehead, Sc.D., F.R.S. (Cambridge: University Press.) Pp. xii. +200. 12s. 6d. net.

"Automobile Batteries." By H. H. U. Cross. (London: E. & F. N Spon.) Pp. viii. +101. 4s. net.

The Municipal Tramways Association.

The 18th annual conference of the Municipal Tramways Association has been held this week at Dundee, where a programme has been provided of both technical and social interest. The proceedings opened on Wednesday with a reception by the Lord Provost (Sir William Don, K.B.E.), after which Mr. T. B. Goodyer (general manager of the Corporation tramways at Croydon) delivered his presidential address. This was followed by a Paper entitled "Where do we Stand?" by Councillor Kelly (convenor of the Glasgow Corporation tramways). On Thursday Mr. A. R. Fearnley, of Sheffield, read a Paper on "Motor Omnibus Services."

Next week we hope to give some further account of the proceedings, but meanwhile we give in what follows abstracts of these three Papers.

Presidential Address.*

By T. B. GOODYER.

We have arrived at a settlement of some problems which caused great anxiety. In regard to the application of the National Transport Workers' Federation for reduced working hours and variations in conditions of labour, every credit is due to those tramway representatives who had to carry out the negotiations with the parties interested, and who arrived at an agreement which fixed conditions of service for the whole of the undertakings The revised conditions will entail a considerable increase in working costs, and we, as employers, have the right to look for increased efficiency on the part of the workers. The owners of tramways, be they ratepayers or shareholders, are entitled to their share of the benefits, and those using the cars should be willing to pay such fares as will give a reasonable return on the capital. As Mr. John Young said in his Presidential Address of 1902, it is well for each Corporation to study their own fares and feel their way before making concessions which they may not be able to live up to. The tramway situation two or three years hence is likely to cause us some concern, when there is less money to spend on fares and when operating expenses will not be much less than now, and we should not take too rosy a view of the immediate future. The formation of the Joint Industrial Council for the tramway industry entailed an enormous amount of labour upon the Executive Council, and it was a matter of considerable satisfaction to me when we met in London in May last to have the constitution endorsed with a few minor amendments.

I felt proud when I read the words of Sir Eric Geddes in introducing the Ministry of Transport Bill: "Except in the one bright instance of the municipal tramways, the transportation systems of this country are not prosperous. Taken all over, these undertakings are earning 7 per cent. on their capital. They are excluded from the Bill." The Ministry have no intention of taking over the working of our tramways. The recently issued report of the Select Committee on Transport (Metropolitan Area) recommends the setting up of a "Supreme Traffic Board for Greater London. It is greatly to be regretted that such a Board has not been set up previously. No doubt the reason is due to "other" interests blocking the way. It is to be hoped, however, that the problem of London traffic will now be seriously grappled with. The Board will accomplish much if it eliminates, to quote the Committee, "senseless and costly competition." The view is generally entertained that the competition with the municipal tramway undertakings, except during the period of the war, has been "aggressive" in character.

The Select Committee condemned the inequitable rating of tramways, and their contribution towards the maintenance of the surface of the roads, as compared with the immunity of the omnibuses from both these charges. The special report of the Local Legislation Committee of last session refers to the anomaly of the compulsion upon municipalities to contribute to the upkeep and the cost of reconstruction of roads, and the immunity of private enterprise therefrom, especially so far as motor omnibuses are concerned. This question, and the allied subject of rating of tramways, have recently occupied the attention of the Tramways Committee of the London County Council. They are both subjects that are ripe for reconsideration. During the last 49 years we have passed through three distinct stages in tramway development as distinct as the stages in geology, and yet we are tied down to the conditions of 1870. In the horse period there was something to be said for the obligation on tramway owners to maintain roads, but now not a single sett is damaged by the rolling stock; the steam period was from 1879 to 1898, and now we have the electricity period.

Housing and transport in the immediate future are two of the most important matters which will enter into social politics, and tramways especially (and also rail-less traction and motor omnibuses) will play a most important part in the new social life and development which is about to be inaugurated in linking-up new housing areas with industrial towns. A Select Committee on Motor Traffic reported some years ago that the duty of originating and accommodating traffic schemes and regulations is a municipal duty. The control of the streets is essentially a municipal function, and the same minds should have before them the question of the adequacy of the street facilities for traffic and its regulation. Lord Islington said recently in the House of Lords that rapid, regular and cheap tramway facilities are an integral and indispensable part of a successful housing scheme.

I have pleasure in welcoming the new general secretary (Mr. J. Beckett) to his first conference of our Association. I have to congratulate the members upon the completion of another year's successful working, which will rank as the busiest, most strenuous and most important year of the Association's existence. The Association is indebted to Mr. W. Clough, Mr. Holford and Mr. Fearnley for their help.

Where Do We Stand?*

By Councillor KELLY.

During the past five years the tramway industry has been carried on under great difficulties. All our ingenuity and our energy have been expended in keeping the car wheels revolving. There have been very few extensions made and the new introduction of new and improved methods has been inevitably neglected. I therefore ask the question, Where do we stand? This question we must endeavour to answer, and to make whatever plans may be necessary to ensure that our tramway systems are placed on a thoroughly sound footing and are carried on in the most efficient way.

I may amplify the question by asking—Where do we stand: (1) Politically? (2) Mechanically? (3) Electrically? (4) Economically? and (5) Traffically?

Where Do We Stand Politically?—In regard to the first it is necessary that we should come to some definite understanding as to what is to be our policy in regard to the tramcar. Some of us have already statutory powers for considerable extensions throughout the districts surrounding our various urban communities. We are now faced with the problems of the motor bus and the enormous cost of laying new lines. We must provide better travelling facilities than we are giving to-day. In some places our people are going to be more spread out. What means of transit can cope with this traffic in the most efficient way? Some favour the railway, others the motor bus, and, of course, a great many call for the extension of the tramway. Each has its limitations, but the most popular means of travel to-day is the tramway.

If the tramcar holds the field, and the spreading of the population must be met by an extension of the tramway systems throughout the country, we will be faced with a huge amount of work. We must consider whether we can make more tramways along their own right-of-way; whether there could not, with advantage, be more amalgamation of tramway concerns. There are at present too many tramway authorities. The electric car should not be confined as it has been in some places up till now. I believe we have in the electric tramway an instrument which is far ahead of any other for spreading the population.

Where Do We Stand Mechanically?—Are we thoroughly up-to-date in our plant, chiefly in our rolling stock? Have our managers selected the best type of car for each set of conditions? The car which is best for one tramway undertaking might not suit another. This, of course, is a managerial question, but we Committee men all take an interest in details. If a car looks well it is almostcertain that the equipment is being well maintained. During the past five years all tramway concerns have had difficulty in obtaining material. In many places the track is in a dreadful condition. Contracts for rails have had to be abroad, as the only alternative was to allow the track to go to ruin.

Where Do We Stand Electrically?—This question does not affect most tramway undertakers, as the bulk of tramway committees purchase the current for the tramways from another department of the Corporation. Great changes are shortly to be introduced into the electrical world. Our great concern just now is the supply of coal. The price is bound to go up, and we doubt whether we shall get throughout this winter sufficient coal to meet our requirements. In 1901 we purchased better coal at 6s. 9d. per ton than we are getting to-day at 29s.

How Do We Stand Economically?—This is perhaps the most important question. The revenue of a tramway undertaking consists almost solely of passenger fares ; there are only one or two tramways on which fares have not during the past three years been increased. Only a very few have been able, however, to increase the statutory maximum. These increases have almost invariably resulted in a largely increased revenue. Passengers are prepared to pay any reasonable increase.

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* Abstract.

* Abstract.

Some years ago there was a controversy between the tramwaymen in this country and the street railwaymen of America as to whether our system of graded fares or their system of a flat fare was the proper system. The 5 cent flat fare in America, owing to the increase in expenditure, is now found to be too low ; some companies have increased the flat fare to 6, 7 and 8 cents. This means that there is no short-distance travel, and the revenue is not increasing, a very serious state of matters.

With us at present our revenue is all right, but what of our expenditure, consisting mainly of wages, which have risen since 1914 over 100 per cent. We have simply had to pay wages which have been fixed for us, and prices for material which we were powerless to question. Both municipalities and companies will require to expend large sums in extensions and for increased plant and equipment. Will we be able to borrow the necessary capital ?

The provision for depreciation and the cost of renewals must now be increased by at least 100 per cent. The profit of a tramway should not merely be handed over in relief of rates, but a tramway should not become a burden on the rates. The fares charged should yield sufficient revenue to meet operating expenses, maintain the undertaking and meet all fixed charges. Many of our municipal systems are too small and circumscribed ; all that is wanted to ensure financial success is a linking up.

Where Do We Stand Traffically?—I may have coined a new word here, but the meaning is plain. During the war we had all great difficulty in maintaining a satisfactory service. Other means of travel disappeared or were restricted, and the cars had to bear the burden. In many places we are not any better after 10 months of peace.

If the population of our towns and cities grows steadily for the next few years, we must tackle the question from the point of view of all classes of traffic. My own view is that if the city traffic were scientifically regulated, we could use the surface of our streets to better advantage than we do at present. In most towns and cities the great bulk of the streets are quiet, even deserted, while the few streets are congested beyond measure. As the population increases and spreads itself over a wider area, our difficulties will increase, and steps must be taken immediately to relieve congested main arteries by opening up new ones. Some cities have a by-law under which slow traffic must keep as near the kerb as possible. This has been found of great service to all fast traffic. Some cities also have a by-law which prohibits any kind of traffic passing between a tramcar and the kerb at a stopping place when passengers are entering or leaving. This by-law is also of service if strictly enforced.

I have not touched on the labour question, the settlement of disputes, the inauguration of Industrial Councils. These matters will all be very much in evidence in the near future. The work of the Municipal Tramways Association is really only beginning. Tramway men should get facilities for studying what is being done on the various tramway systems, not only in this but in other countries. In the years to come tramwaymen will play an important part in solving the problem of our "Ways and Communications."

Motor Omnibus Services.*

By A. R. FEARNLEY.

On recent occasions, when road passenger transport has been under discussion, it has been suggested that extensions of electric tramways should not be made, but that further transport facilities required on the roads should be provided by motor omnibuses. I propose to look at the question from the point of view of the municipality engaged in passenger transport work, and to show as a result of the experience gained whilst working motor 'bus services as auxiliary to a large tramway system, during the past seven years, how and to what extent motor omnibuses can be best made use of. It is comparatively easy for any municipality to obtain powers from Parliament to work motor omnibuses within their own district, and they can also obtain powers to work omnibuses in adjacent districts on varying terms.

In 1907 the Sheffield Corporation obtained a clause which reads as follows : "The Corporation may provide and run motor omnibuses within the city and also in connection with their tramways in certain districts adjoining the city on the following routes." Most of the main roads leading into the city are now provided with 'bus services ; on those which are not so provided powers have been obtained, and in a short time services will be in operation. Another clause provides that the Corporation shall make payment to the road authority of ⅜d. per 'bus-mile run by their motor omnibuses ; also, that the Corporation shall not be required to make any payment in excess of the sum of ⅜d. per 'bus-mile in respect of any road which has not been constructed or re-constructed so as to be adapted for mechanical traffic. Further clauses exempt the Corporation from payment in respect of the cost of raising the standard of any road to meet the requirements of mechanical traffic ; if a grant from the Imperial Exchequer is made towards the cost of maintenance, the amount to be paid by the Corporation is to be proportionately reduced. The Corporation may demand and take reasonable fares and charges for the conveyance of passengers and parcels by their motor omnibuses.

These clauses remain operative for at least five years from the 31st March, 1919, and were settled by agreement with the West Riding and Derbyshire County Councils in the summer of 1918, after five years' experience of the running of the motor 'bus services over their roads.

The Sheffield Corporation have now services covering 37 miles of road, of which 15 miles is within the city boundary and 22 miles outside the city, on County Council roads, employing altogether about 40 motor omnibuses. At least half-a-dozen additional routes are contemplated. The results of the first three years were excellent, but war conditions, especially the last two years, made the working of the services difficult, and at times, owing to the inability to obtain spare parts and carry out repairs, almost impossible. Expenses have increased enormously—that is, from 7d. per 'bus-mile at March, 1915, up to 14d. in 1918 and 17·8d. in 1919. The expenses for the last two years are as follows :—

Sheffield Expenditure.

	1915. Average per 'bus mile. Pence.		1918. Average per 'bus mile. Pence.		1919. Average per 'bus mile. Pence.
Traffic expenses	3·012	...	4·931	...	7·086
General expenses	0·370	...	0·380	...	0·532
Repairs account	1·915	...	4·411	...	4·528
Road maintenance account	0·055	...	0·146	...	0·200
Power expenses (petrol)	1·683	...	4·154	...	5·550
Total working expenses	7·035	...	14·022	...	17·896

The vehicles consist at the present time of 26 Daimlers, 12 A.E.C., one Tilling-Stevens, and one Pagefield (the two latter having been purchased for trial purposes), 75 per cent. being double deck and 25 per cent. single deck 'buses. On country roads the single-deck 'bus is the more satisfactory type of vehicle ; but the preference in the district for the double-deck 'bus is so pronounced that we have tried to meet this requirement, at the same time obtaining the advantage of the greater seating capacity of the double-deck over the single-deck vehicle.

The roads and districts which we work and provide with motor omnibuses are (1) city roads, largely parallel with existing tramway routes, which connect up with busy tramway tracks and routes through districts not fully served by the tramways ; (2) roads branching off from tramway routes into districts where there is much traffic, into the country where the scenery is attractive ; (3) extensions to existing tramway routes which mainly have their terminal points at the city boundary into adjacent villages and rural districts, reaching as far as 7 miles from the tramway terminus. On all roads the motor omnibuses have proved successful. No. (1) class of service (city routes) provides a great public convenience for short distance cross-town traffic through streets and districts which cannot be served by cars ; on roads branching off from tramway routes (2), the traffic developed has been enormous. Roads previously served by horse-drawn char-à-banc, and in some cases having no services at all, soon called for regular 20 minutes service on week-days and six or seven minutes services at the week-ends.

The third class of route, extensions to existing tramway routes, should have the serious attention of all municipalities who have made themselves the transport authority for their district. Besides paying their way as omnibus routes, they brought a great amount of traffic to the tramways which formerly did not reach them, as illustrated by the following data for the last completed week, ended August 17, 1919 :—

Receipts	£2,172. 7s. 11d. (fare 1½d. per mile)
Passengers carried	159,371
Miles run	20,768. (Lost mileage, 59 miles.)
Receipts per 'bus mile	25·1d.

Receipts per 'bus mile up to date this year are 23·59d.

The traffic on 'bus routes is, of course, greater in the summer months than in the winter months, the ratio of difference being much greater than on the tramways. The residents in the villages make many more journeys into our city than they formerly did, and the young people take advantage of the services for attending educational institutions. Applications for special 'buses for evening parties, week-end outings, schools and other bodies desirous of travelling into districts not served by tramcars are very numerous, and if encouraged this business becomes a regular and profitable one. The population of the districts served vary from 1,000 up to 22,000.

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* Abstract.

Having now explained how motor omnibuses are operated, I will give some results which demonstrate that the suggestion of superseding tramways by motor omnibuses requires further and deeper examination, and is not likely to be adopted.

The motor omnibus, so far as it has been developed up to date, is :—

1. An excellent vehicle in acting as feeder of and in connecting up tramway routes and services.
2. An unsuitable vehicle for satisfactorily dealing with heavy town traffic.
3. Quite inadequate for dealing with our peak loads.
4. Financially impossible for workmen's traffic at reduced fares.
5. In regard to average speed maintained throughout the day, has no advantage over the electric tramcar.

The first point has been clearly shown by the description of the 'bus services in Sheffield.

The maximum seating capacity that we have so far been able to provide is 37, against the maximum of 76 permissible on the latest type of tramcar. As the cars seating 76 are comparatively of recent construction, it would be fairer to compare them with the new type of 'bus being put on the streets by the London General Omnibus Company and seating 46 passengers. A great difficulty is that only 22 passengers on the new type of 'bus are provided with cover, whereas the whole of the 76 passengers on the tramcar are under cover and travelling under reasonably comfortable conditions, whatever the weather conditions may be. There are very few tramcars running to-day in busy and thickly-populated districts without top covers. For dealing with the peak loads, the Sheffield type of 'bus, with its maximum of 37 seats, would be of little use.

It is perhaps, however, scarcely fair to ask that the development of the motor omnibus, which has taken place during the last eight or nine years, should be compared with the development of the electric tramcar over a period of 20 years. There is no doubt the latest London 'bus, which carries 46 passengers, is a great step forward.

It must be borne in mind that the 3 ton 10 cwt. maximum weight allowed for the London 'bus is of no use for the provinces. The makers to-day decline to build a body of that type for use in the provinces, owing to the short life and heavy repairs. 4 ton 10 cwt. is the minimum weight of a double-deck omnibus for roads such as are found in our district, and the difference in weight of vehicle per passenger carried in the provinces is, therefore, very little in favour of the motor omnibus as compared with the tramcar.

With regard to expenses, some figures for the year ended March 25, 1919, are appended comparing tramcars and motor omnibuses, and include (1) average expenses per mile run, (2) average expenses per passenger carried, (3) average expenses per seat provided. The figures show that (1) the revenue expenses of running the motor 'bus is 44·5 per cent. more than the tramcar. After giving the motor omnibus the benefit of its comparatively lower capital expenditure, it still costs 33·7 per cent. more than the tramcar to work per mile. (2) The revenue expenses per passenger carried on the motor omnibus are 198 per cent. more than on the tramcar. The total expenses per passenger carried are 176 per cent. more on the 'bus than on the tramcar. (3) Again, per seat provided, the omnibus revenue expenses are 131·3 per cent. higher than the tramcar revenue expenses. The total expenses per seat provided are 114·1 per cent. higher on the 'bus than on the tramcar. The average speed of the 'buses is 9·97 miles per hour. The average speed of the tramcars is 8·65 miles per hour. That is 15·26 per cent. in favour of the 'bus.

As 75 per cent. of this 'bus mileage is run on urban and rural roads, under similar conditions the speed of the tramcar in the provinces is easily equal to the speed of the 'bus, so that in this respect there is nothing to choose between the two vehicles.

What is very necessary at the present time to assist the motor omnibus undertakings in carrying out their work is a plentiful supply of fuel at a price ½d. or 1d. below the monopoly price of petrol. Sufficient work is available for both cars and omnibuses, and it is futile for partisans to speculate upon the disappearance of one or the other. The motor omnibus is not going to supersede the electric tramcar. It can, however, serve a most useful purpose :—

1. For connecting up tramway routes for cross-town traffic which cannot be served by tramcars.
2. For relieving congested tramway routes by diverting part of the traffic along other routes.
3. For connecting up the villages and rural districts with the tramways and railways, and thereby providing such districts with regular and direct transport facilities which they have hitherto badly lacked.

COMPARATIVE FIGURES—EXTRACTED FROM THE 1918-19 SHEFFIELD ACCOUNTS.

Average Expenses.

1.	Tramways per car-mile.	Motor omnibuses per 'bus mile.	'Bus expenses are
Working expenses ...	12·388d. ...	17·896d. ...	44·5% more than trams.
Service of debt (capital)...........	1·688d. ...	0·923d. ...	45·3% less than trams.
Total revenue and capital expenses ...	14·076d. ...	18·819d. ...	33·7% more than trams.

Average Expenses.

2.	Tramways per passen-carried.	Motor omnibuses per passenger carried.	'Bus expenses are
Working expenses ...	0·716d. ...	2·137d. ...	198·0% more than trams.
Service of debt (capital)...........	0·098d. ...	0·110d. ...	12·3% more than trams.
Total revenue and capital expenses ...	0·814d. ...	2·247d. ...	176·0% more than trams.

Average Expenses.

3.	Tramways per seat provided per car-mile run.	Motor omnibuses per seat provided per 'bus-mile run.	'Bus expenses are
Working expenses ...	0·230d. ...	0·532d. ...	131·3% more than trams.
Service of debt (capital)...........	0·031d. ...	0·027d. ...	12·9% less than trams.*
Total revenue and capital expenses ...	0·261d. ...	0·559d. ...	114·1% more than trams.

Traffic Receipts.

4.	Tramways per car-mile run.	Motor omnibuses per 'bus-mile run.	'Bus receipts are
Traffic receipts	16·563d. ...	20·457d. ...	23·5% more than trams.
Traffic receipts per seat provided	0·307d. ...	0·608d. ...	98·0% more than trams.

Fares.

			'Bus fare per mile is
Average fare charged per mile	0·652d. ...	1·5d. ...	130·0% more than trams.

Correspondence.

PREDICTING MAGNETIC STORMS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : In the case of the magnetic storm of September 25, 1909, I was struck with the fact that this coincided with the opposition of Mars and that the declination of that planet was then only about 4 deg. This coincidence suggested the hypothesis that the earth on that day was passing through a well-defined stream of radiant energy (perhaps a stream of electrons) passing between the sun and Mars somewhat like an arc stream between electrodes.

The earth's passage through such an electronic stream might account for the magnetic storm ; and on the assumption that similar streams existed between the sun and each of the planets and each of the asteroids, I concluded that a magnetic storm should occur whenever the earth passes through one of these streams or very near to one of these streams, the latter then being attracted towards the earth by the earth's magnetism.

I have since made observations from time to time which seem to support this theory in a significant degree.

Jupiter was in opposition on March 30, 1910, with a declination of only 2° 30′, and on that date there was a magnetic storm and well-marked displays of aurora borealis. There were no magnetic storms at the oppositions of Jupiter in April 1911 and May 1912 when the declination was 13° and

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*This is an important figure, and one which is oftimes entirely overlooked by the motor 'bus advocates—the impression usually left is that the difference in capital expenditure is much greater.

21° respectively, which might well cause the earth to pass too far over or under the electronic stream.

According to this theory there should have been a magnetic storm about September 17, 1915, when Jupiter was in opposition with a declination of only about 4°. These happenings were not publicly reported during the war, and I do not know whether a storm actually occurred. The Germans reported abnormal conditions, which interfered with their wireless.

The very severe storm of August 12, 1919, occurred when the earth was very nearly in line between the sun and the distant planet Uranus, the electron stream to which may have been deflected in the earth's direction by the attraction of the Perseids, combined with the earth's attraction; the actual opposition of Uranus being on August 23, 1919, with a declination of about 12°.

There was a magnificent display of aurora borealis and probably a magnetic storm (not reported publicly) when Uranus was in opposition about August 10, 1917.

I shall watch for interesting atmospheric conditions and magnetic phenomena from January 31 to February 3, 1920, when Neptune and Jupiter are both in opposition within that brief period. Saturn comes into opposition on February 28, 1920, but the declination of 9° 22′ is possibly too great to permit Saturn's stream to come within the sphere of the earth's magnetic influence.

I would like to know whether any magnetic storm was observed about October 8, 1909, when Saturn was in opposition with a declination of only 5° 40′.—I am, &c.,

London, Sept. 15. C. Orme Bastian.

THE DEVELOPMENT OF THE POULSEN ARC SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Owing to my absence from town I have only recently seen Mr. Elwell's letter in your issue of August 15th.

I hardly think the latter calls for any reply except to point out that as Mr. Elwell's visit to the Knockroe Station took place nine years ago, it is, perhaps, pardonable if he is now under the impression that the 30 kw. Poulsen arc was of German make, seeing that he "remembers" that it was separately excited. That, however, was *not* the case; and it was made in Denmark.

There was at the time also in the said station a 16 kw. arc of German make installed in 1906 by the first British company operating the Poulsen patents in this country. For some unknown reason that company had the greatest faith in German engineers and German work. Circumstances have happily changed since 1906!

As to the remainder of Mr. Elwell's letter, I am quite prepared to take his word when he says that he held, or holds, a large number of shares in the Poulsen Wireless Corporation of San Francisco, and at one time also was a director of that company as well as its chief engineer; but what this and the remainder of his letter has to do with the development of the Poulsen arc system I confess I fail to see.

I gave Mr. Elwell full credit for having reported favourably on that system when he examined the latter on behalf of the American group, and further than that I cannot go; and as far as this Syndicate is concerned, I see no purpose in continuing this correspondence.—I am, &c.,

For and on behalf of
The British & Overseas Engineering Syndicate, Ltd.,
Viggo Gandil, Managing Director.

London, Sept. 10.

[This correspondence is now closed.—Ed. E.]

District Whitley Council for the Electricity Supply Industry in the West Midlands.—At a conference held at Birmingham last Monday it was unanimously decided to set up a District Whitley Council for the electricity supply industry in the West Midlands. A small committee was elected to draw up a constitution.

Radiotelegraph Investigations—Report of B.A. Committee.*

The following Report was submitted at the meeting of the British Association at Bournemouth:—

During the past 12 months the war-time restrictions on wireless telegraphy have continued in operation. A few statistical records from British Colonial Radio Stations have been sent regularly to the Committee, and occasional information from other parts of the world has been received.

In connection with the solar eclipse of May 29th the Committee arranged for the carrying out of experiments on the effect of the eclipse on signals transmitted across the central line. The British Admiralty stations at Ascension and Azores transmitted continuously during the transit of the umbra across the Atlantic Ocean. Observing stations north of the Equator were for the most part asked to listen to Ascension for at least an hour round about the time when the umbra passed between themselves and Ascension; observers south of the Equator were asked for the most part to listen to the Azores. Certain selected stations north of the Equator were asked to listen to the Azores, so as to afford check observations upon the variations which might be observed in signals passing across the central line of the eclipse, and, similarly, selected stations south of the central line were asked to listen to Ascension. The American station at Sayville also transmitted a programme during a portion of the period of the eclipse, and arrangements were made for special experiments between Darien and the Falkland Islands, and between an Egyptian station and a South African station.

The main portion of the experiment hinged upon Ascension. The umbral cone passed from west to east, and was expected to affect in succession the strength in which signals were received at such stations as Demerara, Jamaica, the stations on the coast of the United States and Canada, stations in Ireland, England, France, Italy, in the Mediterranean and Egypt, and some German stations.

It is hoped to render an account of some of the records at the forthcoming meeting of the British Association at Bournemouth.

The thanks of the Committee are due especially to the Admiralty for arranging that their stations at Ascension and the Azores, and at Cairo, should transmit the necessary signals; and also to the American Government for making similar arrangements regarding Sayville and Darien. Thanks are due also to the American, French and Italian Governments, the Admiralty, the War Office, the Air Ministry and Marconi's Wireless Telegraph Company, Ltd., for undertaking observations and recording the variations in signal strength.

Dr. Eccles proceeded to state that a great volume of records had been received, but had not yet been thoroughly analysed. Some records were still en route. It was well known that the coming of darkness and light had a great effect on the strength of wireless signals. Hypotheses to explain the phenomena had been formulated but nothing generally accepted. During the eclipse of May 29th stations were asked to report upon the strength of signals transmitted from Ascension and Azores, and also to report upon the quality and strength of "strays." The conditions in different parts of the world differed considerably with regard to strays and rendered difficult the interpretation of the observations. In Demerara, for example, strays were few, but the day of the eclipse was an exceptional day, being the only clear day for many weeks. In Monte Video, and generally in equatorial waters, there were few strays. In land stations north of 30°Lat. the strays were many. In the British Isles, in France and in Italy, the strays were many and inconveniently strong. In South America they were weak. There had not yet been time to find any connection between the strays and the eclipse.

With regard to signals, European and American stations received the signals from the Azores; the latter station was, however, north of the shadow so that the shadow did not pass between the sending and receiving stations. Apparently, under such circumstances, the eclipse had no effect. Ascension signals were not picked up at Las Palmas, but were strong at Teneriffe. Demerara heard the Ascension signals and observed unusually strong fluctuations in signal strength. The shadow passed between these two stations. Stations near Lyons and Paris heard signals only when the shadow was between sender and receiver. Malta reported a similar observation.

Though strong reflection effects were alleged to occur at sunset, no similar effect was noticed during the eclipse. Monte Video, Durban and stations south of the shadow listened to Ascension, which was also south of the shadow and found no strengthening of signal. The tentative conclusions arrived at were that the penumbra had some effect in modifying signal strength and the umbra not the larger effect one would expect.

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* The Committee consists of Sir Oliver Lodge (Chairman), Dr. W. H. Eccles (Secretary), Mr, S. G. Brown, Dr. C. Chree, Sir F. W. Dyson, Prof. A. S. Eddington, Dr. Erskine-Murray, Profs. J. A. Fleming, G. W. O. Howe, H. M. Macdonald and J. W. Nicholson, Sir H. Norman, Capt. H. R. Sankey, Prof. A. Schuster, Sir Napier Shaw and Prof. H. H. Turner.

In the discussion which followed, Prof. Fortescue mentioned that receiving apparatus designed to eliminate strays was usually founded on the assumption that strays came from the upper atmosphere. It was also pointed out that the umbral and penumbral shadows were not separated by a definite line, but that the transition was very gradual.

Calculating Growth of Current in an Inductance.*

By Dr. CARL HERING.

The formula for calculating the curve of the rise of growth of the current in an inductance involves a variable negative exponent and very small decimals of a second of time. The calculations are so troublesome that they are not made at all in many cases in which it would be better to make them The abscissæ are always the times in seconds and the ordinates the currents at those times. The times enter in the negative exponent, and in plotting the curve they are introduced into the formula in simple numbers of thousandths of a second—a troublesome operation. These calculations, however, become simple if, instead of using seconds as the unit of time, one uses the time-constant of the coil as the unit. This time-constant is easily determined from the given constants of the coil. Certain constants (given below) can also be calculated once for all, as they are the same for all coils, resistances and applied voltages. A series of six of these are given below, thus enabling six points of the curve to be determined by a simple multiplication; this probably suffices for nearly all cases.

The usual formula is

$$I=\frac{E}{R}\left(1-e^{\frac{-Rt}{L}}\right),$$

in which I is the current in amperes at any time t in seconds after the voltage E in volts has been applied, R is the total resistance in ohms (including any resistance external to the coil itself), L is the inductance of the coil in henrys, and e is the base of the Naperian system of logarithms—namely, 2·718281—the common log of which is 0·4342945. The time-constant in seconds, L/R, is a fixed quantity for any given coil if R is the resistance of the coil alone. If R includes any external resistance, then this is the time-constant for that particular combination. The time-constant can readily be calculated once for all for any particular case for plotting a curve of this description; call it k

The exponent of e in the above formula then becomes minus t/k; hence, if this k is taken as the unit of time instead of seconds, by making the times t simple multiples of k instead of simple decimals of a second, that is by making $t=k/2$, k, $2k$, $3k$, $4k$ and $5k$, the calculations become very simple, as the k's then cancel out, leaving e with simple digit exponents. Moreover, this enables the tedious part of the calculation to be made once for all for all coils, resistances and applied voltages, in the form of constant multipliers, thus reducing the above formula to this simple form

$$I=nE/R,$$

in which n has the following values which are constants for all coils, resistances and applied voltages, t being the time in seconds and k the time-constant (therefore including the total resistance)

For $t=\frac{1}{2}k$	$n=0{\cdot}393469$
$1k$	0·632120
$2k$	0·864665
$3k$	0·950213
$4k$	0·981684
$5k$	0·993262

The quantity E/R is the final, steady current—*i.e.*, the horizontal asymptote. After an interval of five times the time-constant the current has reached 99·32 per cent. of its maximum, final, steady value.

On cross-section paper the scale of the abscissæ may be made seconds as before, these six points being then laid off at the numbers of seconds equal to the time-constant k (which is in seconds) multiplied by the corresponding digit.

As an illustration, suppose a coil has an inductance of 0·016 henry, a total resistance of 2 ohms, and is applied to 6 volts. The final current E/R will be 3 amperes; the time-constant $L/R=0{\cdot}008$ second Then, after $\frac{1}{2}k=0{\cdot}004$ second, the current will be nE/R or $0{\cdot}393\times 3$ amperes; after, say, $3k=0{\cdot}024$ second, it will be $0{\cdot}950\times 3$ amperes, and so forth.

Some Results of an Accident to a Turbo-generator.

A case of a turbo-generator breakdown, described in a recent issue of the "Electrical Review" (U.S.A.), has several interesting features and illustrates the complexity of the results that may follow such accidents and its effect on interlinked supplies. On a big central station system there were six 10,000 kw. turbo-generators on one sectionalised bus operating in parallel with three 10,000 kw. and one 25,000 kw. turbo-generator on another section, these two bus sections carrying respectively about 45 and 55 per cent. of their rating. At another station, tied into the above station over tie-lines, were four more turbo-generators carrying about 60 per cent. of their rated load. At a third station three large units, of 20,000 kw. and above, were operating at about 70 per cent. rating. This station was tied in with the other two stations over tie-lines.

One of the field end-plates of a 10,000 kw. vertical type generator became detached, falling between the field and armature. The coils of both field and armature were cut, causing a short-circuit on the 9,000-volt windings and the exciter side of the machine. The defective machine was cleared from the system almost immediately

Following this disturbance several turbo-generators in the same station tripped out, due to overspeed, and a number of synchronous converters in various sub-stations on the system shut down. One rotary burnt up. The system began to hunt and persisted for about 18 minutes after the turbo-generator broke down, the frequency varying considerably above and slightly below normal, and the voltage passing from 7,000 to 8,800 volts in heavy swings. The wattmeters on the tie-lines between the three generating stations swung continuously from one end of their scales to the other, indicating heavy interchange of current between stations. This continued for about 18 minutes, when, for no apparent reason, conditions suddenly quieted down; the system pressure rose to 9,400 volts (about normal).

It was then found that the reactances in the tie-lines between stations had been so hot as to oxidise at the surface of the cables, and the insulating compound on the frame work was blistered. Tie-line ammeters and wattmeters on one end of a tie-line were badly damaged. It was later discovered that one tie-line solenoid operated circuit-breaker and one high-voltage feeder circuit-breaker were in the half-open position, the solenoid of this latter being burned open and grounded; also that the negative return from the oil circuit breaker of one of the 10,000 kw. turbo-generators had grounded and burnt open, and that a dead earth has occurred on the exciter system.

One explanation of the 18-minute surge between the three generating stations is that the breakdown of the defective turbo-generator resulted in a phase displacement between the three systems. As these systems were tied in together through tie-lines, the reactance prevented sufficient synchronising current to flow between systems to bring the systems into phase again. Whether this was due to excess resistance or too much or too little reactance requires investigation. The trouble to the exciter system was doubtless due to the exciter system being subjected to high potential to ground, causing breakdown at several places, and possible weakened insulation at others. Contact between armature and field when the field end-plate cut into the coils caused direct contact between the 9,000-volt system and the exciter system and a consequent breakdown in the immediate vicinity.

While only a few of the salient features of the trouble have so far been recorded, sufficient is known to show that hunting between systems is not a matter that can yet be fully explained nor guarded against under unexpected conditions. The above incident shows that exciter systems may be subjected to direct contact as well as to induced high potentials; hence it is suggested as desirable to give exciter systems the respect given to circuits of higher potential, and to furnish means at individual generators to prevent high potentials dissipating themselves promiscuously throughout the exciter system.

Electricity Supply in China.—According to the "Jijo Shimpo," there are 168 Chinese electric supply undertakings, of which 49 are under foreign management. Foreigners are under a disadvantage, as they cannot do business in China under their own names, and money is invested by them in the shape of loans to Chinese Corporations. There are 23 electrical undertakings in the Canton province, 22 in Kiangsu and 13 in Shengking.

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* Abstract of an article in the "Electrical World."

A Method of Determining the Position of Faults in Cables.*

By E. WURMBACH.

The method, here described, may be useful even to experts; it may be used either for determining the precise position of a fault, or as a method of checking the results of calculations already made. It is so simple that it can be managed single-handed, and has been so used for the last two years on a large network in the east of Germany. In one case a fault was found in a cable in which there was complete breakdown, and in another the case was that of a cable lying in 30 ft. of water. It was also used on other cables, and there was a notable success on two occasions on a direct-current cable which broke down twice at distances 150 ft. apart; in both cases the precise position of the fault was located. Many engineers still employ the plan of cutting the cable to find the defective part; others open some of the joints; all this is unnecessary.

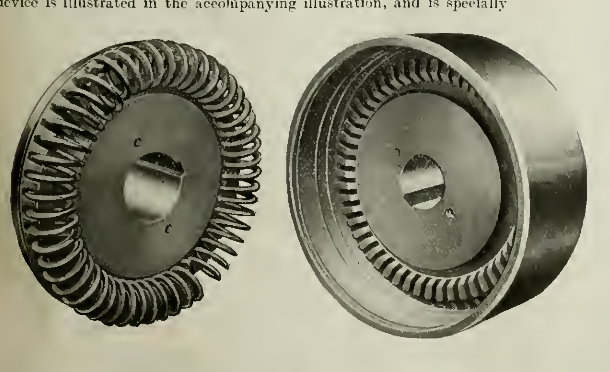
If there is not a complete interruption in the cable, the method can be used in the following cases without interrupting the supply, viz.: (1) In polyphase systems without an earthed neutral if one phase is earthed; (2) in direct-current two-conductor systems, unless one of the conductors is uninsulated, and (3) with direct-current three-core cables, if the middle conductor is insulated and can be earthed if desired. Case (1) can be dealt with without any difficulty; in cases (2) and (3) the defective conductor will require to be earthed through a resistance for a short interval.

In the original Paper a diagram of the connections, necessary for the test, is given. One pole of a direct-current voltage is connected to the defective conductor, while the other can be connected to earth. If the circuit to earth is closed, then the current to earth passes through the armouring on both sides of the fault; a needle galvanometer is now connected in the circuit; it should have its sensitiveness properly adjusted, and should show deviations on both sides of the zero point. The direction of the throw and also its amount should be noted. If the positive pole is earthed, the negative pole of the instrument points towards the fault. When the position of the fault is entirely unknown, the observer proceeds by halving the defective length at each successive test. For instance, over a length of 1,000 yards, it would probably be necessary to test at seven different points. The observations should always be repeated in order to eliminate the effects of any stray currents.

A special clamp, suitable for the purposes of the test, is described. It consists essentially of a V-shaped grip which is passed beneath the cable. The grip is held at the end of a length of tube, through which a sharply-pointed rod can be fed forward by a screw device, which is clamped to the tube. As the pointed rod is fed forward through the grip, it penetrates the jute covering, and makes contact with the armouring of the cable. In this way a steady contact for the purpose of the test is obtained.

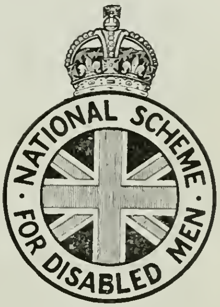
Flexible Shaft Coupling.

We have received particulars from Electro-Metals, Ltd., of their Union patent flexible and Z.V. flexible shaft couplings. The former device is illustrated in the accompanying illustration, and is specially designed for severe service. It will be seen that the coupling consists of two toothed discs, one being keyed to each of the shafts to be connected, and the teeth engaging with the coils of a spiral spring. Thus each coil forms an independent and resilient driving unit. The couple is entirely of metal, and is claimed to be smaller for a given torque than any other flexible coupling, and the absence of any soft wearing parts is conducive to long life. The couple is suitable for either continuous or reversing drives, and for both high and low speeds. A special point to be noted is that the construction renders the coupling capable of storing up energy so that the peak torques are absorbed by the spring, and cyclic variations are damped out. We understand that the coupling is being widely used in rolling mill installations, where, as is well known, the conditions are exceptionally severe. The other leaflet before us refers to the familiar Z.V. flexible shaft, which is likewise adapted to take up shock, and is recommended for non-reversing work. It will be recalled that this coupling consists essentially of an inner and outer disc with suitable bosses, a rim bolted to the outer disc, and an interlaced belt connecting the outer rim and the inner disc.



Aiding Disabled Men.

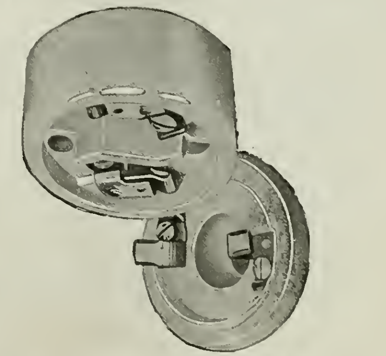
The accompanying illustration shows the device which, printed or embossed upon the letter paper, invoices, &c., of a business firm, intimates that the firm has adopted the Government scheme for aiding disabled men. Use of this seal, which has been christened "the seal of honour," indicates that the firm is employing disabled ex-service men to the extent of 5 per cent. of its staff, and that its name has been placed upon the National Roll. The scheme is administered by the Ministry of Labour, through its local Employment Committees and Exchanges, and in view of the fact that the fate of these men rests upon the national conscience, a large response is expected. The King's recent appeal has brought an immediate response, and it is confidently expected that the seal illustrated here will before long be in general use. The term "disabled" does not necessarily mean unable to work, as thousands of men "disabled" in the military sense are now doing useful and remunerative work in this country.



The B.T.H. "Quiklok" Ceiling Rose.

Of all the worries which beset the daily life of the electrical wireman we should imagine that none can have caused more widespread and frequent annoyance than the labour involved in connecting flexible cord to the ordinary ceiling rose, and the British Thomson-Houston Company deserve the gratitude of every contractor by putting on the market the "Quiklok" ceiling rose, which obviates in a simple manner the difficulty hitherto experienced by wiremen. The distinguishing feature of this ceiling rose is that the terminals are contained in the cover, and can therefore be wired up in comfort on the ground.

The "Quiklok" ceiling rose is wired and fixed in the following manner: screw the base to the ceiling; then wire up the terminals in the cover. This can be done at the bench. Finally fix the cover to the base by a quarter turn. The ceiling rose is made in two patterns—one for ordinary wiring, and the other for cleat wiring—and, if desired, either pattern can be supplied with fuse contacts in the cover. It is obvious that these ceiling roses, if used on a job involving a hundred points or so, would save a considerable amount of time, to say nothing of eliminating a productive source of annoyance and irritation.



"Quiklok" Ceiling Rose, Showing Interior.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 19, 1919.

The Gattie Transport Scheme.

The following is a summary of the evidence of further witnesses before the Board of Trade Committee, which has been sitting to investigate Mr. A. W. Gattie's proposals for the installation of a large central clearing house for the handling of the London goods traffic :—

Mr. **James Swinburne** expressed the opinion that the better method of demonstrating the possibilities of the scheme would be by starting a large scheme in some town outside London, and, supposing this were successful, it could then be started in London itself.

Mr. J. **Reakie** (formerly chief loco. supt. of the Eastern and Bengal State Railway) said the Government ought to go to the expense of placing a "Gattie city" somewhere near London equipped with motor vehicles. There should be no railway goods traffic in London. He believed in the future all such transport would be carried out by road.

Mr. **George Lansbury** said there was a tremendous waste involved in the carriage of coal and goods into London under existing methods. Advocating the adoption of the Gattie scheme, he said that he would like to see such a system in the hands of the State rather than in private hands. He had talked to many railwaymen on Mr. Gattie's scheme, and they considered it an excellent idea. They were not willing to go on risking their lives and limbs in shunting when another scheme could be adopted which would render so much shunting unnecessary.

Mr. F. **Hothersall** advocated the adoption of a system such as that proposed by Mr. Gattie, particularly in connection with the handling of goods at docks.

Mr. C. E. **Turner** (a partner in a firm of shipping agents) said he had been deputed by the Ministry of Shipping to report upon the capabilities of the New Transport Company's machinery, and he considered that the adoption of their system at Liverpool would have done away with the traffic congestion.

Mr. **Edgar Harper** (chief valuer for the Board of Inland Revenue) said traffic congestion was due not so much to the actual number of vehicles as to their stoppages and their various rates of speeds. The most effective remedy was the elimination as far as possible, of the slow-moving traffic, such as railway companies' vans, and this could be effected by a system such as that proposed by Mr. Gattie. He had no doubt of the financial soundness of the undertaking.

Mr. W. S. **Webber**, station master at Lea Bridge G.E.R. station, said trains had stood outside the station 16 hours and in the goods yard 24 hours. The Gattie scheme would save time, power and claims for damage.

Mr. E. W. **Kearney** explained his design of double-tube railways which it was proposed to construct in the north, south and east of the clearing house. He was satisfied that by Mr. Gattie's system a train could be unloaded and reloaded in five minutes, so that the same locomotive could be used for in and out traffic.

Mr. E. G. **Will**, who was for two years a deputy food controller, said a good deal of the nutritive value of food was lost by the present methods of transport, and considerable quantities were condemned. He was in favour of any scheme that would deal with food quickly.

Mr. **Herbert Birch**, who was associated with the construction of the Manchester Ship Canal, stated that the Port of London was declining. A ship which took 40 hours to unload by the present methods would be unloaded in 15 hours if Mr. Gattie's plan was in operation at the docks.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1919 Specifications.

130,350 Beattie. Electro-magnetic methods of detecting submarines. (27/12 17.)
130,368 Hettinger & Vandervell. Telegraphic and other instruments and installations. (31 1 18. Cognate Application, 7,948/18.)
130,369 B.T.-H. Co. (G.E. Co.) Wireless signalling systems. (1/2/18.)
130,375 Heaf & Field. Electric contacting devices controlled by sound waves and the like. (4 2 18.)
130,376 Heaf & Field. Acoustically-operated electric contact actuating mechanism and systems employing the same. (4/2 18.)
130.400 B.T.-H. Co. (G.E. Co.) Electron discharge devices. (15 2/18.)
130.408 Turner. Electric relays. (16 2 18.)
130.427 Steele. Shutters for searchlight projectors. (21 2 18.)
130.429 Townsend. Means for detecting small electric currents. (23/2/18.)
130.432 Western Electric Co. Electrical signalling systems. (30/4/18. Convention date not granted.)
130 435 Burleigh. Dynamo-electric machinery. (30/5/18.)
130.438 Edwards. Ignition plugs. (26 6 18.)
130.441 Wilkinson & Wardle Engineering Co. Electric lamp holders and the like. (16 7/18.)
130,446 Marino. Process for electro-plating metals and particulars for coppering iron and steel. (25 7 18.)
119.651 Menco-Elma Syndicate. Electro-magnetic speed-changing gear. (22/9 17.)
130.451 B.T.-H. Co. (G.E. Co.) Electro-pneumatic braking systems. (29 7/18.)
130.452 White & Baynes & Partners. Spark-plugs for internal combustion engines. (30 7/18.)
130.473 Trier & Martin Trier & Smith & Sons. Constant current dynamos. (1/8 18. Addition to 5,652/10.)
130.485 Jepson & Howarth. Apparatus for measuring the average maximum demand in kilovolt amperes from an alternating current supply. (16/8/18.)
130.489 Ritter. Signalling on primaries of telephone or telegraph phantom circuits. (20 8/18.)
130.490 Ellis (Adcock). Means for determining the direction of a distant source of electro-magnetic radiation. (20/8/18.)
130,491 Upward. Form of portable electric lamp. (21 8/18. Cognate application, 17,038/18.)
119,228 Keene. Electric furnaces. (5 9 17.)
130,500 Morris, Ltd., Robertson & Weston. Electrically-operated pulley blocks, hoists and the like. (12 9 18.)
130,507 Collier. Diaphragms for gramophones, phonographs, telephones, and the like. (28/9/18. Cognate application, 7,815/19.)
130,511 Cracknell. Means for attaching shades or globes to electric lamp holders. (7 10/18.)
130,516 Heath. Sparking-plugs for ignition purposes. (24/10/18.)
130,518 Lucas. Electrically-heated fabrics. (30/10/18.)
130,520 Lea. Electro-magnetic wave signalling systems. (4/11/18.)
130,537 Codd. Make-and-break devices for induction coils and the like. (10 12 18.)
130,545 Tyler & Naylor. Electric batteries. (15/1/19.)
123,077 Splitdorf Electrical Co. Ignition systems. (28/12/16.)
123,320 Faure. Machine for use in electric welding. (11 2/18.)
130,557 Fuller Accumulator Co. & Welch. Automatic cut-in and cut-out electric switches. (18/2/19.)
130,564 Johnson. Spark-plugs. (6 3/19.)
129.256 Bour. Sparking-plugs for internal combustion engines. (29/6/18.)
127.253 Carpenter. Sparking-plugs for internal combustion engines. (17/5 18.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

July 25, 1919.

18,517 Electrical Implements, Ltd., & Beard. Electric reactive windings.
18,522 Chandler. Wireless direction finding apparatus.
18,524 B. T.-H. Co. (G. E. Co.) Manufacturing glass bulbs.
18,525 Bradbury. Electrically operated diaphragm horns.
18,548 Glaser. Hand and electrically-propelled vehicles.

July 26, 1919.

18,589 Aktiebolajet Svenska Kullagerfabriken. Paul and ratchet gear with electro-responsive releasing device. (27/7/18, Sweden.)
18,610 B. T.-H. Co. & Clinker. Static electrical condensers.
18,612 Wilson. Thermo-electric appliances.
18,613 Mepsted. Hand-operated electric switches.

July 28, 1919.

18,627 Cubey. Testing electric circuits.
18,648 Hill. Automatic starter for electric motors.
18,663 Miller. Alternating current motors and rectifiers.
18,665 Davies. Adjusting timing of magnetos.
18,678 Hope. Electric lighting of machines driven by electric motors.
18,711 Bernini. Acoustic telegraphy between aircraft and earth, &c. (27/7 18, Italy.)

July 29, 1919.

18,734 Gunstone. High tension apparatus for hot cathode X-ray tubes, &c.
18,766 Fletcher. Electrically heated hot-plates.
18,787 Godbehere. Double-pole switches and fuse boards.
18,797 & 18,798 Camey & Lacey. Cooling electrical machinery, transformers, &c.
18,801 Collie. Means for making temporary connections with electric supply cables.
18,803 Cohn, Merrell & Spurling. Portable electric lamps and means for generating current therefor.
18,809 Paemelaire. Dynamos. (19 9/18, France.)
18,829 Western Electric Co. High frequency signalling systems.
18,830 Harman & Le Bas. Switches.
18,832 Tolly. Means for laying cables.
18,942 Glaser. Motors.

July 30, 1919.

18,857 Sammons. Condenser cells.
18,863 Wood. Electrically-operated turnstiles.
18,865 St. Helens Cable & Rubber Co. Extrusion presser.
18,868 McConnell. Manufacture of electric steel.
18,891 Suchastawer. Magneto motor acting by repulsive movements between the poles.
18,896 B.T.-H. Co. (G. E. Co.) Electric heating devices.
18,910 Fuller's United Electric Works & Welch. Electric lamps for vehicles.
18,918 Hazelton. Electrical heating elements.
18,928 Becker. Incandescent lamps.
18,829 Atherstone. Device for holding shades on bayonet electric lamp-holders.
18,931 Atherstone. Manufacture of electric batteries.
18,932 Perry. Storing electricity from variable power.

July 31, 1919.

18,950 Turner. Magnetos.
18,963 Sparks & Tonks. Switches.
18,964 Automatic Telephone Mfg. Co., Simister & Archer. Electric heating apparatus.
18,965 Edgeworth. Amplifiers for telephone circuits, wireless telegraphy, &c.
18,975 Heurtebise. Electric motors.
18,985 Automatic Telephone Mfg. Co. Measured service telephone systems. (12 2/19, U.S.)
18,989 Joseph & Sullivan. Variable electric condensers.
19,005 Marks. (Ansaldo.) Carbon electrodes.
19,014 Rowe. Electric lamps for vehicles.

August 1, 1919.

19,042 Taylor. Obtaining alternating currents from existing three-phase systems.
19,056 B.T.-H. Co. (G. E. Co.) Electric heaters.
19,082 Lamkin. Cut-outs.
19,083 Whitecross Co. & Lloyd & Wilson. Electrodes for welding, &c.
19,086 Marks. (Splitdorf Electrical Co.) Distributors for magneto-generators.
19,109 Hunt. Portable electric cooker box.
19,102 Pouchain. Switches. (14/8 18, Italy.)
19,110 Telephone Mfg. Co. & Jackson. Telephone receivers.

August 2, 1919.

19.143 Cook. Electro-magnetic apparatus.
19,167 Burgess. Magnetic cores with electric windings.
19,172 Abbott. Electro-thermostat.
19,182 Lea & Phillips. Shades, &c., for electric lamps.

August 5, 1919.

19,199 Vire. Motor starters, rheostats, &c.
19,215 Knight. Mouthpiece for telephone instruments.
19,219 Williams. Terminal electric connections for sparking plugs.
19,225 St. Helens Cable & Rubber Co. & Lee. Electric conductors.
19,236 Westcot. Electric lighting systems.
19,251 Western Electric Co. Telephone transmission systems.
19,260 B. T.-H. Co. (G. E. Co.) Electric heating devices.
19,284 American Bosch Magneto Corpn. Magneto-electric machines. (27 9 18, U.S.)
19,300 Godfree. Magneto-electric generators for internal combustion engines.
19,316 Madsen. Electro-deposited metals. (26/4/19, U.S.)

August 6, 1919.

19,327 Tucker. Electric switches.
19,335 Duff. Fitting of high-tension magneto-electric machines for collection and use of low-tension current.
19,353 Ile. Electric plug connectors.
19,356 Scott-Taggart. Negative and positive resistance vacuum tube devices for wireless telegraphy, &c.
19,336 Heyes. Arc welding.
19,367 Uglow. Holder for electric welding.
19,377 Hewlett. Switches. (31/10/18, U.S.)
19,378 Collins. Electric furnaces.
19,389 Marconi's Wireless Telegraph Co. Radio-signalling apparatus. (7/2/19, U.S.)
19,393 Akt. Ges. Brown Boverie et Cie. Protection of windings against over-pressures. (6/8/18, Germany.)
19,400 Western Electric Co. & Deakin. Telephone exchange systems. (26/5/19, U.S.)
19,404 Compare. Switches.
19,427 Cowper-Coles. Building up or growing iron upon steel, &c., surface.
19,428 Cowper-Coles. Electro-deposition of iron alloy.
19,429 Cowper-Coles. Manufacture of iron tubes by electro-deposition.
19,430 Cowper-Coles. Apparatus for electro-deposition of iron.

August 7, 1919.

19,436 Seaborne. Electric lighters or igniters.
19,443 Barry. Obtaining currents of two periodicities from one generating unit.
19,450
19,453 Parsons. Electric hand torches, &c.
19,459 Benjamin Electric, Ltd., Ives & Fowler. Incandescent lamp sockets, &c.
19,479 Western Electric Co. Modulating and transmitting systems for electric signalling.
19,488 Burkinshaw. Electric switches.
19,493 Jaquemot & Pattay. Magneto-electric pocket lamp. (7/8/18, Switzerland.)
19,497 Furnival. Regulating electric generators driven by air screws, &c.
19,498 Round. Thermionic devices for wireless telegraphy and telephony.
19,525 Wheeler. Coin freed and electrically freed apparatus for telephones, &c.

August 8, 1919.

19,534 Browne. Electric lighting systems for trains, &c.
19,563 Rutherford. Electric lamp holders.
19,566 Orling. Electric relays.
19,567 Greville & Read. Electrodes.
19,570 B. T.-H. Co. & Young. Magneto-electric machines.
19,571 B. T.-H. Co. (G. E. Co.) Induction furnaces.
19,599 Sanders. Electrical apparatus for heating liquids.
19,605 Kinahan. Electric transmission mechanism.

August 9, 1919.

19,614 Taylor. Obtaining alternating currents of any frequency from three-phase systems of any other frequency.
19,632 Magic Appliances, Ltd., & Axworthy. Electric motor for vacuum cleaners, &c.
19,636 B. T.-H. Co. (G. E. Co.) Electric heating units.

August 11, 1919.

19,660 Suchostawer. Magneto motor acting by repulsive movements between double poles.
19,666 Branfield. Electrodes for electric furnaces.
19,699 Walker. Electro-magnetic step-by-step, &c., mechanism.
19,709 Western Electric Co. Telegraph systems.
19,713 Boite & Slaughter. Dry batteries.
19,717 Zeiler. Dry batteries for pocket lamps.
19,720 Scintilla. Horseshoe magnets. (29/8/18, Switzerland.)
19,721 Scintilla. Magneto-electric ignition apparatus. (13/9/18, Switzerland.)
19,722 Scintilla. Interrupters for ignition apparatus. (13/9/18, Switzerland.)
19,723 Scintilla. Attaching handle for varying point of ignition to interrupter. (13/918, Switzerland.)
19,724 Scintilla. Cable outlets of magneto-electric ignition machines. (1/10/18, Germany.)
19,725 Scintilla. Distributors for high-voltage current of magneto-electric ignition machines. (1/10/18, Germany.)
19,726 Scintilla. High-tension distributors in magneto-electric ignition machines. (28/9/18, Switzerland.)
19,730 Nurnberger Metall & Lackierwaaren vorm., Bing. Electric pocket lamp. (10/10/16, Germany.)

August 12, 1919.

19,799 Western Electric Co. Electric signalling systems.
19,801 Munro. Crossovers of overhead conductors for electric traction.
19,837 Bernard. Magnetos. (7/6/17, France.)
19,838 Bernard. Electric contact breakers. (5/6/17, France.)
19,845 Hill. Electric heaters.

August 13, 1919.

19,852 Watson & Co. & Travis. Electric resistance elements.
19,873 Roberts. Electric machinery.
19,895 Fuller. Galvanic batteries.
19,903 Leonard. Electric heater units.
19,905 Henley's Telegraph Works Co. Removable electric fuse carriers.
19,906 Jones. Electric heating apparatus.

August 14, 1919.

19,986 Tackley. Electric motor starters, controllers, &c.
19,953 Baker. Commutators for electric ignition systems.
19,983 Electrical Apparatus Co. & Martin. Switch mechanism.
19,987 Drew. Collecting and storing electricity from the air.
19,999 Holworthy. Electric cable attachment for sparking plugs.
20,000 Clarke, Chapman & Co., & Harris. Gear embodying electric controllers winches, &c.
20,012 Railing & Hill. Electric cigar, &c., lighters.
20,025 Garoe. Electric lamp holders.
20,029 General Electric Co. & Gassling. Circuits for cascade amplifying.
20,034 Campbell. Electric furnaces.
20,043 Franklin. Aerial system for wireless telegraphy, &c.
20,052 Scott-Taggart. Wireless receiving systems.

August 15, 1919.

20,072 Manton. Lamp signalling attachment for electric torches.
20,081 Woodburn. Electric welding.
20,096 Cowper-Coles. Electrolytic for deposition of iron.
20,114 Jaentsch. High voltage insulators. (6/2/19, Germany.)
20,131 Kjellberg. Assembly of metal parts for electric welding, &c.
20,137 Von der Weid. Incandescent electric lighting apparatus. (13/9/18, Switzerland.)

August 16, 1919.

20,149 Ritsema. Insulating caps for electrical joints. (18/9/18, Holland.)
20,170 Bullen. Electrical rectifier.
20,188 Della Giacoma. Prevention of taking off of current from conductors. (18/2/19, Switzerland.)
20,193 Automatic Telephone Mfg., Co. Motor for railway signalling, &c.
20,195 B.T.-H. Co. (G.E. Co.) Electro-magnetic switches.
20,197 Optalyte, Ltd. & Coulson. Electric batteries.
20,219 Etablissements, Belin, Wire attachments for electrical connections. (8,3,19, France.)

Commercial Topics.

Excess Profits Duty on Electricity Supply.

The Board of Referees have increased the statutory percentage for the business of generating and supplying electrical energy for lighting, power and other purposes in the United Kingdom, carried on by companies incorporated by private Act of Parliament, or by limited liability companies, to 7½ per cent.

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Peruvian Machinery Requirements.

It is reported that there is a good opportunity for the introduction of machinery and machine tools into Peru. Owing to the war, the supplies are very low, and there is a general desire to replenish stocks. The mining industry is being developed, and at the same time there is a demand for the introduction of up-to-date machinery. Hitherto hand tools have been almost exclusively used, but there is a desire to introduce compressed air or electric drills, and there should also be a good demand for electric generating plant, electric motors, mining tools, &c.

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Barcelona Industrial Exhibition

It is announced that the Associacion Dependencia Mercantil, Aribau, 21, Principal, Barcelona, is organising what they term the "1st Salon Internacional de Organizacion Comercial." One of the four groups of the exhibition will be devoted to typewriters, calculators, dictaphones, telephones, mechanical clocks, &c. The exhibition will be held in the Palacio de Bellas Artes in January, 1920, and the British Chamber of Commerce has accepted the Honorary Presidency and the Secretary of the Chamber is arranging for British firms to exhibit. Communications to the Secretary, British Chamber of Commerce, Barcelona.

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Brazilian Consular Invoices.

Commercial associations and exporting houses have recently protested strongly against the new Brazilian regulations concerning consular invoices, which are to be put into force very shortly, and it is now announced that H.M. Minister at Rio de Janeiro has been instructed to support the representations made to the Brazilian Government on the subject. In the majority of cases it will be impossible to comply with the regulations, and if put into force they will introduce serious obstacles to the development of Anglo-Brazilian trade. The regulations require the following (among other) details :—

1. The name of each article and the materials of which it is composed or manufactured. It must be stated whether the raw material is simple, compound, whether trimmed or embellished, and each component part must be shown separately. General designations, such as "chemical or pharmaceutical products," and other general terms are not allowed.

2. Weights must abide rigorously by those called for in the model Consular invoice—viz., gross weight of package, gross weight of goods without the case but with wrappings, packings, cardboard boxes, &c., and the net weight of the goods without packing or wrapping. To give the weight or value of two or more different kinds of different qualities of goods is not allowed.

Whenever the articles can be counted or measured, the Consular invoice must mention the number of objects and their respective dimentions in lineal, square or cubic metres ; also the respective values.

4. Any infraction of the above requirements will render the importer liable to a fine of 10 per cent. on the official value of the goods, which shall not absolve him from other penalties. Half the fine will go to the Customs officer who discovers the infraction.

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Tramways as Goods Carriers.

Hitherto little use has been made of the tramways in this country for the carriage of goods, but on a few systems there are schemes for the collection and delivery of light parcels. Legislative restrictions and the opposition of the railways are responsible for the present state of affairs, and we hope that the new Ministry of Transport will carefully investigate the position, as we believe that the tramways and light railways could be made useful adjuncts in the transport system of this country. During the war Germany made good use of its tramways for the transport of merchandise, and there is no reason why we could not do equally well here if the legislative restrictions and the other checks upon progress were removed.

At all events, we are pleased to see that the Bradford Corporation Tramways Committee is considering a scheme for the extension of its parcels and delivery service, which, if the necessary powers can be obtained, will facilitate the reduction of the congestion which at present characterises the local and national transport systems. It is suggested to secure power to carry goods and heavy articles on a motor-lorry to be run on the local tramway system. It is also thought that the laying of a few "spur" lines from the main routes to the yards of large factories would enable the tramways to undertake the delivery of coal and general merchandise, thus saving a very great deal of time. At present parcels are carried on the drivers' platforms of the tramcars, an arrangement which is both inconvenient and costly, and it is proposed to improve matters by the provision of special luggage and parcels vehicles. The method of collecting and distributing the goods would also have to be modernised ; but the additional facilities could be provided at a reasonable cost. The Bradford Corporation Act of 1910 limits the charges as follows : Parcels not exceeding 7 lb. in weight, 3d. ; exceeding 7 lb. and not exceeding 14 lb., 5d. ; exceeding 14 lb. and not exceeding 28 lb., 7d. ; and exceeding 28 lb. and not exceeding 56 lb., 9d.

Electricity Supply.

Rhyl Council has submitted terms to the Parish Council of Rhuddian for a supply of electricity to that district.

Mr. G. H. Robinson, who has been chairman of the Bradford Electricity Committee for many years, is retiring from the Council at the end of the municipal year.

A committee of ratepayers in Rathdrum (Co. Dublin) has been formed for the purpose of making arrangements for establishing electricity supply in the district.

Glasgow Electricity Committee are asking the Corporation for authority to borrow £1,000,000 for developing the work of the electricity department.

It has been suggested that Bedwelty district should be lighted electrically, and the Urban Council have appointed an Electric Lighting Committee.

St. Helens Corporation has approved the proposal to erect a 5,000 kw. turbo-alternator set, coal-handling plant, &c., at an estimated cost of £57,960.

Gellygaer Urban Council wish to borrow £5,841, repayable in 30 years, for the erection and equipment of electricity works, and offers are invited up to Sept. 22 for the loan.

Heywood Electricity Committee have decided that owing to the abnormal cost of service cable and materials, all new services exceeding 15 ft. in length must be paid for by the consumer.

Wolverhampton Council last week sanctioned increases in the salaries of several of their officials. The borough electrical engineer, Mr. S. T. Allen, was granted an increase from £8,000 to £1,000 a year, and an honorarium of 300 guineas.

At last week's meeting of Bristol City Council the proposal of the Electrical Committee to promote a Bill authorising an extension of the Council's electric supply area to include Bridlington, Long Ashton, Warmley, Kingswood and other districts.

Messrs. Asa Lees & Company, Soho Ironworks, Oldham, have decided to shut down their own generating plant, and supply will be taken from the Corporation. Energy will be supplied at 6,600 volts, and converted to 210 and 400 volts. There are 60 motors, ranging from 3½ h.p. to 175 h.p.

The question of inter-connection of the electricity undertakings of the Ashton-under-Lyne Corporation and Stalybridge, Mossley, Hyde and Dukinfield Joint Board is to be discussed by representatives of the two authorities mentioned and the chief electricity commissioner (Sir John Snell).

The Ministry of Health have declined to sanction the borrowing of £15,000 and £35,000 respectively by St. Anne's and Lytham Councils for the purposes of an electrical supply in bulk to Lytham from St. Anne's, in view of the financial loss which the Ministry consider would be incurred if the scheme were carried out.

Sunderland Town Council has decided that the Coal Clause at present in force as regards other l.t. consumers shall be applied also to those on the general lighting, domestic and heating and cooking rates, in respect of all increases in the price of coal above 23s. per ton delivered and that the unit price in the h.t. tariff be increased from 0·4d. to 0·5d.

The accounts of the Eastbourne electricity dept. for the year ended March 31, 1919, show revenue £35,012 (compared with £39,221 in previous year), and gross profit £8,762 (£18,359). Capital charges required £13,253 (£13,586), and the net result was a deficit of £4.490 (compared with a profit of £4,773). Cost per unit sold was 2·66d. (1·94d.) exclusive and 4·19d. (3·36d.) inclusive of capital charges. Units generated were 2,757,130 (2,986,775), and sold 2,167,297 (2,450,473). Maximum load was 1,349 kw. (1,415 kw.), and load-factor 18·34 (19·77) per cent.

The accounts of the Southport electricity department for the year ended March 31, 1919, show revenue £36,891, working and general expenses £27,410 (compared with £23,021 in previous year), and gross profit £9,480 (£9,255). Interest, sinking fund and repayment of loans required £13,523 (£13,702), and the deficit of £4,042 has been met out of appropriation account, from which also £2,200 has been transferred in aid of rates. Total costs were 21·8d. (1·71d.) exclusive and 3·26d. (2·59d.), inclusive of capital charges.

Burnley Electricity Committee have received a report from their engineer (Mr. J. E. Starkie) regarding a conference of Lancashire and Cheshire representatives to consider the formation of district councils for the electrical industry under the Whitley Industrial Council for an area comprising Lancashire, Cheshire, Westmoreland, Cumberland, and portions of North Wales and North Derbyshire. For the Bury-Southport-Wallasey group Ald. Higham, of Accrington, and Mr. J. A. Crowther, of Wallasey, have been appointed representatives.

The accounts of the Bexhill electricity department for the year ended March 31, 1919, show revenue £13,893 (compared with £13,471 in previous year) and working expenses were £9,377 (£7,869), leaving gross profit £5,033 (£5,602). Interest and repayment of capital required £5,401, and the net result was a deficit of £367 (against £197 profit). Working costs per unit sold were 3·79d. (3·04d.) and capital charges 2·3d (2·1d.). Maximum supply demanded was 436 kw. (503 kw.) and the units generated were 721,803 (802,314) and the units sold 561,101 (619,821).

At Birkenhead Council meeting last week Mr. Graham White moved a resolution expressing the opinion that there should be greater co-operation between Gas and Electricity Committees, and that they should consult together and report to the Council. Mr. D. J. Clarke, Chairman of the Electricity Committee, said until the Government had declared its policy with regard to electricity supply the Committee could not move, although they had several applications for power. Mr. White's motion having been carried, Mr. Clarke resigned the chairmanship of the Electricity Committee.

The board of management of the Co-operative Wholesale Society wish to equip the Shillbottle Colliery, near Alnwick, with electric plant. The Newcastle & District Electric Supply Company are willing to spend £80,000 in laying a cable if the society will take up 30,000 £1 shares at par. To avoid delay the committee seek powers to invest any part of the capital of the society in shares of other societies or companies. The members of the Society at the quarterly meeting approved the proposition regarding the equipment of Shilbottle Colliery, but disapproved of the society taking up shares in companies.

The report of Mr. R. Ayton on the Winchester electricity undertaking for the year ended March 31, 1919, states that revenue was £18,094 (compared with £16,559 in 1917-18) and working expenses were £11,838 (£10,535), leaving gross profit £6,255 (£6,024). Interest, redemption of loans, &c., required £5,630 (£5,579), leaving net profit £625 (£445). The installation department showed a net profit of £67 (increase £7). Units generated were 1,428,271 (1,368,070) and sold 1,140,072 (1,033,155), and maximum load was 696 kw. (636 kw.). Mr. Ayton again recommends the installation of mechanical coal-handling plant. The conversion of the street lamps from gas to electricity (authorised by the Council in 1914) has been held up owing to the war.

Yarmouth Electricity Committee, having been recommended by the auditors to go into the question of depreciation, have reported that they regard the sinking fund as a compulsory depreciation fund so far as expenditure out of borrowed money is concerned. Whilst capital expenditure, otherwise than out of borrowed money, amounting to about £9,950, has been incurred, £6,600 has actually been charged to revenue. On the undertaking regarded as a whole the Committee think no further depreciation is necessary. The Council have decided to obtain a report on the undertaking from Messrs. Preece, Cardew, Snell & Rider, dealing with the best methods of meeting future developments of the undertaking, the position that will be created by the new Electricity (Supply) Bill, &c.

Blackburn's electricity department's accounts for the year ended March 25, 1919, show revenue £70,493 (compared with £53,595 in previous year), and gross profit £16,898 (£23,614). Interest and sinking fund required £19,124 (£19,142), and the net result was a deficit of £2,226 (compared with a profit of £4,472). Total maximum demand was 3,712 (4,354) kw. Units generated were 9,177,686 (10,318,417), and sold 8,353,803 (9,819,986). Mr. P. P. Wheelwright, borough electrical engineer, says, in his report, the decrease in output was partly accounted for by the cotton control coming into operation in the early part of the year, which affected not only the manufacturing industries, but all the trades allied thereto, and partly by the restrictions imposed by the Household Fuel and Lighting Order. Average price of coal was 4s. 5d. above that of the previous year, but the calorific value was very much lower.

The following municipal electric supply authorities have decided to INCREASE THEIR CHARGES FOR CURRENT: Blackburn, 75 per cent. over pre-war rates; Leeds, 80 per cent. over pre-war rates; Burton-on-Trent, revised tariff, lighting flat rate 8d., cinema 6d., plus 15 per cent., heating and cooking 1¾d., power (A) from 4d. to 1½d., plus 15 per cent., (B) 2d. to 1·3d., plus 15 per cent., and (C) m.d. system, 6d. and 2d., plus 15 per cent.; Belfast, a further 7½ per cent.; Hammersmith, 25 per cent., making 50 per cent. over pre-war charges; Motherwell, ½d. on lighting and ¼d. on power and heating; Heywood, 20 per cent.; Ealing increases from 8d. to 9½d. for lighting, and from 1¾d. to 2¼d. for heating and cooking. Maidstone, increase ½d. per unit for lighting, and ¼d. (except in cases with coal clause in the agreement) for power. Swinton and Pendlebury, 25 per cent., making 75 in all.

The Lord Lieutenant of Ireland (Lord French), accompanied by the Chief Secretary for Ireland (Mr. Ian Macpherson) visited the site of Belfast Corporation's new electric power station at Musgrave Channel-road last week, and performed the ceremony of driving the first pile for the foundation. The Chairman of the Electricity Committee (Sir James Johnston) gave a brief account of the history of the electricity undertakings from the starting of the 800 h.p. plant in 1895 to the 17,000 h.p. plant which was running in 1912. The present plans contemplated buildings capable of housing machinery of 150,000 h.p. It was proposed to construct about half of the buildings, and when the necessary plant was ready the cost would be about £650,000. Lord French, having performed the pile-driving ceremony, praised the enterprise of the Corporation in utilising to the utmost inventions which would promote commerce and trade and add to the welfare of the community. There was hardly a trade in which the use of electricity did not mean an increase in the speed of manufacture and a reduction in the manual labour involved. A luncheon followed, presided over by Sir James Johnston, and attended by many distinguished guests, one of whom, Lord Pirrie, proposed the toast of "Success to the new Electric Undertaking." The guests subsequently visited Messrs. Davidson & Company's Sirocco Engineering Works.

Electric Traction.

Sunderland Council have decided that the charge for current for traction purposes shall be increased, owing to increased cost of coal. This will involve an increase of about £1,600 a year in the tramway department's expenses.

For the year ended March 31 last the increase of the Southport Corporation tramways undertaking was £53,491 (compared with £32,582 in previous year), working expenses £32,987 (£18,089), and gross profit £20,347 (£10,263). After providing for capital charges, the net profit was £2,604, of which £2,100 has been allocated in aid of rates. Receipts per car-mile were 17·735d. (11·995d.), and working expenses were 10·938d. (7·564d.).

The Court of Arbitration had a preliminary sitting on Monday to decide whether the Arbitration in regard to the claim for 12s. a week increase for tramway workers should be in one centre or whether there should be a series of hearings for various districts. A long discussion took place, both sides being heard, and arrangements were made for the arbitration proceedings to be opened on Tuesday next at one of the large halls in London, at which all parties will be able to appear and give evidence. It is understood that the arbitration will be national in scope and character, and that the evidence will probably be taken at one centre in London.

We are glad to be able to announce that the Sheffield tramway workers, who have been on strike since the 12th inst., resumed work on Wednesday. On Tuesday the Tramways Committee received a deputation from the men, who were informed that no further concessions as to rates of pay could be given, but the Committee agreed that the application for 12s. per week advance should go to arbitration, and they were also willing that the Whitley Council should decide what period must elapse before an employee was entitled to full rates. At a subsequent meeting of the men it was decided by a large majority to return to work pending the result of the arbitration.

Imperial and Foreign Notes.

Prof. J. C. McLennan, in a recent address to the Special Committee of the Canadian House of Commons on Scientific Research, stated that out of a possible 19 million horse-power obtainable from water-power in Canada, 2,305,310 h.p. had already been developed, and it would not be long before a further one million horse-power would be available.

In his report on the George Town (Penang) electricity undertaking for 1918 the engineer, Mr. O. V. Thomas, says the demands for the supply of current to private consumers have about reached the capacity of the station and network. Prices of current have not been increased during the war. There are still 270 16-c.p. oil lamps in use in the outskirts of the town, but, as they are very inefficient and cost 16 per cent. per lamp more than the 25-c.p. electric lamps, they will be replaced by electric lamps as the material becomes available. There are 3,154 private consumers (a net increase of 176), with the equivalent of 104,206 30-watt lamps. Supply is given to 42 industrial motors (=388 h.p.) and 1,811 fans. Total units sold were 2,070,645 (compared with 1,925,694 in preceding year). Revenue was $409,889 ($383,269), working and general expenses were $208,623 ($168,473), and the gross profit $201,265, representing 18·7 per cent. on expended capital. Net profit was $94,805 (=8·8 per cent. on capital).

Mr. Thomas' report on the tramways states that revenue was $162,692 ($153,707) and expenditure $97,200 ($93,016), and net profit, after providing for capital charges, depreciation and reserve was, $11,840. Passengers carried were 5,840,887, (5 597,667), car-miles run 396,271 (439,318) and units used 258,220 (265,110).

It is stated that the German Government contemplates voting 200,000,000 marks for electric supply purposes in East Prussia, with the object of making the province independent of coal supplies from other parts of Germany.

It is stated that the Government of Chili has decided to convert to electric traction the whole of the State Railways, of which there are about 2,300 miles in operation, and to generate the necessary electrical energy by means of waterfalls on the western slopes of the Andes.

Representatives of the leading metallurgical industries in Italy have drawn up, in collaboration with the Associazione Mineraria, a programme for producing Italian Copper ore in sufficient quantity for the national needs. It is proposed to examine the copper mines of Italy (over 700) very carefully for the purpose of selecting the best to the end that they may be efficiently exploited.

Educational.

The Rt. Hon. A. J. Balfour, O.M., is to be nominated for election as Chancellor of Cambridge University in succession to the late Lord Rayleigh.

At Battersea Polytechnic, London, S.W.11, the day courses for B.Sc. (Engineering) of London University and for the Polytechnic Diploma commence on Sept. 23. Evening courses in c.c and a.c. engineering, electrical design, electrical technology, electric traction, generation, transmission and distribution, electric lighting, &c., commence on Sept. 29. Abridged calendar of evening classes free and of technical day college (3d. post free) from the Secretary.

Miscellaneous.

It is reported from Rome that Senatore G. Marconi has carried out successful experiments with pocket wireless telephones.

The Postmaster-General, Mr. Illingworth, will receive a deputation from the National Union of Manufacturers on Oct. 2 on the subject of the telephone service.

A Reuter's telegram states that Wireless Telephony Experiments are taking place between stations on Porquerolles Island, near Cannes, and Aspretto, near Ajaccio, Corsica, and that messages of 150 and 200 words have been transmitted with complete success.

For the convenience of those who wish to visit the Athens Exhibition, which will be opened on the 13th prox., a summary of the existing travel facilities overland from London to the Mediterranean ports and thence by fast steamers to Piræus (port of Athens) has been issued by the London Offices of the Italian State Railways. One can travel first-class throughout for £29 10s. (including sleeping car) and £16 10s. second class.

With characteristic enterprise the Harbour Commissioners of Belfast have anticipated the development of oil as fuel for ships and are making preparations for the establishment of a great oil depot in Belfast, and the provision of wharfage which would accommodate oil tanks ranging from 10,000 to 20,000 tons. The depot will be close to the new corporation electricity works, so that, should it be decided in the future to use oil instead of coal fuel a supply will be readily available.

At a conference, which was held on Tuesday at the offices of the National Union of Manufacturers and attended by the representatives of 35 trading associations, a strong resolution was passed protesting against the withdrawal of the restrictions against imports without the House of Commons being given an opportunity of considering the subject of the Government's trade policy.

The Treasury announce that applications for permission under the Defence of the Realm Regulations, 30 F, to raise capital in this country where the proceeds of the issue are to be applied for capital purposes outside the United Kingdom, will in future be dealt with by the Board of Trade. Communications should be addressed to the Secretary, Capital Issues Committee, Gwydyr House, Whitehall, London, S.W.1.

The Industrial League has made arrangements to hold Conferences of Employers and Employed in Glasgow, Newcastle, Manchester, Bristol, Portsmouth and Sheffield, and negotiations with a similar object are being conducted in other places. Subjects relating to various aspects of labour and commerce will be considered, including "The Relation of Improved Labour Conditions in this Country and Imported Sweated Goods," an important subject suggested by Mr. Clynes in his Paper at Birmingham on Aug. 13.

Marconi's Wireless Telegraph Company announce that long-distance messages can again be accepted for transmission through their high-power wireless station at Poldhu, Cornwall, to ships not within range of any other British coast station. The Poldhu station communicates to ships at night only, and its range is about 1,500 miles. The address of radiotelegrams for transmission by this service must include the name of the addressee, name of the ship and "Poldhu." Messages can be handed in at any postal telegraph office in the United Kingdom or at the Company's offices (Marconi House, Strand, and 1, Fenchurch-street, London), the rate per word being 2s. 10d.

A visit was paid on Saturday to the works of Messrs. A. Reyrolle & Company, Ltd., Hebburn-on-Tyne, by the members of the Foremen's Mutual Benefit Society. The party, who numbered over 300, were made acquainted with the various designs of switchgear, &c., made by the firm, and the use of the jigs and tools used. The most outstanding feature of the exhibits was the super power station switchgear, which was seen in operation. Tea was served, and a performance given by the band under the direction of Mr. Guy, chief of the l.t. test room. Mr. Burns, representing the F.M.B.S., said the visitors were much impressed by the arrangements for the welfare and safety of the employees of the firm.

The annual report of the Hospital and Distress Fund of the Leigh Works of Callender's Cable & Construction Company states that out of the Hospital & Distress Fund grants amounting to £91 7s. have been made to local and Manchester hospitals, and £229 5s. 1d. paid to necessitous members. To the Special War Fund the employees have contributed £936 10s. 1½d. Out of this sum gifts have been sent to employees who were in the army, £318 has been expended on service men, and £500 allocated for the purpose of assisting those men disabled owing to war service, while a further £150 has been transferred to the Hospital and Distress Fund to meet future cases which may come under this head.

A circular was recently issued by Sir Auckland Geddes, President of the Board of Trade, inviting local authorities to appoint local committees to hear and determine all complaints arising out of the retail sale and distribution of the articles to which the Profiteering Act applies. After setting out particulars of the constitution, powers and duties of the Committees, the circular states that sellers of goods who may be convicted in a court of summary jurisdiction of having made more than a reasonable profit will be liable to a fine not exceeding £200 or imprisonment for a term not exceeding three months. The Board of Trade have already received a large number of replies from Local Authorities accepting their invitation to form Local Committees under the Profiteering t, and many Chairman of County Councils have submitted names of persons selected for consideration as members of the Appeal Tribunals.

A meeting of workers in the engineering industry was held in the Usher Hall, Edinburgh, on Monday, to consider a Scheme for the Amalgamation of Seventeen Trade Unions representing the various branches of the industry. Mr. W. D. Hills (A.S.E.), who presided, expressed disappointment at the small attendance (about 600), and said closer unity amongst the workers was absolutely necessary to effectually improve conditions of labour. Mr. J. W. Clarke (S.I.M.) said if this amalgamation took place it would embrace 550,000 members, and other unions would have to come in. Mr. J. Rowan (E.T.U.) also supported the movement, and the members were strongly urged to record their votes on the question when the ballot is taken.

The Lords Commissioners of the Admiralty have sent letters of commendation to certain cable ship officers in the employment of Siemens Brothers & Company, Ltd., whose services during the war have been brought to the notice of the Admiralty. The letter states that the Lords Commissioners have had under consideration a report of the services rendered by the various cable ships in connection with cable-laying and other operations during the war, which for the most part have been carried out under extremely arduous and hazardous conditions and with complete satisfaction to the Naval authorities concerned. They consider that the work has been of the greatest assistance to the British and Allied cause, the maintenance of the communications of the Empire in particular being of the highest importance to naval and military operation. The officers to whom these letters have been sent are: Mr. A. J. Stopher (cable engineer), Capt. A. D. Gange, Mr. Thos. Johnson (chief engineer), Mr. P. F. Johnson (chief officer), and Mr. R. R. Miller (chief electrician).

Some interesting experiments have been carried out on the raising of the s.s. "Main," which was sunk by gunfire from a German submarine in Luce Bay in the South of Scotland, during the war. The salvage operations were carried out by the Ardrossan Salvage Company, Glasgow, who undertook to test some flexible pontoons, designed, patented and manufactured by Messrs. Vickers Ltd., of Barrow. The pontoons are made of special canvas and cables and weigh when completed, only 1 ton, yet when inflated with air and submerged in water, are capable of lifting 100 tons. On the trials, two of these pontoons were used and fixed to the stern post of the ship and inflated by means of an air compressor on a small tug. The vessel was slowly raised and beached ready for pumping out on the 19th inst. The amount of rough handling which these canvas pontoons withstood was remarkable. When not in use they can be packed into a very small compass and stored in the hold of a salvage ship. From the information gained during the tests, the designers are confident that pontoons of 200 and 300 tons' lifting capacity can be made in the same manner. By the use of this device, it will be possible to raise practically any vessel that a diver can reach. With a little more experience of these pontoons, the designers are confident that they can be increased in size and it will then become possible to tackle such large ships as the "Lusitania."

According to recent Customs Decisions, welding rods of steel or aluminium specially suited for acetone or electric welding, whether British or foreign, are admitted into New Zealand duty free, and electrically self-propelled dump trucks are subject to 20 per cent. import duty if of foreign and 10 per cent. if of British manufacture.

Electric lamp fittings, consisting of a stand or fixture, switch, shade, cord and plug, are subject to 30 per cent. duty if foreign goods or 20 per cent. if British.

According to a recent decision of the Australian Customs Department Wico igniters (h.t. magnetos) are subject to 25 per cent. import duty under the British preferential tariff or 30 per cent. under the general tariff.

Switch controllers, starting switches, regulating resistances and other resistances, insulators and transformers, if parts or appurtenances of factory machinery or of the plant of electric power works, including cable boxes, transformer tanks, &c., may be imported duty free into the Netherlands.

Imports.—The following are official values of electrical machinery material and apparatus imported into this country (*a*) during August, 1919, and (*b*) the aggregate figures from Jan. 1 to Aug. 31, with increase or decrease compared with corresponding periods of 1918 :—

Electrical machinery, (*a*) £47,827 (decrease £1,905), (*b*) £426,599 (decrease £66,563); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £13,347 (decrease £13,750), (*b* £144,850 (increase £36,787); and electrical machinery unenumerated, (*a*) £34,480 (increase £11,845), (*b*) £281,749 (decrease £103,350); telegraph and telephone cables other than submarine, (*a*) £20 (increase £20), (*b*) £8,465 (increase £6,529); telegraph and telephone apparatus, (*a*) £9,139 (increase £7,869), (*b*) £179,978 (increase £145,701); other electrical wires and cables, rubber insulated, (*a*) £901 (increase £901), (*b*) £4,425 (increase £3,768); with other insulations, (*a*) £415 (increase £415), (*b*) £10,842 (increase £10,082); carbons, (*a*) £1,967 (increase £274), (*b*) £19,164 (decrease £7,868); glow lamps, (*a*) £1,618 (decrease £1,025), (*b*) £213,510 (increase £123,623); arc lamps and electric searchlights, (*a*) £3 (increase £3), (*b*) £31 (increase £31); parts of arc lamps and searchlights (other than carbons), (*a*) £8,326 (increase £8,326), (*b*) £52,997 (decrease £9,994), primary and secondary batteries, (*a*) £2,636 (decrease £5,684), (*b*) £30,286 (decrease £77,758; meters and measuring instruments, (*a*) £3,365 (increase £2,615), (*b*) £25,899 (increase £8,411); switchboards, (*a*) £128 (increase £128), (*b*) £1,142 (decrease £989); electrical goods and apparatus unenumerated, (*a*) £43,892 (decrease £8,356), (*b*) £292,107 (decrease £70,254). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £72,410 (increase £5,486), (*b* £838,846 (increase £140,282).

Exports.—The exports of electrical machinery, material, &c., (*a* during August, 1919, and (*b*) from Jan. 1 to Aug. 31, with increase or decrease compared with corresponding periods of 1918 were as follows :—

Electrical machinery, (*a*) £209,344 (increase £129,295), (*b*) £1,019,885 (increase £319,723); including railway and tramway motors, (*a*) £28,177 (increase £25,107), (*b*) £55,999 (increase £29,938); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £118,424 (increase £81,544), (*b*) £576,349 (increase £157,686); and electrical machinery unenumerated, (*a*) £62,743 (increase £22,644), (*b*) £387,537 (increase £132,119); telegraph and telephone cables, submarine, (*a*) £73,983 (increase £39,758), (*b*) £423,311 (increase £23,555); other than submarine, (*a*) £58,242 (increase £36,103), (*b*) £261,483 (increase £66,395); telegraph and telephone apparatus, (*a*) £54,400 (increase £41,040), (*b*) £244,351 (increase £114,691); other electrical wires and cables, rubber insulated, (*a*) £102,511 (increase £93,857, (*b*) £479,454 (increase £433,164); with other insulation, (*a*) £138,614 (increase £130,822), (*b*) £569,994 (increase £510,408); carbons, (*a* 1,092 (increase £12), (*b*) £6,126 (increase £1,740), glow lamps, (*a*) £13,114 (increase £5,296), (*b*) £97,734 (increase £40,961); arc lamps and searchlights, (*a*) £143 (increase £1,994), (*b*) £6,924 (decrease £9,049); parts of arc lamps and searchlights (other than carbons), (*a*) £294 (decrease £1,726), (*b*) £7,808 (decrease £5,518); primary and secondary batteries, (*a*) £42,203 (increase £23,178), (*b*) £308,630 (increase £228,751); meters and measuring implements, (*a*) £33,524 (increase £25,393), (*b*) £148,556 (increase £69,710); transformers, (*a*) £8,587 (increase £4,221), (*b*) £44,364 (increase £23,360); switchboards, (*a*) £5,545 (increase £3,416), (*b*) £31,759 (increase £9,763); electrical goods and apparatus unenumerated, (*a*) £130,963 (increase £107,898), (*b*) £755,324 (increase £475,378). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £663,305 (increase £497,274), (*b*) £3,385,818 (increase £1,983,309).

Tenders Invited and Accepted.

Invercargill (N.Z.) Council require tenders by Oct. 9 for supply and erection of a steam turbo-alternator

Manchester Guardians require tenders by noon Sept. 22 for 12 months' supply of Electric Lamps. Forms of tender from the Clerk, All Saints, Manchester.

Atherton Urban Council require tenders by Sept. 30 for the supply of two 30 k.v.a., single-phase, oil-cooled Transformers. Tenders to the Electrical Engineer.

Dublin Guardians want tenders by noon Sept. 24 for 12 months' supply of Electric Fittings, Ironmongery, Ironwork, Oils, Colours, &c. Forms of tender from the Master of the workhouse.

Sydney (N.S.W.) Council require tenders by 3 p.m. Nov. 10, for the supply of electric motors for use in connection with their motor hiring branch. Specification from the City Electrical Engineer.

The West Ham Guardians require tenders by 10 a.m. Sept. 25 for six months' supply of electrical fittings, ironmongery, oils, colours, &c. Forms of tender from the Clerk, Board Room, Union-road, Leytonstone.

Toxteth Park Guardians require tenders by noon Sept. 25 for three months' electrical and engineers' supplies, ironmongery, &c. Forms of tender, &c., from the Clerk, 15, High Park-street, Liverpool.

Kensington (London) Guardians require tenders for six months' supply of electric lamps and fittings, engineers fittings, ironmongery, paint, varnish, &c. Forms of tender until Sept. 25 from the Clerk, Marloes-road, Kensington, W.8.

Manchester Electricity Committee require tenders by 10 a.m. Sept. 23 for the supply and erection of two 250 k.v.a. and two 500 k.v.a. three-phase static transformers. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester. Particulars from the Chief Engineer and Manager.

West Ham Council require tenders by Sept 23 for supply and erection of (1) one 10,000 kw. turbo-alternator, (2) one 10,000 kw. surface condensing plant, and (3) two water-tube boilers, superheaters and stokers. Specification, &c., from Mr. Fredk. W. Purse, engineer and manager, 84 and 86, Romford-road, Stratford, E. 15.

Tenders are required by Jan. 20 for the supply, &c., to the Australian Commonwealth Postmaster-General's Department, State of Victoria, of Automatic Telephone Switchboards at Collingwood, as per schedule 1,583. Tender forms, &c., from the High Commissioner, Room 406, Australia House, Strand, London, W.C.

Grimsby Corporation invite tenders for the supply and erection of two 1,000 kw. converters and c.c. and a.c. l.t. switchgear, e.h.t. switchgear and cables; coal and ash-handling plant and a 30-ton electrically-driven travelling crane. Specifications from the borough electrica engineer, Lieut.-Col. W. A. Vignoles, and tenders by Sept. 25

Dundee Corporation invite tenders for (section A) Switch gear for one 5,000 kw. Turbo-generator, and six Feeders; and (section B) alterations and additions to present Switchgear for two 5,000 kw. Turbo-generators, one feeder, and one 500 kw. Transformer. Specifications, &c., from Mr. H. Richardson, M.Inst.E.E., general manager and engineer, Electricity Dept., Dundee. Tenders to the Town Clerk by 10 a.m. Oct. 8.

Southend Light Railways Committee have accepted the tender of Sadd & Sons for 660 meter boards, at £211. 2s. 6d.

Cheltenham Corporation have accepted the tenders of Johnson & Phillips, Ltd., for transformers, &c., at £144, and Lucy & Company, for c.i. pillars, &c., at £1,522. 10s.

Manchester Corporation have accepted the following tenders for supplies to the Electricity Committee: British Insulated & Helsby Cables, Ltd., adhesive tape; Ward & Goldstone. dry batteries for flash lamps; Callender's Cable & Construction Company, resin oil and bittite tape, and box compound; Dussek Bitumen Company, box compound; W. Patterson, dynamo brushes; British Electric Transformer Company, auto-transformers and balancers; Johnson & Phillips, W. Lucy & Company and British Insulated & Helsby Cables, Ltd., trifurcating boxes; Brotherton Tubes & Conduits, Ltd., and Simplex Conduits, Ltd., tubing and accessories; London Electric Wire Company & Smiths, silk-covered and Eureka wire; F. Smith & Company, copper and tinned copper wire; Hawkins Bros. & Company, fuse wire.

Manchester Corporation have also accepted the tenders of the Electrical Maintenance Company and R. Seddon & Sons for repair of electric fittings at Harpurhey High School, W. Sisson & Company for a generating set for Baguley Sanatorium, and Chloride Electric Storage Company, for replacing battery of accumulators at Abergele Sanatorium; J. Spencer, Ltd., for supply of tramway pole sleeves; and E. M. Evans & Sons, for electric wiring, &c., at Hyde-road pipe-yard.

Appointments Vacant and Filled.

An instructor in electrical maintenance is required at Willesden Polytechnic. Salary £250-£300. Applications to Mr. B. S. Gott, Guildhall, Westminster, S.W. 1.

A tramways manager is required for the tramways in the boroughs of Stockton and Thornaby-on-Tees. Applications to the Town Clerk, Borough Hall, Stockton-on-Tees, by Sept. 27.

A lecturer in electrotechnics is required at the Borough Polytechnic Institute, Borough-road, London, S.E.1. Salary £300, rising to £400. Particulars from the Principal. Applications by Sept. 27.

Two assistant mechanical draughtsmen are required for the drawing office and machine design in the engineering department of the City and Guilds Technical College, Finsbury. Applications to Prof. Margetson, Leonard-street, London, E.C.

The London County Council requires a rolling-stock engineer, a permanent way engineer, an assistant electrical engineer, a traffic operation superintendent, a traffic statistics assistant, a publicity assistant and two sub-station superintendents. Applications to Clerk by 4 p.m. Sept. 25.

A senior lecturer in electrical engineering is required for the South Wales and Monmouthshire School of Mines, Treforest. Salary £450–£600. Further particulars from the Principal and applications by Sept. 23.

An instructor in practical electric wiring and installation work is required for the evening classes at the Northampton Polytechnic Institute. Forms of application from the Principal, Dr. R. Mullineux Walmsley.

A wiring superintendent is required in the London County Council tramways dept. Pay 80s. rising to 90s. a week, with temporary war wages of 20 per cent. plus £90 a year. Applications to the General Manager, 23, Belvedere-road, Lambeth, S.E. 1, by Sept. 29.

A chief engineer and manager is required for the Dar-es-Salaam Government electric power plant. Salary £400—£20—£500 per annum. Applications (quoting M/G.E.A. 9,133) to the Crown Agents for the Colonies, 4. Millbank, S.W. 1.

Mr. R. H. Campion, borough electrical engineer of Dewsbury, has been appointed electricity and tramways manager to Chesterfield Corporation

Mr. Henry Harrison, of Ashton-under-Lyne, has been appointed assistant traffic superintendent on the Sunderland Corporation tramways, at a salary of £4. 5s. per week.

Business Items.

The office of the Faraday Society has been removed to 10, Essex-street, Strand, London, W.C.2.

It is announced that the name of the British Westinghouse Electric & Mfg. Company, Ltd., has now been changed to the Metropolitan-Vickers Electrical Company, Ltd.

Messrs. Chorley & Pickersgill, Ltd., Electric Press, Cookridge-street, Leeds, offer for sale a slip-ring type a.c motor (35 b.h.p. at 950 revs. per min.), with starter, &c.

The Pyrene Company, Ltd., makers of the Pyrene fire extinguisher, are removing from Gt. Queen-street to more extensive premises at 9, Grosvenor-gardens, London, S.W.1. (Telephone: Victoria 8592-3-4-5).

The Aster Engineering Company (1913), Ltd., of Wembley, Middlesex, has issued its preliminary list, which gives particulars and prices of the petrol and paraffin electric generating sets which the company is now turning out in large quantities for country house lighting. The company also supplies arc welding and cinematograph generating sets, pumping and marine sets, &c. Copies of the list will be sent on application.

Mr. Arthur Ellis, Cardiff City Electrical Engineers and Manager of the Tramways Department, has resigned in order to commence practice as a consulting engineer. Mr. Ellis is a native of Newcastle and served as a premium pupil under the Hon. Sir Charles A. Parsons. Subsequently he held appointments at Cambridge, Southport and Bolton, and in 1900 he was appointed borough electrical engineer and manager of the Cardiff Corporation electricity works and tramways.

Messrs. Simplex Conduits, Ltd., have produced a range of Plexsim small domestic appliances, all loaded at under 600 watts, and, therefore, suitable for working from a lampholder. Each piece of apparatus is supplied complete with flexible cord and lampholder adapter, and packed in an attractive carton. The articles are described and illustrated in the company's list, No. 695.

Messrs. Mossay & Company, Ltd., of 7, Princes-street, Westminster, send us a catalogue of Orwell electric platform trucks, manufactured by Messrs. Ransomes, Sims & Jefferies, Ltd., of Ipswich. Type B has three wheels, and is suitable for running on uneven surfaces and in places where a small turning radius is available. Type C, with four wheels, is preferable where a low platform height is essential to facilitate the loading of heavy goods. Type CE, with elevating platform, will run under ready-loaded tables and pick them up, thus saving the loading time. Type CL Orwell electric locomotive will haul ships or trolleys up to 10 tons on rails or 2 tons on average roads. The battery makers are prepared to enter into contracts for the renewal of the batteries so that the cost of upkeep is a determinable quantity. It is stated that in average service, cost of current, replacing batteries and tyres, and maintenance of an Orwell electric truck is about £30 per annum, and. with driver's wages, interest and depreciation £170, the total cost is about £200 per annum. This includes a driver at £120, but in practice, especially where several trucks are used, the wage item per truck is lower.

Liquidations and Bankruptcies.

The Electricity Meters Patent Development Syndicate, Ltd., is being wound up voluntarily and Mr. Tom S. Jones. 54, New Broad-street, London, E.C., has been appointed liquidator. Claims to be sent to the liquidator by Oct. 7.

A first and final dividend of 2s. 6¾d. is payable at 12, Prince's-street, Truro, to creditors of Fredk. Jas. Hornettt electrician, formerly trading at Lemon Quay, Truro.

A first and final dividend of 4s. 4½d. will be payable on 22nd inst. at Union & Smith's Bank-chambers, Hull, to creditors of Wm. Jas., McCombe, formerly tramway manager, Hull.

Companies' Reports, &c.

An interim dividend of 9d. per share has been declared on the ordinary shares of British Insulated & Helsby Cables, Ltd.

Interim dividends of 12s. per share have been declared on both the preference and ordinary shares of P. & W. MacLellan, Ltd.

The directors of the Globe Telegraph & Trust Company, Ltd., have declared a quarterly interim dividend of 2s. per share on the ordinary shares.

The directors of Bruce Peebles & Company, Ltd., have declared a dividend at the rate of 7½ per cent. per annum (less tax) on the cumulative participating preference shares for the half-year ended June 30 last.

The directors of Browett, Lindley & Company, Ltd., have decided to pay an interim dividend of 4 per cent. (actual) on the ordinary shares for the half-year to June 30.

The Manila Electric Railroad & Lighting Corporation has declared a dividend on the common stock of 1½ per cent. for the quarter ending Sept. 30.

An interim dividend at the rate of 6 per cent. per annum (7⅕d. per share), tax free, has been declared on the ordinary shares of Davis & Timmins, Ltd., for the past half-year.

The Direct Spanish Telegraph Company, Ltd., announce an interim dividend at the rate of 4 per cent. per annum (2s. per share), tax free, on the ordinary shares for the half-year.

The directors of Sir W. G. Armstrong, Whitworth & Company, Ltd., have declared an interim dividend of 1s. per share on the ordinary shares, and the usual dividends on the preference shares.

The Public Trustee invites tenders (by noon Oct. 7) for the purchase of 650,000 6 per cent. cumulative preference and 403,193 ordinary shares of £1 each of the Chilian Electric Tramway & Light Company.

Dividends are announced at the rates of 6 per cent. per annum on the preference shares and 8 per cent. per annum on the ordinary shares of the British Aluminium Company, Ltd., for the six months ended June 30.

The transfer books and register of debenture stockholders of the South Metropolitan Electric Light & Power Company, Ltd., is closed from 19th inst. to Oct. 1 inclusive, for the preparation of warrants for interest for the half-year to Oct. 1.

The transfer books of the Western Telegraph Company, Ltd., are closed from Sept. 19 to 27 inclusive, preparatory to payment on Sept. 29 of a dividend of 3s. per share and a bonus of 4s., tax free, making a total distribution of 8 per cent. for the year ended June 30, 1919.

The report of the Dumbarton Burgh & County Tramways Company, Ltd., for the past year states that a dividend of 5 per cent. has been declared on the ordinary shares, and after providing for sinking fund and redemption of debenture stock, and transferring £2,500 to reserve, £2,816 is carried forward.

The directors of the Eastern Extension, Australasia & China Telegraph Company, Ltd., have declared an interim dividend for the three months ended June 30 last of 3s. per share payable (tax free) on the 15th prox. The share register will be closed from Oct. 7 to 14 inclusive.

The Eastern Telegraph Company, Ltd., announce payment on Oct. 15 of dividend at the rate of 3½ per cent. per annum, less tax, on the preference stock for the quarter ending Sept. 30, and the second quarterly interim dividend of 1⅜ per cent. on the ordinary stock, tax free, in respect of profits for the year 1919. The transfer books of the ordinary stock will be closed from Oct. 7 to 14 inclusive.

New Companies.

BLYTH & PAWSEY, LTD. (158.497.)—Private company; reg. Sept. 4 capital £7,500 in £1 shares, to carry on the business of manufacturers of and dealers in agricultural and other implements, electrical and general engineers, &c. First directors, J. A. Pawsey, J. S. Pawsey, G. P. Pawsey and C. S. Blyth. Reg. office, Rayne Ironworks, Rayne, near Braintree.

BRITISH AUSTRALIAN ENGINEERING COMPANY, LTD. (158,607).—Private company, reg. Sept. 8, capital £25,000 in £1 shares, to carry on in Australia or elsewhere the business of manufacturers, merchants, contractors, mechanical, mining and electrical engineers, &c., and to enter into agreements (1) with H. C. Siddeley, and (2) with R. W. Wild. First directors: R. S. Brailsford, A. Ewing, J. A. Hirst, H. J. Marshall and S. Newell. Reg. office, Australia House, Strand, W.C.2.

EASTERN COUNTIES ROAD CAR COMPANY, LTD. (158,379).—Reg. Aug 30, capital £50,000 in £1 shares, to take over all or part of the business carried on in Suffolk by Thomas Tilling, Ltd. First directors: C. S. E. Hilton, J. E. Spagnolotti, R. M. Tilling, W. Wolsey, jun., and C. Reeves. Reg. office, 32, Silent-street, Ipswich.

EASTERN ENGINEERING & SUPPLY COMPANY, LTD. (158,667).—Private company, reg. Sept. 10, capital £5,000 in £1 shares, to carry on the business of electrical, mechanical and general engineers, manufacturers of machinery, electrical apparatus, &c. Reg. office, 351, High-street, Stratford, E.15.

EBO RUBBER, LTD. (158,751.)—Private company; reg. Sept. 12, capital £3,000 in £1 shares, to carry on business of indiarubber manufacturers, cable makers, &c. First directors, G. Cowap, J. Noone and W. A. Cox. Reg. office, "A" Warehouse, Third Section Seal Wharf, Stratford, E.

ELECTRICAL ENGINEERING (WEST BROMWICH), LTD. (158,578).—Private company, reg. Sept. 6, capital £5,000 in £1 shares, to carry on the business of electrical, mechanical and consulting engineers, electric light and power installers, &c. Solicitor: A. A. Millicents, West Bromwich.

EMPIRE (ALLOY) STEEL CORPORATION, LTD (158,636).—Private company, reg. Sept. 9, capital £250,000 in £1 shares, to carry on the business of manufacturers of high-grade steels, electric steel, alloys of steel and other metals, metal goods, engines, dynamos, boilers, &c., and to adopt an agreement with W. B. Ballantine and D. C. Lee. First directors: D. C. Lee, Lieut.-Com. W. B. Ballantine. Reg. office, 62, Pall Mall, S.W.1.

ENGINEERING PRODUCTS COMPANY, LTD. (158,610).—Private company, reg. Sept. 8, capital £10,000 in £1 shares (6,500 preference), to carry on the business of manufacturers of and dealers in motors, cycles, vehicles, aircraft, mechanical, electrical and general engineers, &c., and to enter into an agreement with W. R. Jones. First directors: W. R. Jones, F. W. D. Jones and S. B. Berry. Secretary: C. J. Wade. Reg. office, 61, Holborn Viaduct, E.C.

GUARANTEE ENGINEERING COMPANY, LTD. (158,711.)—Private company; reg. Sept. 11, capital £1,000 in £1 shares, to carry on the business of general engineers, ironfounders, electrical and mechanical engineers, tool makers, &c. M. Jaffee is sole permanent director. Solicitors, Bulcraig & Davis, Donington House, Norfolk-street, W.C.

INSULATERS, LTD. (158,740)—Reg. Sept. 12, capital £75,000 in £1 shares. Objects: To carry on the business of manufacturers of insulating and chemical materials and products, constructors of and dealers in plant, apparatus and compounds used in the installation of cold storage premises, buildings, &c.

JOHN COATES (ELECTRO PLATERS), LTD. (158,645).—Private company, reg. Sept. 9, capital £1,500 in £1 shares, to take over certain plant, machinery and assets, suitable for business of galvanising, electro-galvanising and electro-plating iron and steel, from N. Crowther, of Gratton-road, Bradford. First directors: N. Crowther, H. Croft and J. Coates. Reg. office, 41, Gratton-road, Bradford.

KENDALLS (NOTTINGHAM), LTD. (158,755.—Private company; reg. Sept. 12. capital 7,500 in £1 shares, to take over business of a plumber, electrician, coppersmith and motor and general engineer carried on by F. Kendall, at Forman-street, Nottingham. First directors, F. Kendall and G. E. Hadley.

PHŒNIX ELECTRICAL COMPANY, LTD. (10,621).—Private company, reg in Edinburgh, Sept. 10, capital £20,000 in £1 shares, to carry on the business of engineers, electricians and dealers, carried on as the Phœnix Electrical Company, or by T. H. Large, in his own name. First directors: J. Boag and T. H. Large. Reg. office, 32, Broomielaw, Glasgow.

JOHN SPENCE & SONS (AIRDRIE) LTD. (10,610).—Private company Reg. in Edinburgh Sept. 1, capital £10,000 in £1 shares, to carry on business of brass and iron founders, plumbers, gasfitters, electricians, engineers, &c. First directors: P. Spence, J. Spence, P. Spence, jun., M. S. Spence and J. J. McMurdo. Reg. office, Billsdyke Works, Airdrie.

McKEOWN & MARTIN, LTD. (4,778). Private company, reg. in Dublin Sept. 2, capital £5,000 in £1 shares, to carry on the business of electrical engineers, &c. First directors: J. J. McKeown and C. R. Martin. Reg. office, 3, Bridge-street, Belfast.

S. S. & F. L. MURRAY, LTD. (158,521.)—Private company; reg. Sept. 4, capital £1,000 in £1 shares, to carry on the business of ironfounders, electric and general engineers, &c. First directors, T. S. S. and F. L. S. Murray. Reg. office, 42, Lower-road, Rotherhithe, S.E. 16.

PATEX, LTD. (158,653.)—Private company; reg. Sept. 9, capita £100 in 1s. shares, to carry on business of patent experts, electrical, mechanical, constructional and general engineers and contractors, scientific instrument makers and dealers, &c., and to enter into an agreement with A. E. Coyne and A. C. Hunt. J. J. Jubb signs as "director." Reg. office, Albert-buildings, 151-7, Fitzwilliam-street, Sheffield.

POWER EQUIPMENT COMPANY, LTD. (158,743.)—Private company; reg. Sept. 12, capital £6,000 in £1 shares, to take over the business of electrical and mechanical engineers carried on by J. Cruwys and J. P. Keith at Crown Works, Cricklewood. First directors, J. Cruwys and J. P. Keith. Reg. office, Crown Works, Cricklewood, N.W. 2.

R. M. RADIO, LTD. (158,602).—Private company, reg. Sept. 6, capital £10,000 in £1 shares, to buy, sell, let or otherwise deal in radio apparatus, establish and maintain a registry of radio operators and a school of instruction, transmit and receive radio messages, and carry on business of engineers and manufacturers of radio apparatus, &c. Reg. office, 5, Chancery-lane, W.C.

SEMCO, LTD. (158,689).—Private comany, reg. Sept. 10, capital £7,000 in £1 shares (3,000 10 per cent. preference), to carry on business of electricians, mechanical engineers, suppliers of electricity, &c., and to adopt an agreement with A. E. Grubb, S. E. Grubb, T. E. Nankivell and E. F. Burrill. Directors: A. E. Grubb, T. E. Nankivell, E. F. Burrill and S. E. Grubb. Reg. office, 19-20, High-street, Shoreditch, E.1.

Prices of Metals, Chemicals, &c.

			TUESDAY, Sept. 16.	
		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£110 0 0	£1	—
Electrolytic bars ...	,,	£121 0 0	£1	—
H.C. wire, basis ...	per lb.	1s. 4$\frac{3}{16}$d.	$\frac{1}{4}$d.	—
Sheet	per lb.	1s. 3$\frac{5}{8}$d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	per lb.	1s. 8$\frac{3}{16}$d.	$\frac{1}{4}$d.	—
Brass 60/40—				
Rod, basis	,,	0s. 11d.	$\frac{1}{8}$d.	—
Sheet, basis	,,	1s. 2$\frac{3}{8}$d.	—	—
Wire, basis	,,	1s. 2$\frac{1}{4}$d.	—	—
Pig Iron—				
Cleveland warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	£33 10 0	—	—
Lead Pig—				
English	,,	26 10 0	5s. 0d.	—
Foreign or colonial	,,	25 5 0	2s. 6d.	—
Tin—Ingot	,,	286 0 0	3 0 0	—
Wire, basis	per lb.	0 3 6$\frac{1}{2}$	$\frac{1}{2}$d.	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £21.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £42.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6$\frac{1}{2}$d.

Shellac.—480s. October delivery 470s. to 472s. 6d.

Rubber.—Para fine, 2s. 5$\frac{3}{4}$d.; plantation 1st. latex 2s. 1$\frac{3}{4}$d. lb.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W.T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Sept. 16, 1882.]

THE WAR.—Colonel Webber, R.E., has taken control of the telegraph at Ismailia.

EDISON *v.* MAXIM.—A suit has been brought by the Edison Company against H. E. Maxim for infringing Edison's incandescent lamp patents. The trial will probably take place in Paris in November next.

ELECTRIC LIGHT AT GRIMSBY.—During a fete held in the grounds of Mr. J. Wintringham, at Grimsby, in aid of the funds of the Hull and Grimsby Orphan Home, the grounds were lighted by Brush lamps, supplied and erected by the Midland Brush Electric Light Company. There were six lamps altogether, the power being derived from an engine supplied by Messrs. Riggall and Hewins.

NEW DYNAMO.—A provincial contemporary reports the exhibition at Scarborough by a Mr. Herbert Grantham, a seaman, of a new dynamo constructed on the shunt principle. The machine was shown at works in the Aerated Water Factory of Mr. Jos. Peacock at Scarborough, and is stated to have kept both an arc lamp and several Swan incandescent lamps burning steadily. The same authority reports that Mr. Grantham will supply a small machine (no estimate of the size is afforded) for £30.

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Notes.

Municipal Tramways Association.

THE annual meeting of the Municipal Tramways Association which was held last week reflected the general feeling of uncertainty which at present pervades the industry. These uncertainties extend in many directions, as was emphasised by Councillor KELLY in his Paper entitled "Where Do We Stand?" Apart from this general uncertainty, the main feature which was noticeable was the growing favour with which the motor omnibus is now regarded. This was evident, not merely from Mr. A. R. FEARNLEY'S Paper, which we reproduced in abstract last week, but also from the discussion of which we give some account in another column. Mr. FEARNLEY'S Paper was particularly interesting as it gave actual figures of the results obtained at Sheffield, and shows how important an adjunct the motor 'bus may be to the electric tram. The Corporation now have services covering 37 miles of road, of which 15 miles are within the city boundary and 22 miles outside the city, and for these services 40 motor omnibuses are employed. The figures given by Mr. FEARNLEY are interesting as showing the relative advantages of the two forms of transport. At the present time it cannot be said that conditions are very suitable for exact comparisons. Expenses have increased enormously—in fact, more than might have been anticipated. Thus, for the 'bus-mile, the expenses have increased from 7d. in 1915 up to 17·8d. in 1919. It cannot be said that any particular item is essentially the offender in this respect, for all expenses seem to have risen. As regards relative expenses, it is interesting to note that the total revenue and capital expenses are 33·7 per cent. more for the motor 'bus than for the tram. When it comes to the cost per passenger carried, the cost is again heavier, being 176 per cent. The comparison is also favourable to the tramway on the basis of seat per 'bus-mile, the expenses being 114·1 per cent. higher. It becomes obvious, therefore, that the fares charged must be higher than it is on tramways. In the case of Sheffield the fare is 1·5d. per mile, as against 0·652d. per mile for the tramway, and this gives higher receipts to the extent of 130 per cent. The comparison is rather less favourable to the motor 'bus than might have been expected. This is due to the fact that, although the capital charges are considerably lower, namely, 45·3 per cent. less, yet the working expenses are higher nearly to the same percentage; but the figure on which the percentage is based is larger for working expenses than for capital charges, and consequently the cost as a whole is greater. It must be borne in mind however, that the comparative figures are based on the 1918-19 accounts—*i.e.*, on the present abnormal conditions—and these will not necessarily hold at some later date. Some of the motor 'bus costs (for example, petrol) have certainly risen higher than the corresponding items for tramways.

The Would-be Consumer.

AT the present time it is a common complaint of many electricity supply engineers that they have more orders than plant, and consequently cannot undertake to accept more consumers, or even to emphasise the advantages of electricity by suitable publicity. This, we think, is a mistaken attitude. The services of electricity during the war have been very much emphasised and the average member of the public is now well aware of the advantages to be gained through electricity supply. Obviously the station engineer should take advantage of this frame of mind and obtain as many consumers as possible so long as he does not overload his plant. If no effort is made in this direction the would-be consumer will naturally turn to other methods, and once he has done so it will not be so easy to win him back and to induce him to spend money upon changing his installation. The station engineer has, of course, in front of him the most difficult time of year. It should be possible, however, to connect a certain number of consumers on condition that they take a supply of a limited character, which might be based on correspondingly favourable financial conditions. Even in highly industrial districts, having a good flat load curve, there is usually a small ultimate peak which must be borne during four or five nights of the week for perhaps an hour or so between the months of October to January. Waiting consumers might often be glad to take a supply on condition that they should refrain from use during those hours, or at least keep within some fraction of their full load. The main thing is to tide over the present position of plant shortage without restricting new business or allowing the public to gain the impression that there is a deficiency of supply

The Ironfounders' Strike.

THE ironfounders' strike which is now in progress must be regarded as one of the most unfortunate actions of labour that could have taken place. Claims were put forward recently by both the unions and the employers, on the one hand for an increase in wages, and on the other for a reduction. Both claims were refused by the Court of Arbitration and consequently the present wages hold good for a period of four months. The unions now involved were bound, along with a large number of other trade unions, by an agreement whereby such claims should be referred to arbitration. These three unions objected to the award and the present strike is the result. What makes it more than usually serious is that the action is due to responsible people in the trade unions and not to uncontrolled rank and file. It is all very well to say that constitutional methods have been followed in breaking the agreement. The fact remains, as pointed out by the Ministry of Labour, that the unions are at least morally bound to observe the conditions just as much as employers are legally obliged to pay the wages given by the award. One-sided agreements are quite useless in the carrying on of industry. Moreover, it must be realised that advances in wages will have to cease at some particular period, and not only so but that at some future date wages will have to be reduced. This is inevitable, and the sooner this elementary fact is realised the better will it be for both Capital and Labour.

Built-in Electrical Machinery in the Home.

In this country, as yet, it cannot be said that electrical labour-saving devices have been properly developed for domestic use. Heating apparatus has made considerable headway, but it is rare to find the dish-washing and dish-drying apparatus which seems to be a regular feature in American hotels, as well as in some private houses. In laundries, also, electrical machines for washing clothes are not prevalent. In America all such devices are much more familiar, no doubt because of the scarcity of domestic labour. The disinclination to enter domestic service which has arisen during the war may compel us towards a freer use of such labour-saving devices. Meantime, it is interesting to notice that, according to the "Electrical Review" (U.S.A.), a new stage in the application of such devices is being reached. Already "built-in" apparatus, such as ice boxes, book racks, sideboards and even beds are becoming customary in the home, and it is urged that similar practice in regard to electrical machinery would be very desirable. Instead of a portable dish-washing apparatus, for example, one would use a properly built-in and permanently wired one, placed in the position where it can be most easily filled and drained. It is suggested that the electrical work would be executed more satisfactorily in these circumstances, and that the arrangements for cleaning would be much better. In particular, a stationary electrical washing apparatus could be combined with an electrically-heated drying chamber. Most tenants would be willing to pay a somewhat higher rent for houses so equipped. In view of the probable popularisation of the use of electricity for all domestic purposes, which we hope for in the future, this movement should be watched.

Optical and Photo-electric Properties of Molybdenite.—A Scientific Paper, No. 338, issued by the Bureau of Standards, Washington, summarises some experiments by Dr. W. W. Coblentz and Mr. H. Kahler on the above subjects. The transmissivity, reflectivity and photo-electrical sensitivity of molybdenite M_0S_2 was determined in the spectral region of 0·36μ to 9μ. The effect of temperature, humidity, intensity of the exciting radiations, &c., upon the electrical conductivity was investigated. Molybdenite is conspicuous for its high photo-electrical sensitivity to infra-red rays, extending to 3μ; being especially sensitive for radiations at wave-lengths $\lambda = 0{\cdot}73\mu$, 0·85μ, 1·02μ and 1·8μ. Samples of molybdenite from various localities reveal a great difference in sensitivity, which from the tests at liquid air temperatures seems to be one of degree rather than one of quality.

International Electrotechnical Commission.—A plenary meeting of this Commission will be held in London on October 20, 21, 22 and 23. This is the first plenary meeting since the outbreak of war, and important questions in regard to the future work of the Commission will come forward for decision. It is confidently expected that 40 to 50 delegates will be present, representing 16 to 18 countries.

Use of Gas Masks in Mines.—The "Iron Trade Review" calls attention to the impression among miners who have returned from the war that the gas masks used as a protection against poison gas in France can be used for rescue work in mines. It should be realised that the functions demanded of the masks used in warfare are quite different from those required in mining work. War-masks are designed for the protection of men against special noxious gases, and contain absorbent material. They were adapted for use in the open air, not in confined spaces, and afford no protection against a vitiated atmosphere containing very little oxygen, such as may exist after an explosion of fire-damp. On the other hand, this type of mask might be developed for protection against poisonous gases, such as carbon monoxide or fumes given off in smelting operations, and experiments in this direction are proceeding.

Electric Resistance Furnaces for the Heat Treatment of Steel.—A form of electric resistance type furnace which is stated to have special advantages for the heat-treatment of steel, which requires a relatively low temperature, and also for melting non-ferrous metals, has recently been developed in the United States by the Electric Furnace Company, in Ohio, and was described in the "Iron Trade Review" The heating element consists in a ring trough, made of carborundum sand, encircling the inside of the furnace above the hearth and filled with granulated carbon. The shell of the furnace is equipped with a geared mechanism for tilting, and full electric controlling appliances, including oil-break switch, transformer and meters are provided. A pyrometer designed in such a way that the switch is automatically opened when the furnace has reached a given temperature, can also be used.

Central Heating in Berlin.—With reference to the remarks recently made on the desirability of studying central heating systems, it is interesting to observe that, according to "Engineering" a new scheme for supplying some public buildings of Berlin with heat, and also with warm water, was adopted in Berlin in July last. The warm water is to be derived from the exhaust steam of the turbo-dynamos of the Berlin electricity works and from some coke-heated boilers, and is to enter the pipes superheated at a temperature of 120°C.; the pipes are to be laid in concrete conduits along the streets, the pipe sections to be welded together and to be provided with stuffing-boxes and with sliding bearings. The distribution area is to have a radius of 2·5 km., and to include some tenement houses. The contract has been given to the firm of Körting A.G., and it was hoped to start supply by next winter; the execution of the whole scheme appears doubtful, however, under actual conditions.

Tests of Chemical Resistive Power of Powdered Glass.—When the resistive power of glasses to chemical action is tested, the glass is commonly used in the form of powder in order to hasten the solvent effect, and the test proceeds at high temperatures. Both these factors accelerate the test, but it seems doubtful whether they do not invalidate comparisons to some extent. The point is dealt with by Mons. P. Nicolardot, who, in the "Comptes Rendus," suggests a series of tests at 100°C., 120°C., 140°C. and 160°C., respectively. He submits results of tests on Jena and Krasna glass (the best and worst tested), both whole glass blocks and coarse, medium and fine powder being used. He shows that the effect of boiling in HCl (as revealed by loss in weight) increased greatly with the fineness of the powder. So far as water is concerned the attack remains constant if results are expressed per unit of surface presented, but this does not hold good with the acid. Moreover, the difference in degree of action with different glasses appears in this case to be much less marked.

Wireless Telegraph Licences.—There is now general activity among those who before the war held wireless telegraph licences, and also among many who during the war were engaged in wireless telegraphy and are desirous of setting up stations of their own. The Advisory Committee of the Wireless Society of London has been authorised to advise on the suitability of applicants for transmitting licences, and the hon. secretary of the society (Mr. Leslie McMichael), 30, West End-lane, West Hampstead, N.W.16, would be glad if secretaries of wireless societies and clubs already formed, or about to be formed, would communicate with him as soon as possible, giving particulars of numbers and the area of their membership.

Progress in Legislation on Factory Lighting in the United States.—We have previously drawn attention to the progress being made towards legislation on factory lighting in the United States, where five States, New York, New Jersey, Wisconsin, Pennsylvania and Oregon, have adopted codes of industrial lighting. In the discussion on a recent Paper by Mr. G. W. Stickney, summarising progress of this nature, some interesting data were presented regarding the operation of the code (in New York) which was introduced in August 1918. During the seven months from August 1918 to February 1919, 3,185 orders for improved lighting were issued, and 1,566, about 50 per cent., of compliances secured. It is stated that employers cordially accept the recommendations made, their chief anxiety being to ascertain exactly how the lighting ought to be carried out. With the view of affording instruction, inspectors receive special education in illuminating engineering, attending classes at which the results of lighting tests and experience in visiting factories are discussed.

The Disappearing Filament Type of Optical Pyrometer.—A recent Paper presented by Mr. W. E. Forsythe, of the Wela Research Laboratory, U.S.A., before the Faraday Society, gives a very full account of the above type of optical pyrometer, which the author remarks, hardly received enough attention in the special discussion on "Pyrometers and Pyrometry," that took place in 1917. While not intended for temperatures exceeding that of melting palladium (1,828°K.), disappearing filaments are claimed to hold their own well with thermo-couple types within this range, as regards accuracy and constancy of calibration. The simplicity of construction is also an advantage. As is well known, optical pyrometers may be based on determination of (1) brightness either of the total radiation or a selected region of the spectrum, or (2) the colour of the emitted radiation. The nature of the "black body" which serves as the comparison standard, is explained and various pyrometers are illustrated. The results of tests are appended to show the good agreement attained by different observers and the high order of accuracy, and various supplementary questions such as the choice of colour-screens and the nature of the lamp-filament are discussed.

A Theory of Invar.—The explanation of the characteristic properties of "invar" (a nickel steel containing 35·4 per cent. of nickel and small quantities of carbon and manganese) has been much discussed, and a theory is put forward in a Paper recently presented before the Faraday Society by K. Honda and H. Takagi. An attempt is made to explain the small expansion of invar without assuming any compound of iron and nickel. By the aid of diagrams illustrating the thermo-electric properties, and especially the critical point-concentration curve, some light is thrown on the behaviour of invar, the coefficient of expansion of which, though very small at room-temperatures, increases rapidly from 200 deg. and above 300 deg. has an ordinary value. In the author's words the remarkable property of invar is obtained "by bringing the temperature of the minimum elongation, or that of the A_3 transformation, to the vicinity of room-temperature, through a suitable addition of nickel to iron." In these circumstances the addition of small quantities of other elements bring this minimum elongation slightly above or below room-temperature, so that the coefficient of expansion has a very small negative value in the first case, and a very small positive value in the second. There is then no need to assume that the property of invar is due to the formation of the improbable compound Fe_2Ni.

Birmingham Electric Club.—An interesting Paper was read on Saturday, September 13, by Mr. H. F. Steventon, upon "High Efficiency Projector Arcs." The author gave some account of the pre-war projector, using the pure carbon arc, and explained the general principles of light projection, pointing out that even before the war the greatly increased range of gun-fire called for greater efficiency in projector arcs. In this connection an interesting account was given of the work of Beck in Germany and Elmer Sperry in New York, and of their experiments with flame carbons which, under certain conditions, were found to yield a greatly increased candle-power, with a decrease in the area of the light source. The author also gave much information about the ingenious methods which the two experimenters used to cool the carbon and prevent oxidation, and also treated of the rival methods of automatic carbon feed and rotation. The latest form of searchlight was developed in Paris, using only one carbon, the negative electrode being a copper ring through which water is forced for cooling purposes. In the author's opinion this type of lamp will not compete with the lamps of the Sperry or Beck type, although probably having a future for cinema work.

The Functions of a Drawing Office.—It is common experience that the work undertaken by a drawing office attached to a large manufacturing firm is in these days vastly more important and complex than in the past. This department, in fact, tends to assume a great deal of the original work and the planning of new schemes. Mr. N. Gerrard Smith, commenting on this fact in "Engineering and Industrial Management," classifies the five chief functions of a drawing office as follows: (1) To design product and manufacturing plant and appliances; (2) to collect ideas and use them to the best advantage; (3) to experiment with and demonstrate all new products and appliances; (4) to deal with time study on which is based costs, reward payments and piecework rates; (5) to record all data, especially experiments and alterations to processes, and to note whether they prove successful or not. Although, as we admit above, drawing offices have naturally extended their scope, some may, perhaps, justly consider that the above schedule involves the usurpation of duties which should belong to other departments; for example, the department of research. In any case, however, such departments must work in close co-operation with the drawing office, if only for the reason that the latter can conveniently have assigned to it that tabulation and presentation of data in diagrammatic form. All this involves close co-operation and good team-work, conditions which, the author remarks, are the more difficult to secure because the expert in the drawing office must necessarily possess original gifts, and therefore somewhat individualistic tendencies.

Personal.

The marriage took place yesterday (Thursday) of Capt. Vincent Ziani de Ferranti, M.C., and Miss Dorothy Wilson, only child of Mr. and Mrs. Reg. P. Wilson.

The marriage of Capt. J. B. Hartley, M.C., electrical engineer at the British Westinghouse (now Metropolitan-Vickers) Company's works, and Miss A. Stuttard took place at Burnley on Friday last.

Mr. B. Sankey, engineer and manager of the Port Elizabeth municipal electricity works, is president for the current year of the Association of Municipal Electrical Engineers of the Union of South Africa, and Mr. E. Poole, of Durban, is hon. secretary and treasurer. At present there are 36 full members of the Association, but it has now been decided to admit honorary and associate members.

Arrangements for the Week.

FRIDAY, Oct. 3rd.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Paper to be read on "The Deduction of Formulæ from Plotted Figures," by Mr. A. J. Paxman.

The Electrical Driving of Rolling Mills.

By A. P. PYNE, M.I.E.E.

Summary.—The driving of rolling mills by electricity has made slow progress in this country compared with the Continent and America ; but its advantages are now realised and nearly all new mills are electrically driven. Much, however, can still be done in converting existing mills from steam to electricity. The advantages of the electric drive cannot always be expressed in £ s. d. Mills operate under widely varying conditions, and the nature of the current available exercises considerable influence on the type of plant that should be used. The most suitable type of motor to fulfil given requirements is considered ; also the conditions under which rope or gear drives should be adopted, the applicability of various types of control gear, and practical considerations affecting selection of slip regulator. The advisability of installing measuring and recording instruments is emphasised.

THE advantages of electrically operating rolling mill auxiliaries have long been recognised, and the use of electric power for such purposes has become almost universal ; but, for various reasons, driving the actual rolling mill itself by electricity has not been as popular in this country as on the Continent or in America. This attitude is now rapidly being abandoned. Most new mills installed during the last five years are electrically operated, and during the same period a number of conversions from steam to electricity have been made in the drives of existing mills.

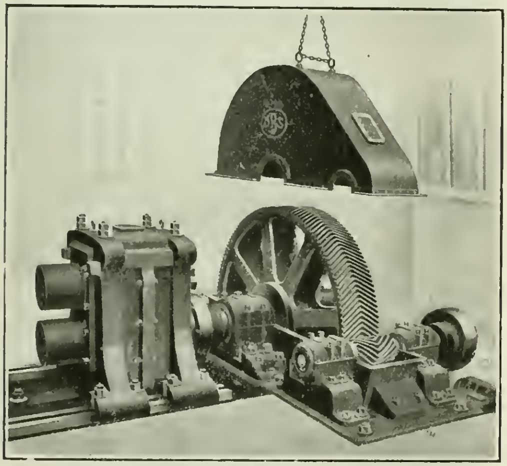

Fig. 1.—60-in. Heavy Type Single Reduction Gear, Transmitting 80 to 1,000 h.p., at 350 to 35 revs. per min. (David Brown & Sons.)

In view of present-day conditions, and of the more extended use of electricity probable in the near future, there still remain many steam-driven mills that could with advantage be converted to the electric drive.

A certain amount of literature now exists in the form of Papers and articles in the technical press showing—sometimes in considerable detail—the advantages accruing from the adoption of the electric drive. In spite of this, however, the deciding factor is too often allowed to lie in a comparison between the cost of raising steam and that of generating or purchasing electricity.

After giving due weight to relative capital outlays, and to the advantages of using steam for the main mill or mills combined with exhaust or mixed pressure steam turbo-generators, providing electricity for the auxiliaries, the balance will under present-day conditions generally lie with electricity for the main mill, and will certainly do so if blast furnace gas or other form of waste heat is available for the generation of electric power.

Even should the cost of steam power be less than the cost of electric power, the adoption of the electric drive may still be extremely desirable from considerations difficult to express in pounds, shillings and pence, such as relief to congested sidings due to smaller quantities of coal to be handled ; greater freedom from stoppages ; lower cost of upkeep and repairs ; ease of distribution and control and the facility with which electric power can be measured and recorded. The effect of an even turning moment on the product of the mill is in some instances of considerable importance.

Modern developments in the design of electric motors have resulted in the production of standard types of machines capable of operating reliably and satisfactorily under practically any conditions pertaining to rolling mill practice.

As the conditions existing in different works vary within

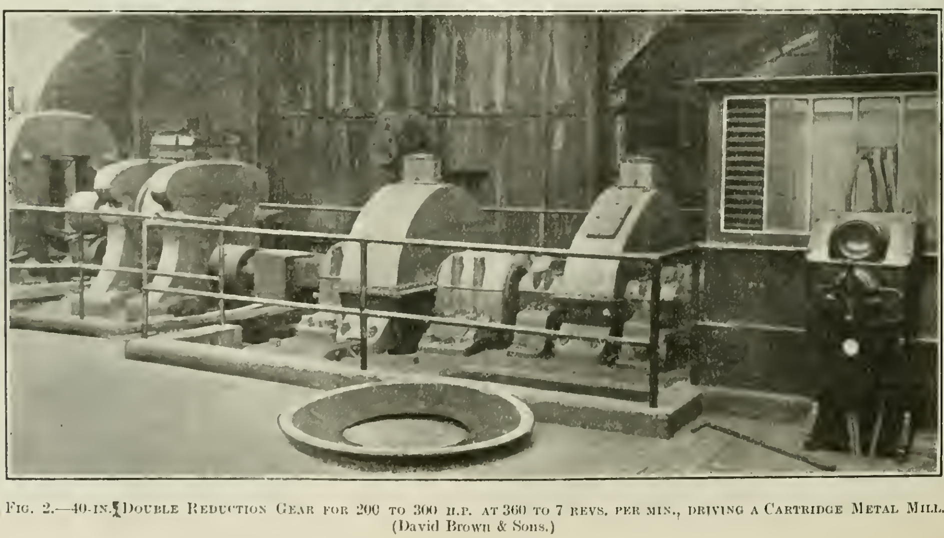

Fig. 2.—40-in. Double Reduction Gear for 200 to 300 h.p. at 360 to 7 revs. per min., driving a Cartridge Metal Mill. (David Brown & Sons.)

extremely wide limits, the relative merits of the steam and electric drives must be decided for each establishment in accordance with its local conditions.

Assuming that a decision has been made to adopt electricity as the motive power, it may be opportune to consider the possibilities and limitations of electric motors and control gear when applied to rolling mill drives, and to emphasise certain points not always brought to the user's notice when the latter is initially considering the most suitable type of plant or apparatus to apply to a particular mill.

In view of the great dissimilarity of power supply systems existing at the present time, the problem involved in driving any particular mill must be considered in conjunction with the electric current available before a concrete proposal can be prepared.

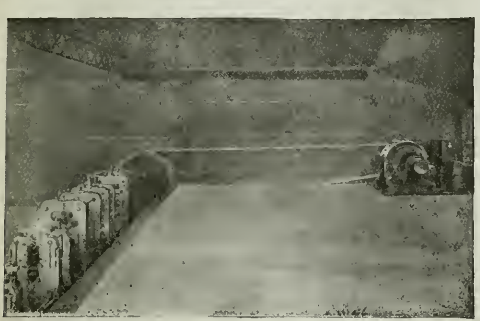

Fig. 3.—350 h.p. Motor, Driving by rope a Small Section Mill. The 7-ton rope wheel acts as a flywheel. (General Electric Co.)

The following remarks will deal more particularly with the larger mills of, say, 250 h.p. and upwards. They may be divided into two main classes :—

1. Constant speed.
2. Variable speed.

The latter can be subdivided into two, namely :—

(*a*) Continuous running in one direction.
(*b*) Reversible.

If direct current is available, no difficulty will be experienced in obtaining a motor to satisfy the requirements of either class of mill ; there will, however, be several points external to the motor which will require consideration.

If alternating current only is available, difficulties may arise which are not easy of solution.

The majority of mills of the first class will be employed in rolling sheets, plates and small sections. The speed of the rolls will generally lie between 30 revs. per min. and 120 revs. per min. Assuming that no speed variation is required, such mills can be driven equally well by alternating as by direct-current motors. The brake-horse-power of the motor will depend largely on the output demanded from the mill ; sufficient data now exist to enable this brake-horse-power to be predetermined with considerable accuracy. The speed selected for the motor becomes to some extent a matter of personal opinion, depending on the form of speed reduction favoured, and the relative costs of same as compared with that of a slow-speed motor driving directly on to the mill shaft.

The alternative to a direct drive will be a single gear reduction, examples of which are shown in Figs. 1, 4, 5 and 11 : a double gear reduction, as shown in Fig. 2 ; or a rope drive, either alone or combined with one and sometimes two gear reductions. Fig. 3 shows a plain rope drive without gearing.

The flexibility of a properly looked after rope drive has resulted in its having had many advocates in the past ; but the increasing value of floor space and the compactness and smooth running of modern machine-cut gear wheels has latterly brought this form of speed reduction into prominence.

A further factor to be considered when fixing the speed of the motor is the position of the flywheel, which usually forms an indispensable adjunct to mills of the class under consideration.

It must also be remembered that the alternating-current motor, which is generally of the three-phase type, even if of low periodicity, cannot be run at as slow a speed as the direct-current motor without adversely affecting the efficiency and power factor.

With mill speeds in excess of 60 revs. per min., the motor, if of the direct-current type, can be coupled to the mill shaft, which will also carry the flywheel. It is not desirable to instal alternating-current motors of so low a speed, although there are examples of mills directly driven by three-phase motors running at about 70 revs. per min. when on a 25-cycle system.

Fig. 4 shows an alternating-current motor driving on to a slow-speed mill shaft which also carries the flywheel. This arrangement, very frequently adopted where it is desired to use an existing plant, is by no means as silent and smooth running as that illustrated in Fig. 5, where the gears are of the double-helical machine-cut type run in oil, and which may certainly be regarded as standard practice for the future. These two figures will give an idea of the saving to be gained if for the large flywheel shown in Fig. 4 there could be placed a suitable wheel on the motor shaft. It also will be seen that the extra cost of a slow-speed motor, where it is feasible to place it on the mill shaft, will be largely offset by the cost of the gearing, a somewhat heavy item whether due to the weight of metal involved in Fig. 4, or the expense of cutting the gears indicated in Fig. 5.

With mill speeds of, say, 60 revs. per min. or below, at least one reduction of speed will usually be found essential. The motor speed can then be as high as considerations of gear design will admit, the flywheel can be placed on the motor shaft and a great saving in size and weight effected, observing, however, that in this case the gearing must be designed to withstand the stresses transmitted by the flywheel.

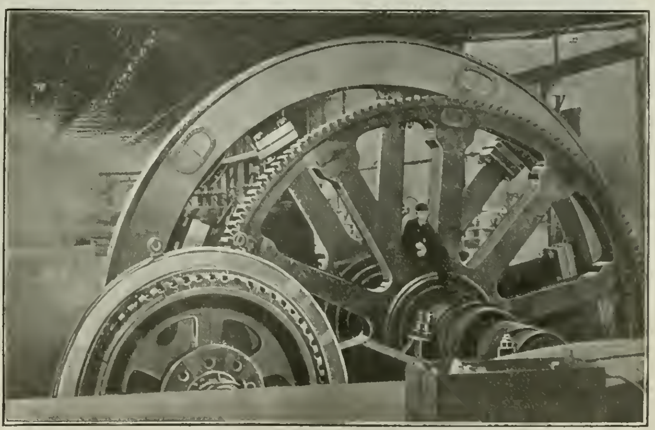

Fig. 4.—1,000 h.p., 3-phase, 2,000-volt Motor, 187 revs. per min., Driving a Tin Plate Mill at 30 revs. per min. (British Westinghouse Co.)

Should a rope drive be adopted, the flywheel effect can be embodied in the driven rope wheel or a separate flywheel provided.

In the case of very slow mills, particularly such as those dealing with non-ferrous metals, a rope drive combined with one or two gear reductions is frequently employed, in which case the flywheel should be placed on the shaft carrying the driven rope pulley.

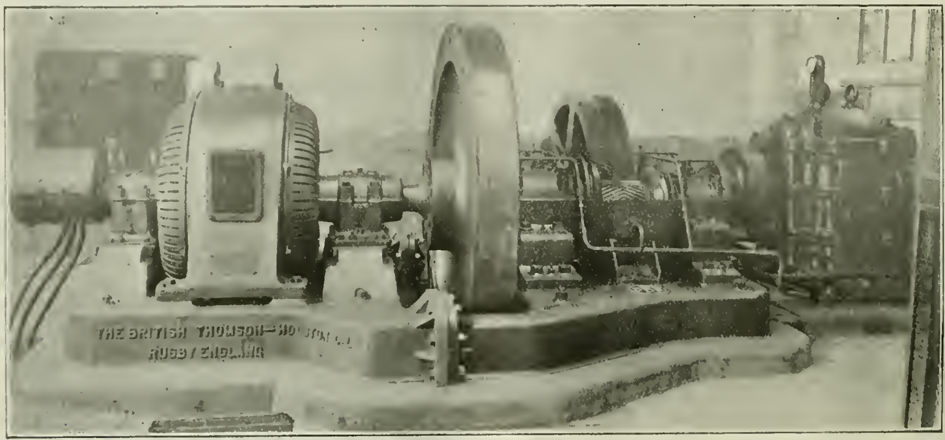

Fig. 5. 400 to 800 h.p. Motor with Flywheel on Motor Shaft, Driving a Small Cogging Mill. Single Reduction to 750 to 125 r.p.m. Steel Flywheel, 7′ 6″ diam.; Rim, 3 tons in weight, with water-cooled Brake. (British Thomson-Houston Co.)

Small continuous-running mills having a cogging or roughing stand separate from the finishing stands and running at differing speeds are frequently driven from the same engine or motor by connecting the faster mill directly to the driving shaft and providing a rope drive for the slower mill. This answers very well when the cogging or roughing stand is placed in front of the finishing rolls; but when two or more stands to be driven at different speeds are placed in line with each other a gear drive is preferable. Figs. 6 and 7 show two views of an interesting example of such a drive. It will be observed that the flywheel is mounted on the motor shaft, which drives the intermediate shaft through one pair of wheels, whilst a further reduction is provided between this shaft and each of the mills. The motor in this case runs at 360 revs. per min., and drives one set of 24 in. cold rolls at 11 revs. per min. and one set of 30 in. cold rolls at 8 revs. per min., a very considerable speed reduction, which could hardly be effected by ropes alone, or by a combination of ropes and gearing, without occupying appreciably more floor space. Such gears when enclosed in cases and efficiently lubricated, run smoothly and silently, and require very little attention. The lower halves of the gear cases are visible in position in Fig. 6, and the upper halves can also be seen raised above them. The pump used for distributing the oil over the gears may be seen in Fig. 6; in this case driven from the main shaft. In the case of very heavy gear wheels it is advantageous to provide forced lubrication for the bearings also, and to duplicate the pumps.

Generally speaking, for the sake of compactness and simplicity, the majority of mills of the first class should either be directly driven or driven through a single reduction gear.

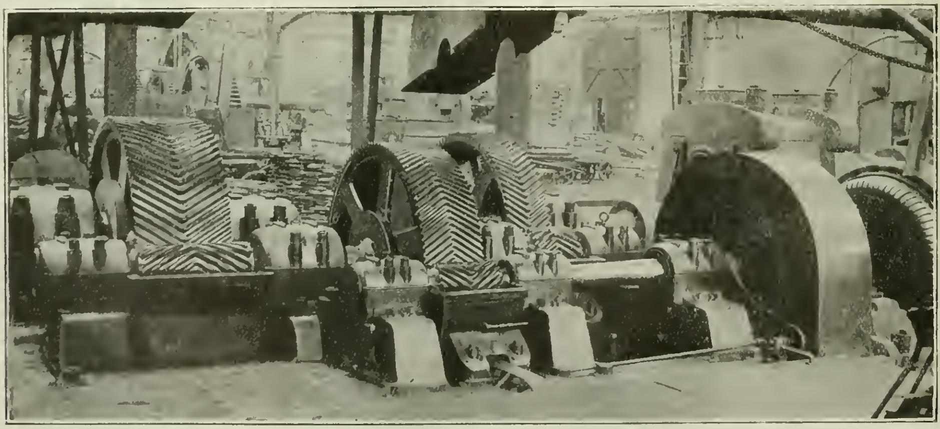

Fig. 6.—Special Double Reduction Gear Driving one set of rolls at 11 r.p.m. and one at 8 r.p.m. (David Brown & Sons.)

Direct-current motors for such mills will be compound wound, the series winding being so arranged as to slow the motor down sufficiently to allow the flywheel to give up the required energy as the load increases.

In the case of alternating current, the motor will not appreciably slow down with increasing load unless the resistance of the rotor circuit is somewhat high. Hence, to obtain the speed reduction necessary to enable the flywheel to become effective, a slip resistance must be provided which may be placed permanently in circuit or be of the automatic type. In the former case the motor will commence to slow down as soon as the load comes on it, and the peak will not be subject to the same limitations as can be arranged for with an automatic slip regulator. Fig. 8 shows a comparison of the loading of an induction motor working (1) with an automatic slip regulator and (2) with a permanent slip resistance, from which it will be seen that for a demand of 750 h.p. from the mill only 350 h.p. is taken from the motor with the automatic regulator, as against 480 h.p. with the permanent slip resistance, which also has a somewhat adverse effect on the efficiency of the motor. It may further be pointed out that the automatic slip regulator may be used as a starter for the motor, whereas a separate starter, usually of the liquid type, will be necessary when a permanent slip resistance is used.

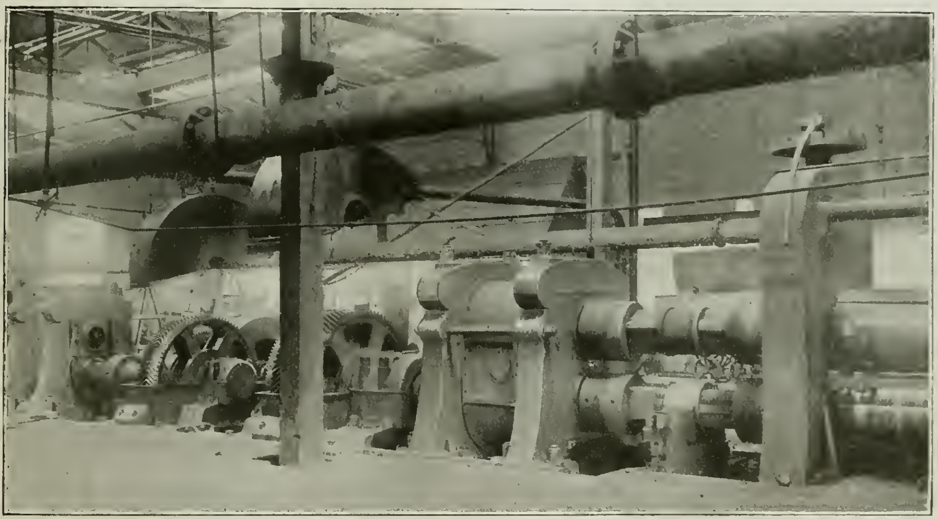

Fig. 7.—Another View of the Double Reduction Gear shown in Fig. 6. (David Brown & Sons.)

Dealing now with the second class—namely, variable speed mills—we may take, first, those running continuously in one direction. It may be desired that the required speed variation should take place from pass to pass as when rolling long sections, the speed increasing with the length of the section. On the other hand, it may merely be necessary to provide for a change of speed to suit a change in the nature of the output of the mill. The direct-current motor can easily be designed to fulfil either condition by providing for sufficient variation in the field strength to cover the range of speed desired, and which in such mills is unlikely to exceed 2 to 1.

It is quite otherwise, however, with alternating-current motors; the ordinary types available do not permit of any speed variation whatsoever. The first requirements could be met indirectly by fitting a direct-current motor to the mill and providing this motor with current from a motor-generator driven by an alternating-current motor having a flywheel and controlled by a slip regulator. This, known as the Ilgner principle, will be referred to later; it provides for an almost infinite number of speeds, but the cost of the plant is out of proportion to the advantages to be derived from it for mills of this section.

With regard to the second requirement (namely, that a mlli should run for a certain time at one speed and at other times at another speed), this may be effected in an alternating-current motor by pole-changing devices, or by adopting a cascade winding; or, again, by a combination of two alternating-current motors on the same shaft, giving much the same effect as a cascade winding; or one alternating and one direct-current motor used in conjunction with a rotary converter. In the latter arrangement the alternating-current motor takes its supply directly from the mains, its rotor being connected to the slip rings of the rotary converter and the commutator of the latter to the armature of the direct-current motor, both direct-current motor and rotary converter being separately excited. This arrangement is quite as effective as a direct-current variable-speed motor, but is cumbersome and expensive; and, although a flywheel can be used quite satisfactorily, the Ilgner motor-generator system is preferable.

Such devices have not, in fact, found favour in this country, no doubt partly due to the abnormally long delivery usually associated with special motors. Where reduction gear is used the requirement may be met by installing a double set of gearing provided with sliding pinions.

Reversing mills are in a somewhat different category to those already dealt with; they include mills of the largest size and requiring up to 25,000 h.p. maximum. The motors operating them are required to accelerate heavy masses up to full speed and to stop and reverse to full speed in the opposite direction in the shortest possible time. This necessitates the exertion

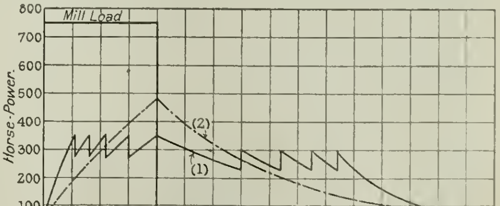

Fig. 8.—Comparison of Loading of Induction Motor working with (1) Automatic Slip Regulator and (2) Permanent Slip Resistance.

Flywheel effect 3,300 ft.-tons. Final speed reduction, 15 per cent. Mill load, 750 h.p. for 8 secs. at infrequent intervals. Slip at 350 h.p. with slip regulator = 5·2, 6·8, 8·9, 11·5, 15 per cent. Slip at 350 h.p. with permanent slip resistance = 11·15.

of a heavy torque on the part of the motor, which must be able to run at any speed from zero to full speed. Under such circumstances, the momentum of the revolving parts must be kept as low as possible; this imposes a limit on the diameter of the armature, which may necessitate its division into two or more parts mounted on the same shaft. Such a construction should be adopted for machines exceeding about 10,000 h.p. maximum, and for smaller machines of, say, 8,000 h.p. to 9,000 h.p. when the maximum speed exceeds about 100 revs. per min.

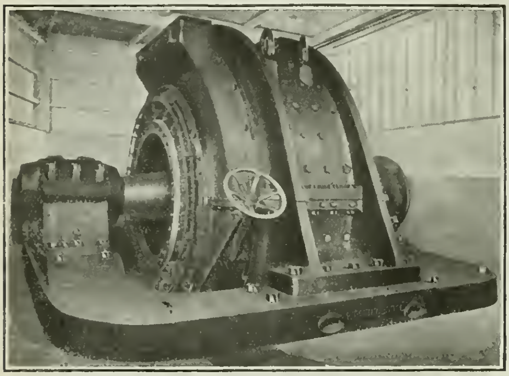

Fig. 9.—Single Armature Reversing Motor. 8,000 h.p., Driving a Cogging Mill Direct. (British Westinghouse Co.)

Fig. 9 shows a mill motor of 8,500 h.p. maximum, of the single-armature type, and Fig. 10 shows a similar machine of larger size, constructed on the double-armature principle.

The use of a flywheel on such mills is obviously inadmissible, nor can an alternating-current supply be utilised directly for the mill motor. Small motors up to, say, 1,500 h.p. maximum or peak load if of the direct-current type can obtain a supply directly from the mains and be controlled partly by armature resistance and partly by manipulation of the field. Such a motor, driving through enclosed machine-cut steel wheels, is shown in Fig. 11. Better results will, however, be obtained through the use of a motor-generator, which is essential in the case of alternating current and also for direct-current motors of the large dimensions referred to above. Where a motor-generator is used to control the mill on the Ward Leonard system combined with a flywheel, the mill motor will function equally well whether the supply is of direct or alternating current; but, should direct current be available, it will be slightly more efficient than alternating current, the control will be slightly less complicated, and a somewhat more flexible arrangement of machines composing the motor-generator will be possible. On the other hand, the greater advantages of three-phase transmission and the ability to utilise high-voltage motors for the motor-generator will probably ensure the use of alternating current for all such mills in future.

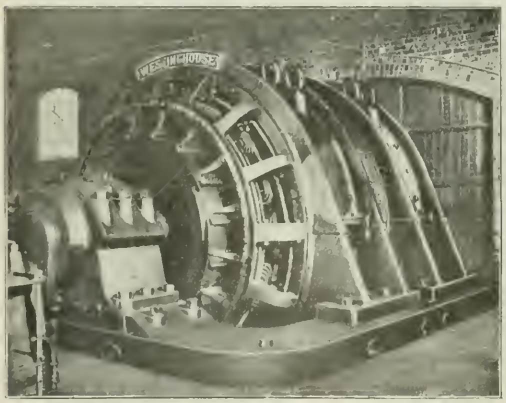

Fig. 10.—Double Armature Reversing Motor. 13,700 h.p., for 38-in. Cogging Mill. (British Westinghouse Co.)

The controlling and protecting devices of the smaller mills hardly call for comment. Standard practice is usually followed for the motors of class (1) and for the continuous-running motors of class (2). The desirability, however, may be emphasised of providing, in addition to the usual watt-hour meter, a recording watt-meter having two speeds, one (the slow) to be used for continuous records over, say 24 hours, and the other (the fast) for obtaining the power taken over one pass or series of passes. Care should be taken to ensure that the movement and inking arrangements are suitable for high-speed work;

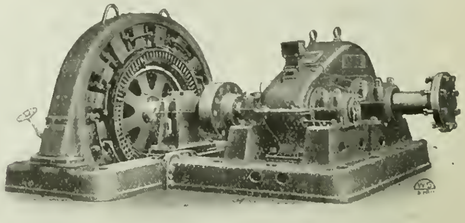

Fig. 11.—B.T.-H. Motor of 1,000 to 1,500 h.p., Driving a Reversing Mill through Heavy Type 45 in. Single Reduction Gear, 188–75 revs. per min. (David Brown & Sons.)

A tacheometer should be provided for variable-speed motors.

Various patterns of slip regulators are now manufactured for use with three-phase motors, and some consideration should be given to same. If it is to consist of a plain resistance, it should preferably be of the grid type of some metal other than cast iron. In addition to this resistance, an ordinary motor starter will be necessary, usually of the liquid type. Should it be considered desirable to obtain the greater efficiency of the automatic slip regulator, then several types are available,

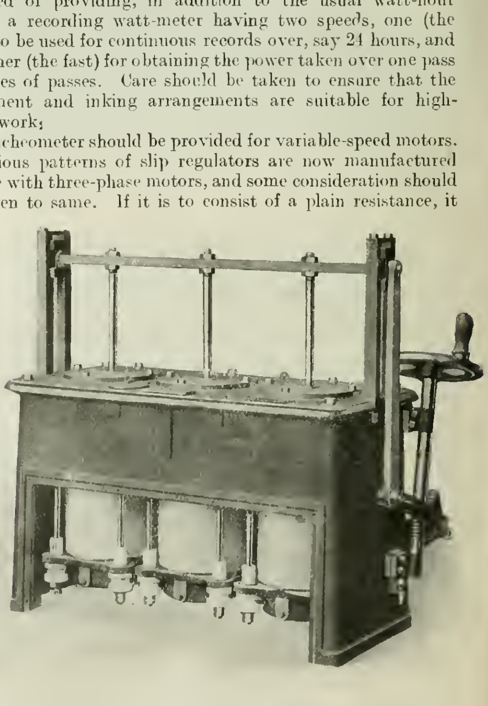

Fig. 12.—Liquid Type 3-phase Motor-starting Switch, convertible to Slip Regulator by adding Torque Motor. (Allen West.)

either liquid, eddy-current or metallic operated by contactors. Liquid starters and slip regulators are usually of one or other of three patterns, the most common being that in which the electrolyte is contained in three (for three-phase systems) earthenware pots clamped to the underside of a tank (*see* Fig. 12), which contains a portion of the electrolyte in contact with cooling tubes, through which a more or less abundant supply of cooling water must be kept flowing; fixed electrodes are fitted at the bottom of the earthenware pots, the movable electrodes are suspended from a cross-arm, and approach or recede from the fixed electrodes as the load on the motor varies. In the case of slip regulators, motion is usually given to the cross-arm by suspending it from the end of a lever or levers attached to the spindle of a torque motor, as shown diagrammatically in Fig. 13. When the torque on this motor exceeds that due to the weight of the electrodes, its rotor revolves slightly, raising the electrodes, and thus inserting more resistance in the rotor circuit of the main motor, which indirectly reduces the turning moment of the torque motor until a balance is struck. This type frequently suffers from insufficient circulation of the electrolyte, with consequent overheating and cracking of the earthenware pots, and occasional boiling of the liquid. Unless particular attention is given to this point the type is one to be avoided.

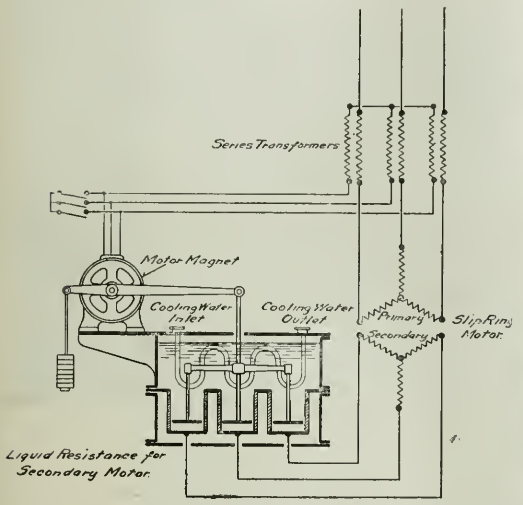

Fig. 13.—Diagrammatic Arrangement of Westinghouse Liquid Slip Regulator with Torque Motor.

Another pattern consists of a tank containing the electrolyte and fixed electrodes; a small pump continually running circulates the liquid, which flows over a weir into a sump, from which it is lifted by the pump. The weir is adjustable by means of a torque motor as before, and resistance is introduced or removed by lowering or raising the level of the liquid in contact with the electrolyte. An example of this apparatus arranged as a controller is shown in Fig. 14.

A further pattern acting on the same principle effects the alteration of level of the liquid by lowering or raising a weight in a chamber connected to the tank containing the electrolyte, thus raising or lowering the level of the latter; this type has much to recommend it.

Generally speaking, liquid slip regulators are difficult to keep clean and are a prolific source of minor troubles. They are not always rapid enough in action, but the nubmer of steps of resistance may be said to be practically infinite. The space occupied is less than that required for contactor gear with metallic resistances. In view of the fact that transformers

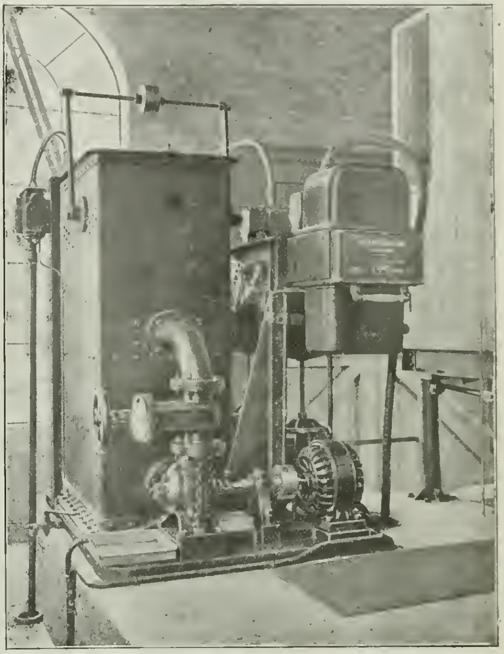

Fig. 14.—Weir Type Liquid Controller for 700 h.p. 3-phase Motor. (British Westinghouse Co.)

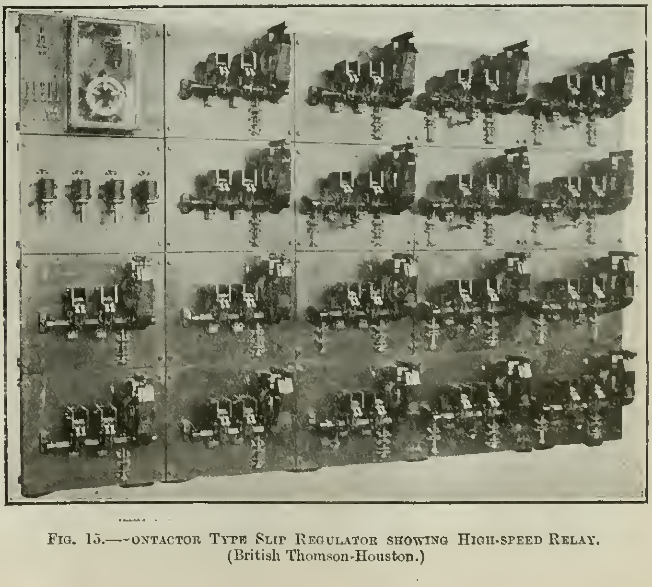

Fig. 15.—ontactor Type Slip Regulator showing High-speed Relay. (British Thomson-Houston.)

are necessary between the motor and regulator where high-tension supply is given to the main motor, the liquid regulator is not free from complications. The consumption of cooling water is considerable, and its price is, under present conditions of manufacture, quite as high as for contactor gear.

The eddy-current slip-regulator consists of low-resistance coils wound on iron cores, so arranged as to ensure that the external circuit of the rotor shall consist as nearly as possible of reactance. The apparatus generates a comparatively high E.M.F. in opposition to that of the rotor. Should the torque for which it is designed be exceeded, it will at once slow the motor down and allow the flywheel to part with some of its stored energy. When the overload is removed the motor will automatically run up to speed again. This apparatus is extremely simple and reliable. It provides for a large initial starting torque, and ensures that the maximum current for which it is designed shall not be exceeded, a separate starter for the motor is, therefore, unnecessary. This type of slip regulator has not had any very wide application to main rolling mill motors at present, though it is in successful operation on one or two of the smaller mills in this country.

Slip regulators of the contactor type have been in use on the Continent for some years, and are now much more favourably viewed in this country also. Their more general use has resulted in the evolution of a very reliable and robust type, the standardisation of which is reflected in the cheapening of production. During the last two or three years contactor gear, therefore, has hardly increased in price in proportion to other types of switchgear. It has the not very material disadvantage that a large number of contacts must be used if a large number of steps are required. It is, further, somewhat difficult to ensure sufficient rapidity of action, and care must be given to this point, otherwise a heavy load may be thrown on the motor before the slip regulator has time to act. If proper attention is given to this point, the contactor apparatus will be very reliable and require considerably less supervision than the liquid type.

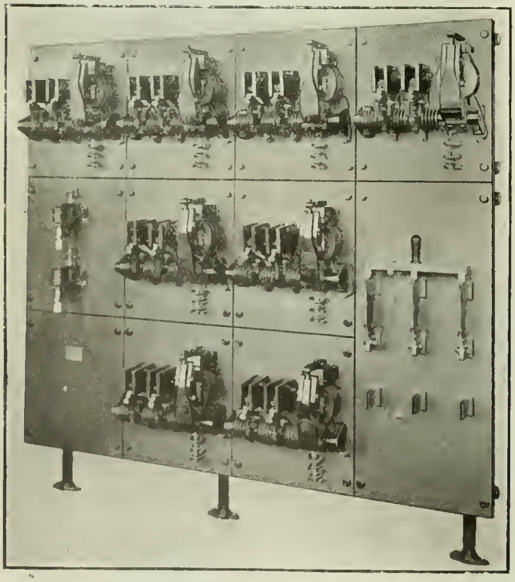

Fig. 16.—Contactor Panel showing Three-pole Hand-operated Switch for Reversing Mill Motor. (British Thomson-Houston.)

Fig. 15 shows a contactor-type slip regulator of large size, and provided with a special high-speed relay on the Tirrill voltage regulator principle; its function in this instance is to rapidly open the regulating contactors at a definite current setting. As the contactors will operate in rotation at any pre-arranged current, the current taken by the motor at any time can be limited to that corresponding to its normal full load.

Fig. 16 shows a smaller panel provided with a three-pole hand-operated switch for the stator circuit, in this instance arranged for reversing the mill motor in case of a cobble or when otherwise desired. If this switch was replaced by a contactor which could be operated from one or more push-buttons, the mill could be stopped and started from any desired position, and, if the necessary over-load and no-volt relays and indicating and recording instruments were also fitted on this panel, no other switchgear would be necessary for most of the smaller mills.

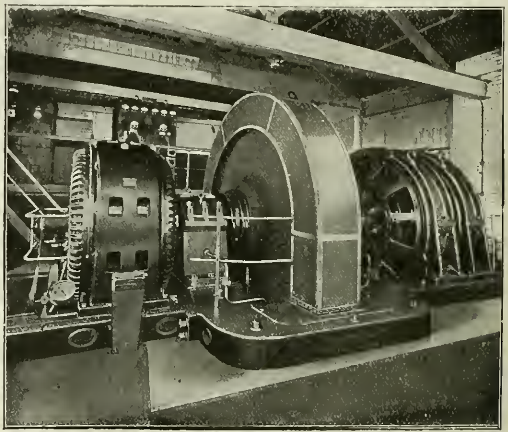

Fig. 17.—High-speed Motor-generator, 600 revs. per min., 3-phase, 5,750 volts. Maximum Output, 6,000 kw. Two Generators in Series. (British Westinghouse Co.)

A further type of automatic slip regulator, designed by the B.T.-H. Company, consists of a motor-generator of comparatively small capacity. The motor end is connected to the slip rings of the mill motor and the generator end to the supply. The motor increases the slip, and at the same time, by means of the generator, returns to the mains the greater part of the power that would otherwise be lost in the resistance. A further advantage of this arrangement is that it can be utilised to raise the power factor, a feature of considerable value where mill motors of low speed are used.

Controlling arrangements of large reversing mills are in a very different category to the foregoing, and in fact, provide problems of even greater magnitude than that of the design and construction of the mill motor itself. That such motors are operated to-day with every success is almost entirely due to the Ward Leonard system of control coupled with certain improvements and refinements which have been introduced from time to time, and which, whilst apparently of a complicated nature, have largely assisted in attaining that ease of control and reliability which is now a feature of these large equipments.

It is assumed that the motor-generator is part of the control gear. Whether the primary source of power be alternating or direct current, the same principles are involved—namely, to utilise the power from the mains in an electric motor which drives the generator or generators supplying the current to the mill motor. The latter is actually controlled by varying the generator field in strength and direction, which correspondingly alters the voltage applied to the mill motor armature, thus determining its speed and direction of rotation. A flywheel is placed on the shaft of the motor-generator. Its function is to equalise the load of the motor by absorbing energy during periods of light load and provide energy to cope with the peak loads. If this motor is of the multi-phase type, a slip resistance or regulator is just as necessary as in the case of continuous running mills driven by alternating-current motors. For comparatively small machines a single generator can be used; but with large machines, or when the peripheral speed is high, two or more generators should be run in series, or in some instances in parallel. Fig. 17 shows such a motor-generator. It will be noticed that the motor, which is of 1,300 H.P., is overhung on the shaft end, there being no outer bearing. Fig. 18 shows a similar motor-generator, but of larger capacity, the generating portion consisting of three units. The double armature mill motor and slip regulator are also shown in the same motor house.

The relation of input at the motor end to output at the generator end, and hence the size of the motor driving the motor-generator, will depend on the nature of the material rolled by the mill. The maximum ratio obtainable in practice is as 1 to 7, although it will rarely exceed 1 to 6, which, however, is quite frequently attainable in the case of cogging mills, which usually roll ingots into billets or blooms of comparatively short lengths. It is very different with mills rolling long sections, where the period during which energy is taken from the flywheel is long compared with the period during which energy is put into the flywheel. The preferable arrangement is to fit solid couplings throughout, irrespective of the length of the machine, to provide slotted packing strips under the feet of bearings and machine casings, spare strips being available for raising a bearing to compensate for wear, &c., when desired. Fixed hydraulic jacks are sometimes advantageous to quickly take the weight of parts of the machine during such adjustment. Observations should be taken periodically of the alignment of the machine, and adjustment such as indicated carried out at a week-end or even during a meal hour.

Such machines will frequently run for a lengthy period after current has been cut off, in some instances for quite two hours. In order, therefore, that adjustment may be carried out during, say, a meal hour, it is essential to provide some means of bringing the machine completely to rest. This is frequently done by placing a slipper brake on the flywheel, operated by a hand wheel and screw mechanism. Such a brake generates much heat when in operation, and it will, therefore, be found necessary to water-cool it. The resultant leakage and rust is very objectionable, particularly if the water is allowed free access to the surfaces in contact, as is usually the case.

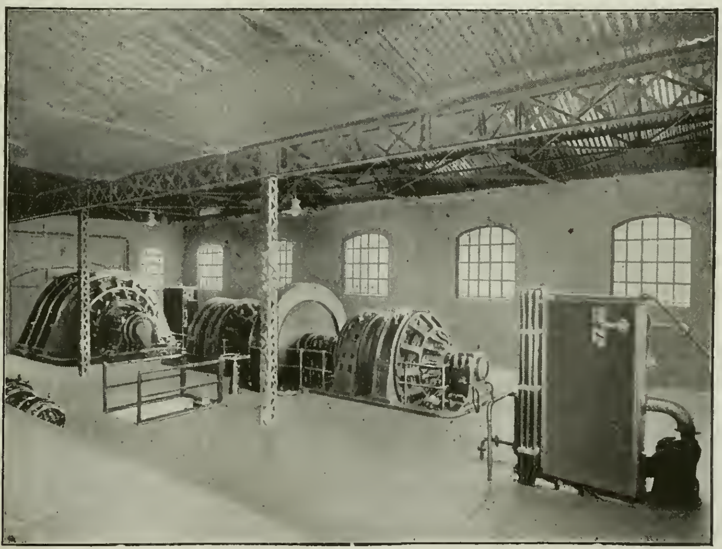

FIG. 18.—MOTOR-GENERATOR, SIMILAR TO THAT SHOWN IN FIG. 17, BUT OF LARGER SIZE. (British Westinghouse Co.)

The question of the speed of the motor-generator is one which will considerably affect the price of the plant. On the Continent, such motor-generators are usually run at between 400 and 450 revs. per min. There appears to be no valid reason why they should not be perfectly reliable at speeds 50 per cent. in excess of this, and such machines are actually in satisfactory operation in this country running at approximately 600 revs. per min., and having a maximum output at the generator end of about 6,000 kw. In this case a flywheel would be necessary, which, if cast solid, would be limited to about 12 ft. in diameter. Flywheels having a higher peripheral speed are supplied by several manufacturers, but of the built-up type. Much thought has been given to the question of flexible couplings between the flywheel and the other portions of the plant; in some instances they have even been placed between each unit. A considerable volume of opinion exists in favour of these flexible couplings, for which there is certainly insufficient justification in practice. The lengths of the shafts are frequently so long that a considerable amount of permissible flexibility exists, which would enable the machine to run, even though unnoticed settlement of foundations had taken place.

A much preferable arrangement is to generate energy in one or more of the dynamos and absorb this in resistances. The machine will then be brought up without the harshness and wear inherent in the mechanical brake; but the plant should be carefully arranged to ensure that undue load shall not come upon the generator, and to provide the maximum amount of certainty that this static braking effect will be available, which would not be the case if, for instance, the means for exciting the generator field became non-existent.

In the case of a direct-current supply, the motor would be compounded to provide for an automatic drop in speed of from 12 to 20 per cent. with increase in the load. In the case of an alternating-current supply, the automatic slip regulator will also be arranged for a speed reduction of between 12 and 20 per cent. The type of regulator used would be similar to that previously referred to.

With regard to the voltage of the mill motor, and therefore of the generators of the motor-generator, this should, of course, be as high as possible to keep the armature current within the lowest possible limits; but, although 1,000 volts have been employed in this connection, it is hardly advisable to exceed, say, 800, which, if two dynamos are used, can be easily obtained by winding them for about 400 volts each and running them in series. This also permits of obtaining, say, 440 volts supply from one or both generators by slightly increasing the field excitation, should this be desired in an emergency, when, of course, the main mill motor would not be running.

As already mentioned, the actual control of the main mill motor is effected by varying the field of the generator or generators of the motor-generator both in amount and direction. The available turning moment of the motor is constant throughout the whole of the speed range provided for by this arrangement. Higher speeds can be obtained by weakening the field of the mill motor. In this case, however, although the horse-power of the mill motor remains the same, the turning moment falls away with increase of speed, which, however, is usually immaterial, as the maximum torque is not generally required at the mill when rolling long passes at high speed. In this connection it may be pointed out that the diameter of the rolls has considerable bearing on the turning moment to be exerted by the motor ; smaller rolls running at higher speed will usually result in a smaller mill motor, although the motor horse-power and output of the mill may be the same.

The provision for manipulating the generator field current frequently consists of a metallic resistance placed directly in series with the field or arranged as a potentiometer. The resistance for weakening the field of the mill motor is operated from the same controller, which is actuated by a hand wheel or lever, the motion of which follows that of the ingot or section. This arrangement, however, made up in the form of a face plate controller, occupies a very large amount of space, and may, from either of a number of causes, be very unsatisfactory in practice. A large number of contacts are required carrying a fairly heavy current of an inductive nature, necessitating the periodical and frequent dressing up of the contacts. If of the potentiometer type, care should be taken to see that the field circuit is broken when the controller is centred and not merely short-circuited, as under certain circumstances the amount of residual magnetism in the generator field is considerably augmented thereby, rendering control sluggish, and in some instances there is a tendency for a motor to revolve in the opposite direction to what is intended for the first two or three contacts of the controller, and the special steps taken to overcome these disadvantages introduce objectionable complications. Contactor control gear obviates some, but not all of the above objections, and, of course, has the disadvantage that a very large number of contacts are necessary if the same degree of control is to be obtained.

A far preferable arrangement is to use a small exciting motor-generator which, in its latest form consists of three generators driven by a motor, all four machines being, of course, mounted on the same shaft. One of these exciting generators provides the field current for the main generators, a second exciting generator provides the field current for the mill motor, a third and smaller generator provides the field current for the two exciting generators. The ultimate control of the mill motor is actually effected by varying the field currents of the two small exciting generators. With this arrangement the current handled by the controlling apparatus is extremely small. The face-plate type controller may be used without hesitation. A large number of contacts will be employed, and a very fine degree of regulation obtained. An important item in the success of this equipment lies in the rapidity with which the various fields build up and attention must be given to same if success is to be assured, otherwise a disagreeable amount of sluggishness will be introduced. On the other hand, it is quite possible, with careful design, to obtain an arrangement that is too rapid in its action. There is, therefore, no excuse for sluggish control. Means are now commonly employed for sending a small current round the generator fields to neutralise residual magnetism.

It has been found by actual experiment that the flywheel absorbs a considerable amount of energy due to air friction. To overcome this, attempts were made to run it in a vacuum. The power, however, required to maintain the vacuum was found to be greater than that absorbed by "windage," and it is now usual to fit a casing round the flywheel, which largely diminishes the wind friction. It may be pointed out, however, that it is only necessary to encase the outer periphery of the flywheel and to some extent the sides near the outer periphery.

The argument, frequently heard, that the various safety devices now becoming common in connection with such mills are unnecessary and unreliable, and likely to add to the number of stoppages that may take place is entirely fallacious. Apparatus of this description has reached such perfection and the mill machinery is of such a valuable nature that it is necessary to utilise all the safety arrangements which may be available. The lay-out of the plant, however, and the nature of these arrangements will require careful consideration in order that the best results may be obtained.

The provision of overload relays and no-volt trips or the equivalent for the motor of the motor-generator, will form no protection to the mill motor, the armature circuit of which must be provided with a circuit-breaker arranged to open under excess current from whatever cause it may arise, including failure of the motor field. Provision should also be made for dealing with earths in whatever part of the system they may arise, and for minimising the effects of a sudden rupture of the generator or motor fields. In the latter case, if the fields are excited from direct-current mains supplying auxiliary motors, no serious effects need be expected from the inductive discharge ; also, where excitation is from a multiple unit motor-generator, the chances of damage from this cause are greatly reduced. The motor-generator should be brought up automatically in the event of its attaining too high a speed or too low a speed ; in the latter case the mill motor-man's attention should be drawn by a bell or lamp to the drop in speed somewhat before the trip gear comes into operation.

The lubrication of the motor-generator is generally effected by a pressure system. Oil rings should also be provided to enable the machine to continue running for a short period after failure of the main supply. In the event of a shortage of oil an automatic signal should be given shortly before a total failure of supply, and immediately prior to the failure the automatic devices controlling the motor should trip, observing, however, that the motor-generator will continue to run for some considerable time under the momentum of the flywheel unless brought to rest by the brake. A satisfactory arrangement is to obtain the necessary pressure of oil from an overhead tank having a smaller tank above it ; the oil pump delivers into the small tank, from whence the oil passes to the main tank. Oil delivered by the pump in excess of the requirements of the plant passes by an overflow pipe back to the sump. The small tank contains a float operating an electric bell which would ring in the event of failure of the pump. The capacity of the main tank is sufficient to provide an ample supply of oil whilst the attendant is rectifying the trouble or starting up a spare pump. Should the oil in the main tank be exhausted, the motor-generator would automatically be brought to rest.

The ventilation of large reversing motors is effected by separate fans, which force air through the windings. The air should be clean and cool, necessitating some form of air filter. If this is of the cloth screen type, the risk of fire, with consequent damage to the motor, is considerable. The screens require frequent renewal, and there is no cooling effects.

Electrostatic air cleaning appears to have possibilities in this connection ; but so far has not been applied to any extent to such motors.

The most satisfactory method appears to be that of wet cleaning, which at the same time cleans, assures some cooling effect (assuming cold water is used), and avoids all risk of fire. If properly installed and operated there is no fear of damage to the motor from excess moisture.

The filter plant and fans should be duplicated ; in fact, duplication of all auxiliaries should be carried to the point of ensuring, as far as possible, that a breakdown of any one auxiliary shall not result in a complete shut down of the mill.

Electrical Practice in the Equipment of Blast Furnace Plant.

By J. PERCY HODGES, A.M.I.E.E.

Summary.—A general description is given of the electrical equipment of a modern blast furnace plant. This includes the use of capstans, transfer and telpher cars, hoists and overhead travelling cranes equipped with electro-magnets for clearing the pig-beds.

THE scope of this article as the above heading implies, will be confined within the limits of the actual blast furnace plant, excluding all the various electrical problems concerned in the equipment of the ironstone mines, the winning of the iron-stone and its transfer to the immediate vicinity of the blast furnace plant. In dealing with the question of the electrification of the blast furnace plant generally, I shall describe it in the order and sequence of the handling of the ironstone, limestone and coke, their transfer to the blast furnace, the handling of the finished combs or pigs on the pig-bed, and subsequent transfer of these pigs from the pig-bed into trucks, for removal by rail, or charging on wharf from the trucks into the holds of vessels for exportation.

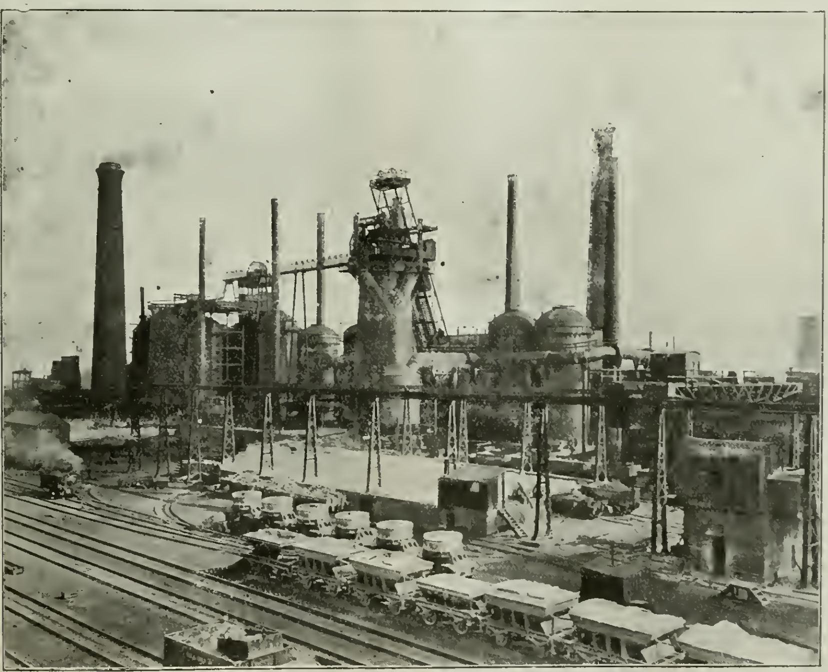

Fig. 1.—General View of Typical Blast Furnace Plant.

Fig. 1 shows most of the details pertaining to a blast furnace general equipment, and though taken some years ago it is interesting because it shows, on the left-hand side, the old type of blast furnace with its vertical hoist, and on the right-hand side the modern type of blast furnace with the skip hoist structure and double enclosed revolving top. On the side of this furnace is shown the gas down-comers which terminate in a dust catcher. It will be noticed that the pig-bed requirements are served by an overhead travelling crane; these cranes being generally of some 5 tons capacity with a long travelling speed of some 400 ft. per minute. In this view the crane is situated in close proximity to, and just above, the pig breaker to which I shall refer later on. In front of the pig-bed are shown, firstly trucks containing broken pig iron, secondly slag ladles, and finally, in the foreground, a train of lime trucks. Just above the travelling crane a locomotive can be observed, shunting trucks over the calcining kilns which are at the back of the furnace and thus not visible on the photograph.

Tuyere Pumps.

On the extreme left and right of the photograph one can discern the water-cooling towers which deal with the water circulating through the tuyeres, which, after cooling, is pumped back into the reservoir or sumps, as the case may be, with a certain amount of additional make-up, to provide for losses by evaporation.

These tuyeres are situated round the furnace hearth and thus at the hottest part of the furnace and serve to keep the furnace lining at a temperature below its melting point. Centrifugal low lift and large capacity motor-driven pumps are employed with a steam-driven stand-by, and lift the water, either to a reservoir from which it flows by gravity, through the tuyeres, or otherwise pump it directly through them and thence through the cooling towers and back to the reservoir or sump. The former method is to be preferred, as a stoppage of less than 5 minutes of the circulating water in the event of a failure of the supply of current is sufficient to cause the burning out of the tuyeres.

The first process in the manufacture of pig-iron from the crude ironstone, from which the greater portion of sulphur stone has been removed by a process of picking from moving belts before tippling into the trucks, is that of calcining the ore and limestone ; and for this purpose calcining kilns, which are heated by the blast furnace gases and which are in sufficient number to hold an ample stock for the working requirements for the furnaces concerned, are employed. The ore and limestone on their arrival in trucks are run up an incline to the top of these calcining kilns and there distributed from the truck into the calcining kilns by dropping the truck bottom.

Electric Capstans.

To avoid the continued presence of a locomotive to shunt these trucks into their respective positions over the kilns, electric capstans are provided of the totally enclosed pattern, sunk to the level of the gantry, each one forming a complete unit in a cast-iron weather-proof case, fitted with inspection doors. Each case contains a direct-current or three-phase motor of about 12 B.H.P. with resistances and controller, the latter being operated by a foot lever protruding from the case, with spring-off action. Each of these capstans is capable of hauling four loaded trucks or a proportional number of empty trucks, and they are placed at convenient intervals along the gantry in order to ensure that no more trucks than those which the output of the motor is able to deal with safely, can be hauled at one time.

In addition to the calcined ore and limestone the blast furnace requires certain proportions of coke, and all these three materials have to be transferred from either the kilns or bunkers to the various forms of furnace hoists to be raised in succession and rotation to the furnace top to charge the furnace. In the latest practice the coke bunkers are arranged on each side of the well into which the skip is lowered, and which can be filled by simply lowering a shoot and raising it when filled, thus stopping the fall of coke, but as regards the calcined ore and limestone, these have often to be carried considerable distances to the hoists, and this in all modern blast furnace plants is achieved by electric traction, which has superseded the old method of hand barrows, wheeled by men employed for this special purpose, as shown in Fig. 2.

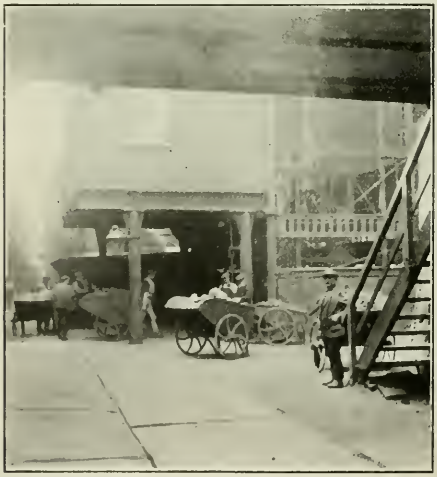

Fig. 2.—Barrows for Charging by Hand.

In the writer's experience two forms of electric traction are employed, one known as the Transfer car system, the other as the Telpher car system, the general features of which are as follows and as depicted in the following illustrations.

Transfer Cars.

Fig. 3 gives a general view of these cars which run on an oval track about 145 yds. major axis by 28 yds. minor axis and 3 ft. gauge.

The bins for both coke and limestone are arranged in three parallel rows along the major axis of the track, one facing the furnaces and skip hoists, the other two at the opposite side of the track facing each other.

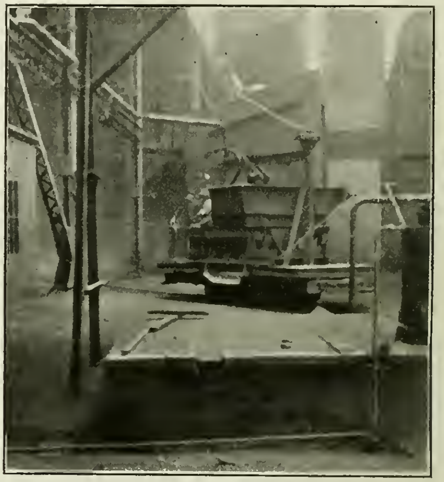

Fig. 3.—Transfer Cars.

The electrical equipment of these cars consists of: two motors of 5 H.P. each with series parallel control at 220 volts direct current geared to the main axles with a ratio of 4 to 1 for the travelling motion.

These motors, together with their controllers, are of the well-known Westinghouse totally enclosed tramway type, and well suited to withstand rough usage and the very dusty and often very wet conditions prevailing round blast furnace plant. These cars are capable of drawing a trailer, should the furnace requirements need one, but under normal conditions one car suffices for each furnace. Each car is fitted with an automatic weighing machine, the weight of ironstone being equal to the capacity of the skip, namely, about 36 cwt., the tipping of the contents of these cars in this case is done mechanically. Current for these is provided by two trolleys from the overhead network which is stayed and suspended in the open and rigidly fixed along the kiln runs.

Telpher Cars.

This system of furnace charging differs from the transfer cars in that the car and trailer are suspended from the lower web of an H girder, on which the tred wheels run as shown in Fig. 4. These iron and limestone kilns are circular and the track is sectionalised in such a way that the cars and trailers can circle round the kilns or travel along the straight to the skip hoists, by an arrangement of switches at every kiln. The electrical equipment of the cars consists of two long travel motors of 5 H.P. each, working in parallel and one tippling motor for each of 1 H.P., the supply being at 220 volts direct current. A weighing machine is attached to each car and the weight of ironstone carried in each container is approximately 36 cwt.

One of these telpher cars with its trailer is capable of supplying the needs of one furnace, one spare one being kept in reserve.

As regards the overhead equipment, this was originally designed as a two-wire insulated direct-current system, but experience proved that this was quite unnecessary, and at present the negative is earthed. There is thus only one insulated positive trolley were to attend to, and the wiring to the motors on the cars themselves is correspondingly simplified.

One of the greatest difficulties which we had to contend with, with the double trolley system, was the flashing over to earth during the slightest shower of rain, causing very frequent total stoppages whilst the rain lasted. This flashing over to earth occurred at all the insulating supports of the overhead trolley wires due to the thick deposit of calcined ore dust, which when moist proved a very efficient conductor; this trouble, however, was removed by the addition of protecting bells, shown in Fig. 4, fixed to the supporting brackets under which the Sansohn insulators, carrying the conductors, are fixed. No trouble is now experienced in the heaviest storms of rain.

Fig. 5 shows the straight run to the hoist with the kiln shoots in the near foreground on the right, the skip on the point of being raised with the operating house behind it.

Hoists.

There are two kinds of electrically-driven hoists working in connection with the charging of blast furnaces. Those in use with the old type of furnace, as shown in Fig. 2, have a vertical lift, whereas with the more modern type of furnace the skip travels up an inclined plain to the furnace top, where the rails are bent over, so that the contents of the skip can be emptied into the hopper (Fig. 5). It should be noted that in the modern type of furnace there is a double enclosure, so that the material can be charged into the furnace without loss of gas, and this receptacle is made to revolve so that the load is evenly distributed around the furnace walls, by means of a worm reduction and bevel gearing driven by a three-phase, 440-volt, 10 h.p. motor. A quarter of a turn is given after each charge, and a dial fixed at the hoist bottom opposite the driving cabin shows the exact turning movement. A drum type controller with the necessary resistances controls the motor of the revolving top and are placed in the driving cabin.

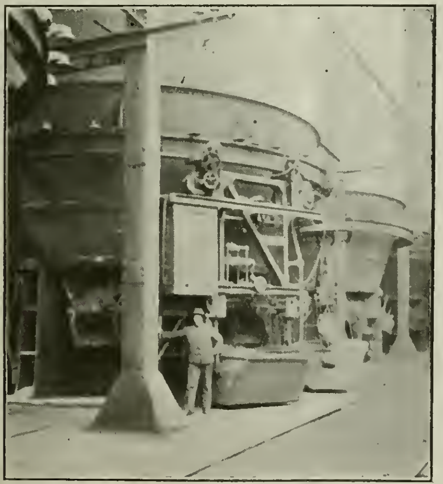

Fig. 4. Charging Kilns by Telpher Cars.]

Dealing first with the electrical equipment of the vertical hoists, a direct drive from a three-phase induction motor was first tried, but found to be impracticable, owing to the varying weights which had to be dealt with, and it was also found impossible to make the table stop exactly at the floor level without a certain amount of manœuvring and consequent loss of time, for unless the table is made to stop exactly at the ground level, it is impossible for the men to wheel their barrows either on or off the table.

These hoists are now driven by a direct current 75 h.p. 1-hour rated motor, 520 revs. worked on the well-known Ward Leonard control system, the equipment consisting of a three-phase induction motor of 80 h.p., 1 hour rated, driving a direct current generator giving 116 amperes at 440 volts, with exciter 1·6 kw., 220 volts, directly coupled to an extension of the shaft.

The exciter rheostat is regulated for a certain constant voltage which is found experimentally, and is in this case about 100 volts.

These hoists are entirely automatic in their action, so that when the signal is given for the hoist to rise or descend, the man in charge has only to push a lever straight over forwards or backwards. This lever is shown in Fig. 2 between the heads of the two men, the chamber above being the hoist engine-room, and the vertical hoist and framework being shown on the right of the photograph.

This lever operates a controller through a bevel gear, which is electrically connected to an accelerating and retarding drum driven off the main drum shaft, and which during each wind turns through an angle of some 320 deg. The controller acts principally as a master switch, all the regulation being effected by the drum. The drum is fitted with a series of segments which are connected respectively to the various relays, brake magnet, dynamo field regulating resistance, adjusting resistance and motor field weakening resistance.

The make and break on these sectors is adjusted by varying the length of the sectors till the correct accelerating; running and retarding intervals and final stoppage of the cage at ground level, conform with the predetermined cycle of operations. When once this has been achieved the hoist becomes entirely automatic in its operation and quite independent of any difference in the load to be lifted.

The principal data are as follows:—

Height of lift	100 ft.
Time of lift	25 secs.
Interval (average)	50 secs.
Maximum weight to be lifted, 2 barrows of ironstone	3,416 lb.
Minimum weight to be lifted, 2 barrows of coke	1,680 lb.
Load hoisted in 8 hours	193 tons 4 cwt.
Number of winds	156
Total units per 8 hours	60 units.
Average units per wind	0·25 units
Average units per ton raised	0·32 units.

Skip Hoists.

These hoists present a much simpler electrification problem, in that the time of travel is longer than that of the vertical hoists, namely, 35 to 40 seconds for some 145 ft. travel, though the linear speed remains about the same; moreover, the skip can be viewed from the driver's cabin as it approaches its resting point, and this point is not limited as in the vertical hoists to the actual ground level, there being a latitude of some feet either way. Owing to the increased travelling time it is also possible to fix a skip position indicator so that the driver knows the position of the skip at any point of the run.

The holding capacity of these skips is also larger than that of the combined two barrow loads of ore on the vertical hoists, their capacity being slightly over 36 cwt. of ironstone: this fact necessarily reduces the number of runs for charging purposes with limestone and coke as well.

In view of these conditions the old steam engine was replaced by a three-phase, 440-volt, 100-h.p., 1-hr. rated induction motor, running at 580 revs. per min., and geared to the winding drums. These hoists houses, one of which is shown in Fig. 3, top centre, are above the operator's cabin, which is on the ground level facing the hoist. The stator and rotor leads are taken down to the driving cabin and connected to a drum-type reversing controller with its bank of resistances. The driving cabin thus contains, in addition to the above, an automatic oil switch with overload and no-volt release, time lags and ammeter of suitable range, skip position indicator, also the drum-type controller and resistances for the control of the revolving top.

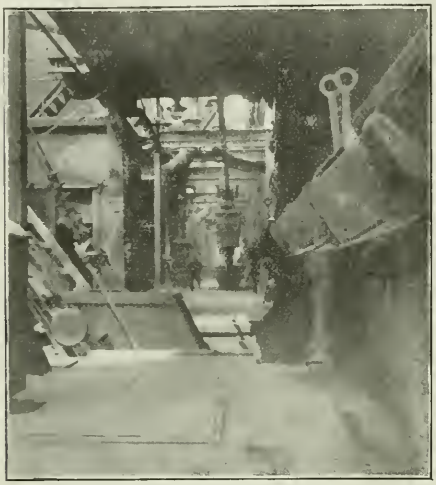

FIG. 5.—SKIP AND OPERATING HOUSE.

CLEARING THE PIG-BED.

The molten iron is tapped at intervals from the blast furnace and run on to the pig-beds through main channels made in the sand, and thence diverted into a series of smaller channels forming what is known as a comb or sow and pigs, when the pig-iron has been run into them and solidified. The number of these combs depends greatly on the working of the furnace and also on its capacity, and may amount to as many as 30 and over for each cast.

The entire comb is composed of a sow or back of the comb and 32 pigs corresponding to the teeth of the comb, and is about 17 ft. in length and 4 ft. broad and weighs approximately 2 tons.

Up to quite recently the general practice has been to break the sows and the pigs off the sows by hammer blows when the pig-iron is at a black heat, and then lift the broken portions by hand labour and throw them into a bogie, which is fitted with a cradle so that the complete bogie load can be slung and lifted by cranes and thus lowered into the holds of the vessels, or into trucks, as the case may be. At the present time hand labour is being supplanted very rapidly by the use of electro-magnets slung from electric cranes which run the entire length of the pig-bed.

With regard to the electric equipment of the magnet crane, this depends a great deal on the source of supply to the crane itself. If the supply is direct current at 220 volts, which is the standard voltage for which the majority of magnets are wound, the problem is simple, and the only requirements as far as conductors are concerned are the addition of two cross traverse wires with their trolleys.

The control gear generally consists of either a contactor type of panel with master switch, or else a drum controller, and in either case in order to dissipate the inductive reaction of the coils of the magnet, a discharge resistance has to be shunted across the magnet terminals before opening the magnetic circuit and disconnecting it before the circuit is closed again.

In either of the above cases the direct current transmitted through the controller or contactor gear, through the cross traverse trolley wires and thence by the collector, is transmitted to the magnet through a spring drum, which can be adjusted to automatically uncoil and coil up the magnet leads, within the limits of their travel.

The current taken by these magnets varies, according to their size and their number, from some 25 amperes in the smaller size of single magnets to some 70 amperes for combinations of the larger magnets.

In the case where the supply is three-phase alternating, as in the writer's experience, to avoid the complication of both alternating and direct-current mains and trolleys, it is found preferable to install a motor generator set on each crane of

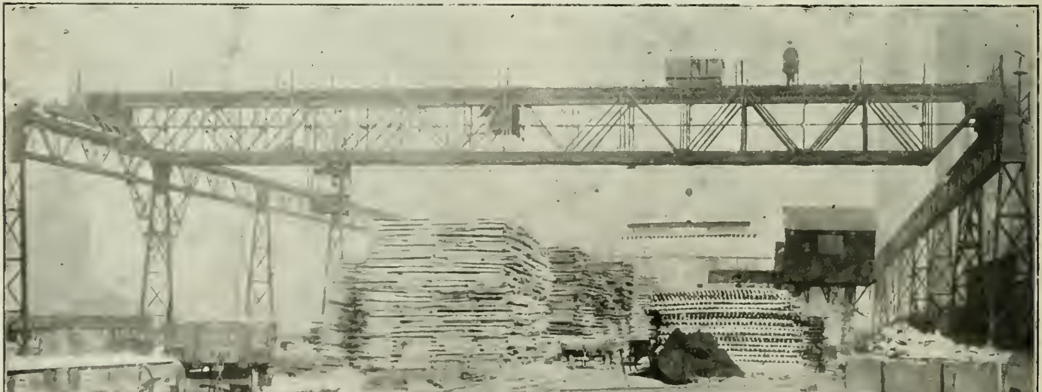

FIG. 6. OVERHEAD STOCKING AND BREAKING MAGNET CRANE.

sufficient capacity to supply the total magnet requirements at any time, namely, about 15 kw., thus rendering each crane self dependent, and in this case it only necessitates the use of two extra cross traverse trolleys, which can be placed on the cross girders opposite the trolleys supplying the three-phase current to the cross travel and lifting motors.

This method not only avoids the complication of additional long travel trolley wires but also dispenses with, in many cases long leads from the direct-current generating centre and consequent duplication of the wiring system, and also restricts any stoppage to each individual crane should anything happen to the main generating set.

The above remarks naturally apply to a large blast furnace installation worked by three-phase current, where the furnaces are separated by considerable distances, and where the cost of running the necessary overhead direct-current transmission lines would exceed the extra cost of the individual motor generator sets.

They apply not only to the overhead travelling cranes of the type shown in Fig. 6, but also to jib cranes, such as are used on wharfs for ship loading, or for those uesd on pig-beds of the " Under-hung " type, where the limits of the crane run are exceeded by the railway track, and where the jib has to protrude from over the bed to load the pig-iron into the trucks.

In these cases a very heavy balance weight of pig iron, or other material has to be accommodated behind the driving cabin to equilibriate the weight carried at the end of the jib, and a portion of this weight can be very usefully taken up by the substitution of the motor generator set.

In steam travelling jib cranes a generating set is also a necessity, and in this case a small turbo or other steam-driven generator can be driven from the crane boiler.

As regards the handling of pig-iron on the pig-beds by electro-magnets, we are faced by two entirely different problems.

In the case of a furnace which is making hæmatite iron it is a simple matter to lift the entire comb by means of two or more electro-magnets, suspended from a bar which is itself slung from the crane hook and to transport the comb to the pig breaker which mechanically breaks up both sow and pigs, which pass through a shoot into the truck for transport to its destination, as shown in Fig. 6.

Which illustrates the method of handling the combs, of stacking and breaking them into trucks. The overhead crane from which the magnets are suspended, was erected by the firm of Messrs. Herbert Morris, Ltd. It has a span of 120 ft., a capacity of 5 tons, main travel speed 400 ft. per minute, cross traverse 330 ft. per minute and hoist about 36 ft. per minute.

The magnets, of which there are two, are of the well-known Phœnix type, are oval in form, their dimensions being 5 ft. by 2 ft. 6 in., the approximate weight of the pair of magnets and cross-bar is 56 cwt., and the current consumption 40 amperes at 220 volts. Trials on these magnets have shown that they are capable of lifting the entire comb out of the sand, even with a piece of wood 1½ in. thick inserted along the pole pieces between the magnet faces and the comb.

The pig breaker, which is shown on the left-hand side and which has filled the trucks standing in the foreground with broken combs, requires a motor of about 20 H.P. to drive it, and the comb when placed on the rocking table by the magnets is advanced pig by pig ; these are broken off in succession, falling through a shoot as shown on the photograph, into the trucks.

The following figures, which, though unofficial, I believe to be absolutely reliable, have been given to me to show the results obtained by using magnets in this special instance. Before the magnets were installed, it used to take four hours to strip a bed of 22 combs ; with one set of magnets as described, the same work is accomplished in 16 minutes. To clear the bed by hand labour, 30 to 40 men were employed, whereas now, only two or three good ground men are required.

The handling of the Cleveland pig is, however, a more complicated problem, owing to the fact that the comb must be broken on the bed at a black heat, as the different qualities of the pig-iron are judged by the crystalline structure of the fracture, and until the iron-users can be prevailed upon to judge the quality of the pig by some other method, special forms or combinations of magnets have to be devised to lift these broken parts of each comb so as to clear the bed in the least possible number of journeys. But here again, owing to the length of the comb, namely, 17 ft. as above mentioned, which exceeds the length of the standard truck, it is evident that two journeys at least will be required to completely clear one entire comb, or in other words, some 60 journeys for an average cast of 30 combs.

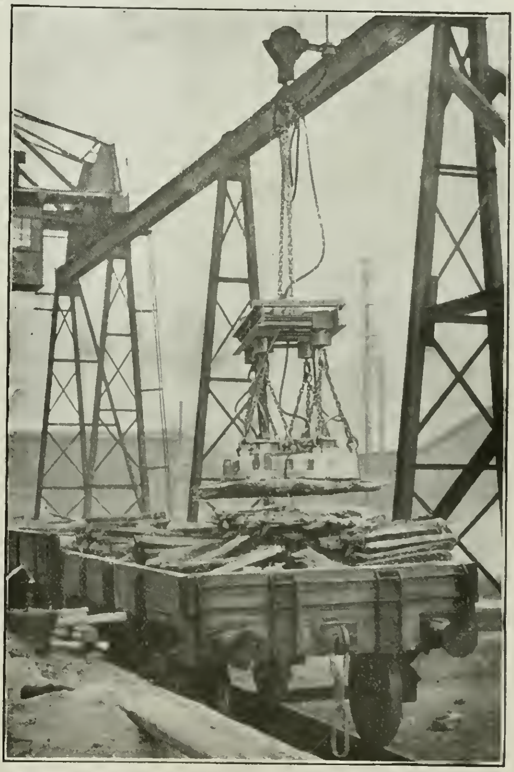

Fig. 7.—Combination of Four Kramer Magnets.

The combination shown in Fig. 6 can be used for lifting broken pigs off the bed by shifting the magnets closer together on the beam, and with this arrangement a pair of magnets can lift some 24 broken pigs, which correspond to rather more than two-thirds of the actual weight of the entire comb, but as another journey has to be made to pick up the remaining combs, it seems a better policy to employ magnets which, though lifting less, would reduce the weight on the crane very considerably and also the current consumption.

Fig. 7 shows a combination of four 24 in. Kramer magnets, loading broken pigs into railway trucks, the combined weight of which is only 24 cwt. Each magnet takes about 5 amperes, or 20 to 25 total amperes, against 40 of the other combination. With this combination the services of seven or eight men per pig-bed have been rendered unnecessary.

Another useful combination of the Witton Kramer Company is that of three rectangular magnets, two of them being 36 in. and a centre one of 20 in., suspended from a beam, their distances apart being arranged in such a manner that the three magnets take up a space of 8 ft. 6 in., this combination being thus capable of lifting exactly one-half of the comb at a time.

Fig. 8 is a very instructive photograph showing the actual pig-bed with the sand moulds in the foreground, and below the set of four magnets the hot combs, half of one having just been lifted. In the background are seen the pigs stacked from the broken combs ready for hand lifting.

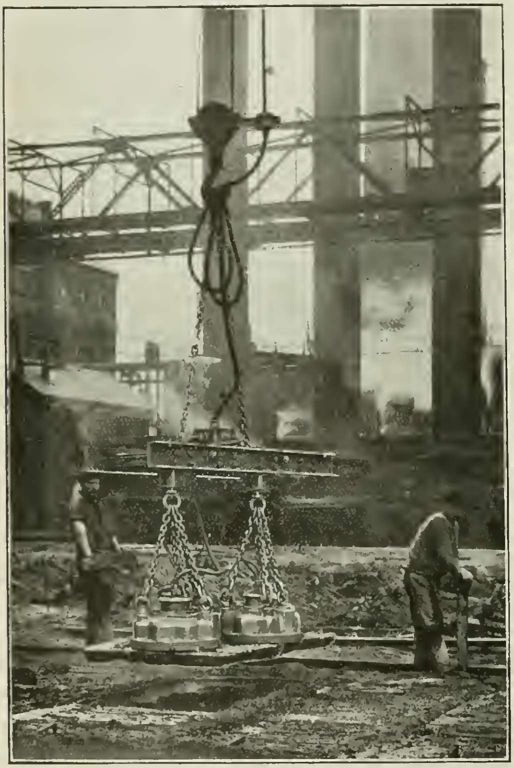

Fig. 8.—Pig Bed and Magnets Lifting Hot Combs.

It will be understood that for handling broken pigs on the bed, there is no standard practice as regards the choice of magnets, but this will depend very largely on the exigencies of the work, and various types and combinations can be adopted to suit the special conditions of each pig-bed.

Fig. 9 shows a "Witton-Kramer" standard 42 in. magnet, loading pig iron into charging boxes at the rear of the trucks. The weight of this magnet is approximately 27 cwt., and its power consumption about 6 kw., and it is capable of lifting from 12 cwt. to 20 cwt. of pig-iron.

With all the varied applications of electromagnets for handling pig-iron or any other material, the question of safety arises should the current at any time fail when the magnets are performing their duties, and in this connection the Phœnix patent safety device for their magnets should be applied in all cases where the event of failure of the current, and the consequent release of the load, might cause serious injury to persons, or damage of any description.

The device consists of a set of accumulators connected up to two automatic switches carried on the top of the magnet frame in such a manner that should the main current fail the accumulators are instantly and automatically connected across the magnet windings. There is a special switch in the driver's cage which enables the driver to put the accumulators on charge each time the magnet makes a lift and to disconnect the same when it is necessary for the magnet to release its hold. It is impossible for the accumulators to come into operation across the magnet so long as the main current is on the magnet feeding wires, and the magnet can only be made to loose the load at the will of the crane driver.

The magnets are constructed of special high permeability steel, and the action of the device depends on the principle that when once a magnet has been magnetised to a very high degree it only takes a fraction of an ampere to retain the magnetism for holding the load ; therefore, by the automatic switching on of the accumulators the load is sustained for any length of time.

The magnets are constructed of a class of steel which, in the case of the current being accidentally interrupted by broken wires, or any other mishap, will ensure that they themselves retain sufficient magnetism to hold their full load for a few seconds, thus giving the auto switches ample time to come into action, and it is impossible for the magnets without the action of the crane driver, to leave hold of a load when once switched on. The feeding wires can be disconnected at any point, excepting through the specially constructed switch situated generally in the driver's cage, and the magnets will still retain their full load.

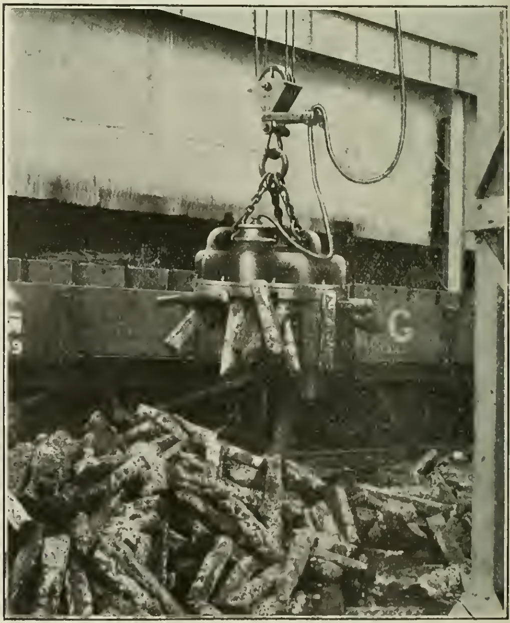

Fig. 9.—Standard "Witton-Kramer" Magnet Loading Pig Iron.

In conclusion, I must express my indebtedness to the Witton-Kramer Company for photographs reproduced in Figs. 7, 8 and 9, and to the Phœnix Magnet Company for photograph of Fig. 6; also for some of the interesting information on the subject of electro-magnets with which these firms have kindly supplied me.

The Electric Control of Steel Mill Auxiliaries.

By C. HOWARD.

Summary.—The choice of system, whether alternating current or direct current, requires careful consideration; so far, the majority of installations have been carried out with direct-current motors. Automatic control, as against hand control, is particularly advantageous in steel works. With regard to types of control, the author gives four classes, and proceeds to give details of these. Certain items of plant require special forms of control, and, as examples, mention may be made of approach rollers, manipulators, screw-down gear, swinging table and skids. In conclusion, reference is made to hydraulic pumps and air compressors.

The period of war, 1914-1918, has been noteworthy for the number of large electrically-driven rolling mills ordered and set to work, but notwithstanding these examples there are still certain types of mills and certain conditions under which the electrical drive may be of doubtful advantage. The same cannot be said, however, of the auxiliaries in connection with the mills, and for the driving of live rollers, skids, saws, shears and similar plant electricity may be taken as having definitely ousted any other method. This is no doubt due to the absolute certainty and convenience of control, in conjunction with the comparative reliability, low maintenance and running costs, when the plant installed is chosen with a view to the conditions under which it has to work.

These conditions are, in the writer's opinion, as severe as any possible conditions under which electrical machinery can operate in the industrial field, and the case of the screw down motor on a reversing mill provides a typical example of the duty required. This motor operates during the time the ingot has left the main rolls and is being manipulated on the live rollers, and, as the endeavour of every mill manager is to cut the time of rolling to a minimum, it is not uncommon for these motors to be started and stopped 10 to 15 times per minute.

Any equipment, either controller or motor, which will stand up to this duty in a satisfactory manner is of no common order of merit.

With the increased size of the ingot and main rolls in a modern plant, the size of the auxiliary motors has become correspondingly greater and the necessity for improved forms of controllers has been made manifest, and it is of interest to note that whilst very few British manufacturers are in a position to offer a specially suitable steel works motor of the totally enclosed type, made in England, the situation regarding controllers is much more satisfactory.

The unfortunate position of the British manufacturer regarding steelworks-type motors is no doubt due to the abnormal situation created by the war, but it is to be hoped that every effort will be made to supply the present and future undoubted demand for this type of motor without recourse to imports from America or the Continent.

The following notes are set down relative to the auxiliary motors used in connection with mills rolling down ingots, blooms, or billets, down to finished rails, plates, sections or tinplate bars, and have no reference whatever to the smaller plant used in connection with sheet or tinplate mills.

Choice of System.

The choice of system to be adopted for the mill auxiliaries will be generally determined by the character of the existing plant, but where a new power system is necessitated it may be doubtful in some cases whether to put in alternating-current or direct-current motors for the mill.

Leaving out of consideration any other factors which may affect the issue, and weighing the respective merits and disadvantages of each system for the auxiliary drives, the situation from the control point of view appears to the writer to be as follows:—

For any plain reversing motor without any great speed regulation, such as is used for live rollers, the alternating-current motor is somewhat more simply controlled than the direct-current motor if a reversing switch in the stator circuit, together with an eddy current starter in the rotor circuit, is used. The direct-current motor requires a reversing switch, and a starter of several steps.

The eddy current starter is placed adjacent to the motor, and has no moving parts; in order to retain its simple character, the line current at switching is a function of the starting torque, whereas with the direct-current equipment this current can be limited to a predetermined value in relation to the full-load current. For any other condition of starting and reversing, the advantage lies with the direct-current equipment, inasmuch as the rotor and stator circuits are inter-connected, whereas in the alternating-current motor the two circuits are quite separate.

Any special requirements in the way of quick and accurate stops and automatic returns, further accentuate the advantages of the direct-current plant, as dynamic braking is not possible with alternating-current motors.

This feature is of special value on the tilting fingers of manipulators and for the lowering motion of ladle cranes by potentiometer control, and although the latter drive hardly falls within the scope of this article, the subject is of such great importance that the writer has ventured to add a short description and explanation of a suitable control equipment for this duty.

The chief advantage of the alternating-current plant lies in the higher voltage which may be adopted, thus economising on the wiring, but except in cases where the eddy current controller is used, this advantage is very slight, as the rotor circuit has also to be wired back to the control panel.

The total amount of copper in the wiring will be generally not less for the alternating-current system than the direct-current system, as the stator voltage should not be higher than 550, and the rotor voltage should not exceed 300 at standstill, if a sound winding is to be secured. This voltage at standstill is, of course, doubled at the instant of reversal.

It is interesting to note that the majority of installations have been carried out with direct-current motors, although a number of modern mills of large outputs are successfully running with the auxiliaries driven by three-phase power.

Hand v. Automatic Control.

Practically the first successful controller on the market for steelworks use was the Dinkey type faceplate controller on the early Wellman charger, and for motors of moderate power this type of improved design and of more robust construction still has satisfactory features, especially in the number of steps obtainable.

The drum or tramway type controller was then developed, and after passing through various phases of design, resulted in the present "metal and mica" construction of the modern makes which gives very satisfactory results under certain conditions.

This design was followed on the Continent, and in America, by a controller consisting of a series of switches operated by cams on the controller shaft, but the Continental design had certain undesirable features in its design, whilst the American controller was practically a set of hand-operated contactors, and developed simultaneously with the magnetically-operated contactors.

So far as English steel works practice is concerned, the apparatus in present use is really confined to (*a*) faceplate type, (*b*) tramway type, (*c*) magnetically-operated switches or contactors, and the last-named type will be, in course of time, probably the only type considered for motors larger than 30-40 h.p.

There are several good reasons why this is so, chief of which are: Unskilled operators are employed, decreased maintenance costs are obtained, and less physical strain is entailed in operation, thus allowing one man to operate more controllers than would be possible with manually operated faceplate, or tramway, type controllers.

With the class of labour available on steel mills it has been found that the upkeep of manually-operated controllers reaches a very high figure due to the improper handling, as the control handle is often thrown over from one extreme position to the other in order to reverse and even to stop the motor. The provision of permanent resistances in the motor circuit in one installation in South Wales resulted in a very decreased maintenance cost, and a great reduction in the number of breakdowns.

This course has been strongly condemned by enthusiastic contactor advocates, but, as will be seen later, certain auxiliaries cannot be safely operated without a "stalling" resistance, and in other cases the operation of acceleration and reversal is so rapid that the last contactors do not often come into operation so that some resistance is always in circuit.

Under these circumstances, it appears to the writer that the number of contactors might be somewhat reduced and a line resistance added, the maintenance costs being consequently reduced whilst the operation remains unaffected.

There are several makes of contactor apparatus available, and satisfactory results have been obtained with all, when the apparatus has not been wrongly applied. Wrong applications are generally due to insufficient information being supplied to the makers of the control equipment, and in view of the number of ways in which current limit and other interlocking can be carried out it is essential that the fullest information should be furnished in order that the most suitable type may be installed.

The contactors may be closed by coils wound to take the full motor current or to connect across the full control voltage, the latter being generally the line voltage unless the latter is above 500 volts. The former are termed series contactors, and the latter shunt-operated contactors.

Series contactors are used for certain classes of non-reversing motors, and are generally arranged to "lock out" when the current exceeds a certain value. This action is effected by arranging a leakage path for the flux set up by the rush of current, and delaying the passage of the flux, through the main path by means of a damping winding. When the current decreases due to the speeding up of the controlled motor the contactors close, as the main flux exerts a closing power greater than the locking out power exerted by the leakage flux. For mill auxiliaries, however, and in many cases where speed regulation by hand control is desired, it is customary to use shunt-wound contactor coils and interlocks are arranged to complete the circuit whenever the current rush on the previous step has subsided to a suitable value.

The general practice is to put in a current relay for each automatically operated contactor, and whilst these relays have proved eminently satisfactory in practice, the writer prefers the arrangement adopted by Messrs. Allen West in arranging the lock out on a similar principle to that of the series contactor detailed above.

It will be noticed from Messrs. Allen West & Company's diagrams that the hold-out coil is split up into two portions, one of which is cut out when the preceding contactor closes; thus the lock out is definitely established for any current up to this point, and is cut out at a safe running current.

As previously stated, the current relays usually adopted have very few failures in their record, so that the only reason which can be given by the writer for the preference is that any method which secures the same results and eliminates the making and breaking of control circuits at relays should be welcomed.

Types of Control.

The number of types of control required may be divided roughly into four broad classes, viz.:—

1. Non-reversing operation, with or without speed regulation.
2. Reversing operation, with or without speed regulation.
3. Reversing operation, with dynamic brake for stopping.
4. Reversing and non-reversing operation with automatic features.

The first class is suitable for continuous or intermittent running machines, such as saws, shears, accumulator pumps, &c. For manual operation the control gear does not differ materially from the ordinary industrial control panels for similar sized motors, whilst for contactor control the apparatus would be similar to that used for the second class, except that no reversing contactors are required, and the master controller might be replaced by a simple switch in cases where automatic acceleration to one speed only is required.

The second type of control is suitable for such auxiliaries as "approach table" and "run out" rollers, and would consist of a reversing drum controller, or corresponding contactor equipment, arranged with the necessary number of speed control points. For the contactor equipment three points are usually provided on the master controller.

1. Checking point.
2. Slow speed.
3. Acceleration to full-speed under a current limit control.

The first position is provided to take up any backlash in the gearing from, or any rotation due to, operation in the reverse direction and the current at standstill on this point would be about one-third of full-load current. The second and third points are self-explanatory. A suitable diagram for this scheme of control is given in Fig. 5.

The third class is a modification of the above, and consists in arranging a suitable section of resistance in series, or in parallel with the armature, and additional contactors, or segments on drum controllers, so as to produce the necessary braking effects required.

In view of the variety of arrangements which are possible on direct-current circuits to secure this braking effect it will not be possible to describe them in detail, and readers desiring further information on this point are recommended to consult an article by Mr. J. A. Jackson in the "General Electric Review" for June, 1917, on "Dynamic Braking Speed-torque Curves of Series Motors."

Where dynamic braking at the off position is required, a motor with some proportion of shunt field winding is usually desirable, or additional complications arise in the arrangement of the series field coils leading to the loss of torque in starting. This class of control is applicable to screw down motors and skid fingers for plate mills.

The last class consists in modifying one of the above types, so that the control circuits are made or broken by switches operated by the movement of the mechanism to be controlled. This class is suitable for the control of manipulator tilter fingers, certain types of ingot chariots, and non-reversing motors such as hydraulic pumps used in conjunction with accumulators, air compressors or plant of similar nature.

The following descriptions are given of some of the auxiliaries necessary in a modern steel works, and a few diagrams of suitable control are given. It will be noted that most of these are for direct-current motors; as previously pointed out, it is impossible to obtain dynamic braking with alternating-current equipment.

The diagrams prepared by the writer have been reduced to the simplest possible form consistent with the requirements of the driven apparatus, and it should be understood that almost any degree of protection can be easily, and in most cases cheaply, given by adding contactors and interlocks as required. The addition of this protection would add considerably to the labour of reading the diagrams, and would then only be correct for the particular make of apparatus illustrated.

An example of this additional complication can be given by comparing Fig. 1 with Fig. 1A, reproduced from the "General Electric Review" of March, 1917. The latter diagram illustrates the same scheme of control, but includes full provision against overloads, loss of voltage, and loss of shunt field and also compels the operator to bring the controller to the off position to restart after a compulsory stop.

Following the course of the ingot from the reheating furnace through the mill, the following auxiliaries may be encountered.

Ingot Chariot.

Depending upon the layout of the mill, this chariot may consist of a movable self-tilting chair driven by rope to the mill approach rollers, or a movable approach table fitted with live rollers operated by a separate motor from the main travel motor. If the former, the chariot motor might be advantageously controlled by a controller arranged to slow down and stop automatically at each end of the track, but generally an automatic slow-down is only essential when the ingot is on the chariot, and is consequently arranged at the mill end. A suitable diagram of main connections would be as per Fig. 1, the operation being as follows :—

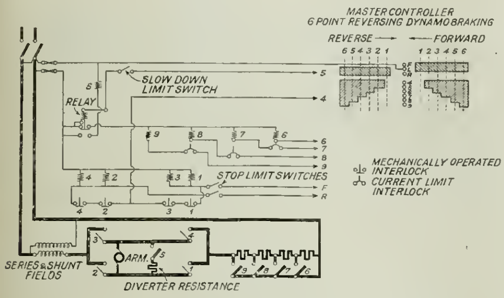

Fig. 1.—Diagram of Connections for Ingot Self-Tilting Chariot. (D.C. Motor with Shunt and Series Winding.)

First Notch.—According to the direction in which the controller barrel is turned, *F* or *R* is energised, throwing in contactors 1 and 3 or 2 and 4. It will be noted that the stop limit switches prevent any movement in the wrong direction when the chariot has reached the end of the track.

The relay coil is not energised, so that the shunt coil of contactor 5 has the full line voltage acrosss the terminals through the two bottom contacts of the relay, thus closing the contactor and putting the diverter resistance across the armature. The motor rotates slowly, whether the slow down limit switch is open or closed.

Second Notch.—On this step a circuit is completed between fingers 4 and 5 on the master controller, and provided the limit switch has reset after a previous operation, the relay coil operates and breaks the circuit of contactor No. 5 open-circuiting the diverter resistance across the armature. The motor consequently speeds up to the value permissible by the series resistance.

It will be noted that the action of the relay is to complete the control circuit to contactors 6, 7, 8 and 9, in readiness for notches 3, 4, 5 and 6.

Third and Succeeding Notches.—Fingers 6, 7, 8 and 9 are energised on notches 3, 4, 5 and 6 respectively, but the operation of contactor coils 7, 8, 9 are restrained by current limit interlocks on the previous contactor.

The acceleration is thus limited to a safe value, and is also under the control of the operator.

Action of Limit Switch.—The stop limit switch opens the reversing contactor circuits, and consequently contactors 6, 7, 8 and 9 and relay circuits also. The circuit of contactor 5

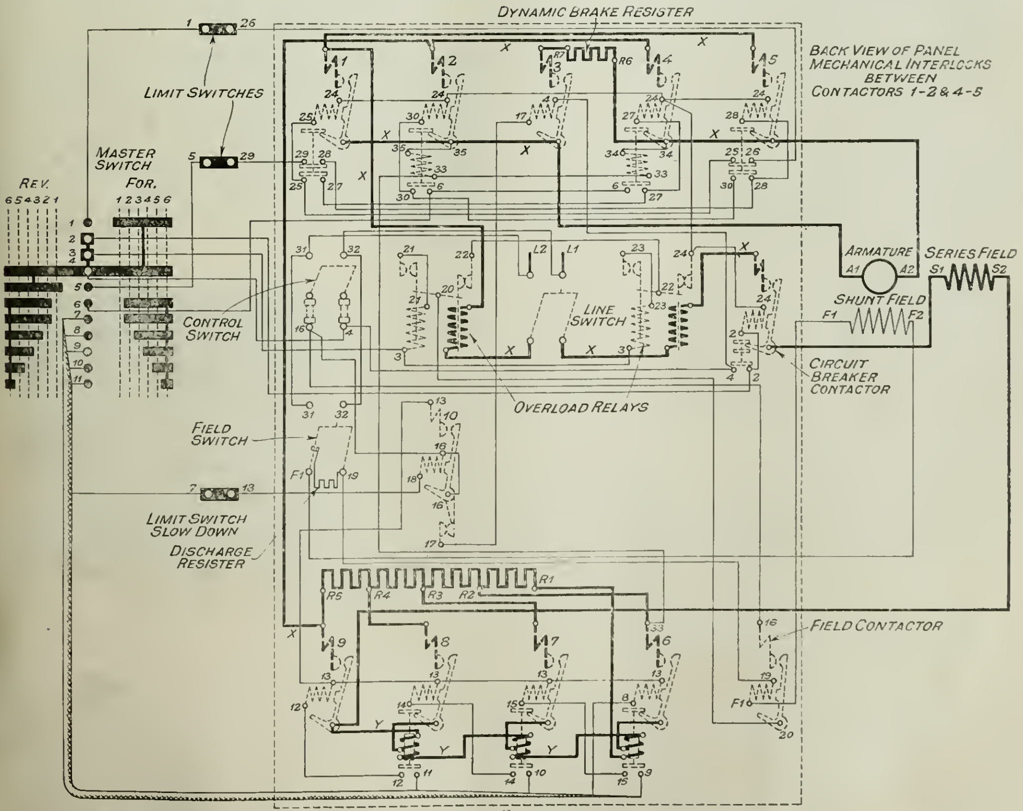

Fig. 1a.—Wiring Diagram of an Equipment Furnishing Speed Control and Automatic Slow Down and Stop by Dynamic Brake.

is again completed, and the divertor resistance put across the armature ; this action, together with the breaking of the main circuit, results in a powerful braking effect.

The action of the slow down limit switch is to break the relay coil circuit, together with the supply to the resistance contactors, at the same time closing contactor 5. The increase in resistance in the main circuit, and the further reduction in armature current caused by the diverter effectively slows down the motor. The chariot can be slowed down at each end of the track if desired by another limit switch. The two switches would be wired up in series.

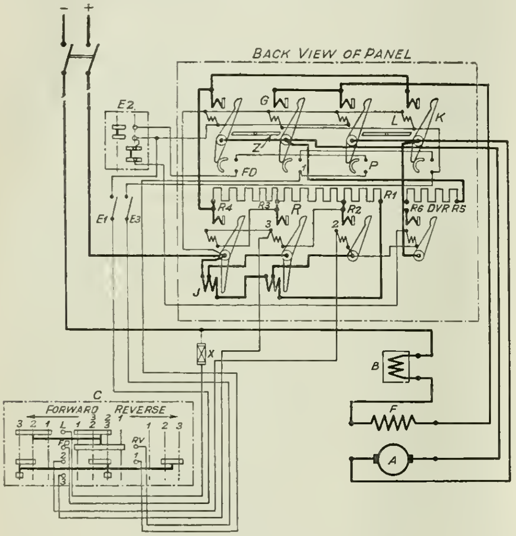

Fig. 1b.—Diagram of Connections of 4-point Single-Pole Reversing Contactor Panel for Use with Series Motor Driving Rope-propelled Ingot Chariot.

A.	Armature.
B.	Series Brake.
C.	Master Switch.
DVR.	Diverter Resistance.
*E.*1.	Limit Switch (Stop) Delivery End.
*E.*2.	Limit Switch (Retard) Delivery End.
*E.*3.	Limit Switch (Stop) Soaking Pit.
F.	Series Field.
G.	Blow Out Coil.
J.	Lock Out.
K.	Contactor.
L.	Operating Coil.
P.	Interlock Contacts.
R.	Series Resistance.
X.	Fuse.
Z.	Mechanical Interlock.

Another method of control with only three running speeds is shown by Figs. 1b and 1c, kindly furnished by Messrs. Allen West & Company, and the illustration Fig. 1b shows the actual method of connection on the panel itself. The action of the retard limit switch is to break the circuit to the resistance contactor coils, and make that of the diverter contactor coil, and the "stop" limit switch causes all contactors to drop out.

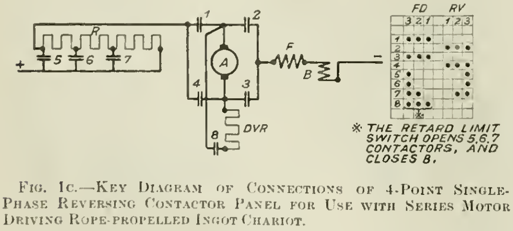
1
2
R
+
5
6
7
A
4
3
F
B
-
8
DVR
FD
RV
3 2 1
1 2 3
1
2
3
4
5
6
7
8
※ THE RETARD LIMIT SWITCH OPENS 5.6.7 CONTACTORS, AND CLOSES 8.

Fig. 1c.—Key Diagram of Connections of 4-Point Single-Phase Reversing Contactor Panel for Use with Series Motor Driving Rope-propelled Ingot Chariot.

In the case of the chariot fitted with separate motors for live rollers, and for travelling, an ordinary reversing equipment of either the hand or magnetically-operated type would be suitable, as an operator would be required to travel with the chariot, and the control would be identical with that of a small electric crane. An interlock between the two motions might be fitted with advantage, and this could conveniently take the form of a throw-over switch, allowing one controller to take care of the two motors, and preventing the live rollers being operated whilst the chariot is in motion. Suitable diagrams of connections for drum controllers for alternating current and direct-current motors are given in Figs. 2 and 3.

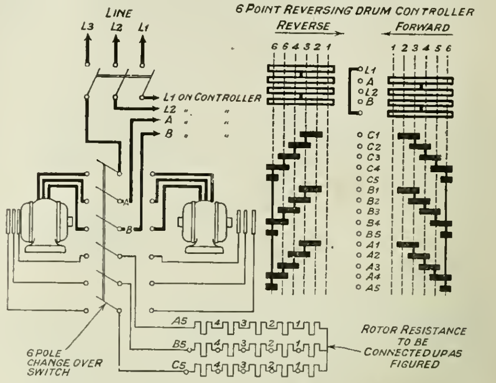

Fig. 2.—Diagram of Connections for Two-Motor Ingot Chariot. (Two Alternating-current Motors with one Controller and Throw-over Switch.)

When the ingot leaves the chariot it is delivered to the approach rollers which run the ingot to the mill main rolls and manipulators.

Approach Rollers.

The control of these rollers is of the second class given under section 4, the direction of rotation being governed by the direction of the ingot through the mill. Suitable diagrams for controller apparatus for alternating-current and direct-current systems are given in Figs. 4 and 5.

In Fig. 4 it will be noticed that the rotor circuit is permanently connected to the eddy current controller, which consists of three solid steel cores fitted with insulated copper windings. This design offers an impedance proportional to the frequency of the rotor voltage, and permits of a high torque with minimum stator current. This point is of the utmost value at the point of reversal. It is, however, subject to the disadvantages of being deficient in speed control. As the motor speeds up the impedance decreases, so that at or near synchronous speed the windings act as a true rotor resistance of very low value, corresponding to a practically short-circuited rotor circuit.

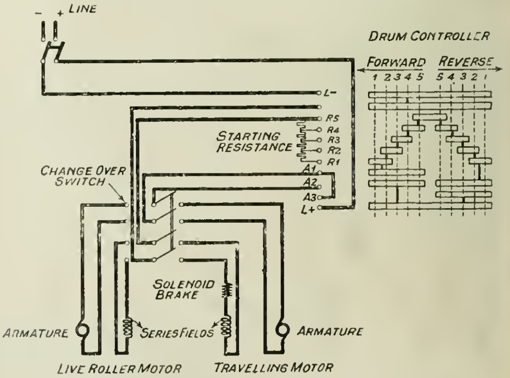

Fig. 3.—Diagram of Connections for Two-Motor Ingot Chariot. (Two Direct-current Motors with Change-over Switch to Interlock Motions.)

The writer has had no experience of them in actual practice, but there seems no valid reason why they should not be quite efficient in operation. They can be installed quite near to the motor, thus saving on cabling; and having no moving parts, should require little or no attention.

Fig. 4A illustrates this type of controller, made by Messrs. Electric Control, Ltd., and readers interested in reports of the performance obtained in practice are referred to the "Proceedings" of the I.E.E., No. 277, Vol. LVII., pp. 35-47.

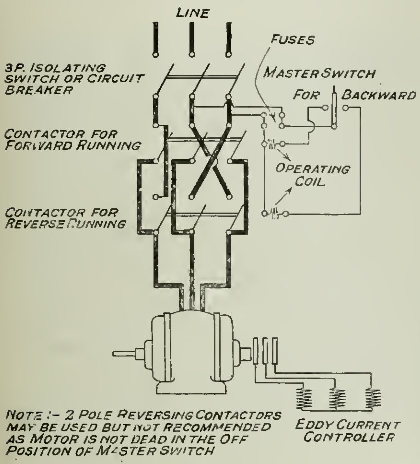
LINE
FUSES
3P. ISOLATING SWITCH OR CIRCUIT BREAKER
MASTER SWITCH
FOR
BACKWARD
CONTACTOR FOR FORWARD RUNNING
OPERATING COIL
CONTACTOR FOR REVERSE RUNNING
NOTE :- 2 POLE REVERSING CONTACTORS MAY BE USED BUT NOT RECOMMENDED AS MOTOR IS NOT DEAD IN THE OFF POSITION OF MASTER SWITCH
EDDY CURRENT CONTROLLER

Fig. 4.—Diagram of Connections for Live Roll Control. (Alternating-current Motor with Eddy Current Starter.)

Fig. 5 shows a direct-current equipment, also of the second class, as described above in section 4, the operation being as follows: The first step of the master controller closes contactors 1 and 3, or 2 and 4, according to the direction of rotation, thus throwing the motor across the line with all resistance in series. The value of this resistance is shown, so as to keep the torque of the motor to a low value, so as to check any previous rotation in the opposite direction, and thus eliminate all backlash in the gearing. The second step allows contactor No. 5 to close and short-circuit sufficient resistance to allow the motor to turn slowly under normal working torque. The third step closes contactors 6, 7 and 8 in the order named, the rate of closing being determined by the current taken during acceleration. It should be understood that Fig. 5 only shows the principle upon which these contactors are closed; the actual connections vary with different manufacturers, according to the method of current limit control adopted.

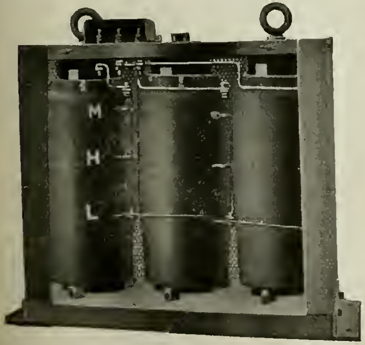

Fig. 4A.—Eddy Current Starter.

MANIPULATORS.

When nearing the mill the ingot, if not in the correct position for rolling, is handled by the manipulators, which have been, in the past, chiefly arranged for operation by hydraulic rams. With the increased size of ingot and the necessity for increased output, there has been a demand for a better class of manipulator than hitherto available; and the following description of the Universal Manipulator made by Messrs. Davy Bros., Ltd., of Sheffield, will probably be of interest, and illustrate the duties thrown on the electrical equipment, as these are of a comparatively novel nature.

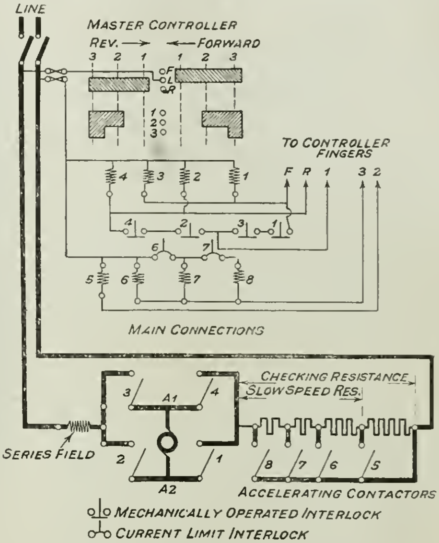

Fig. 5.—Diagram of Connections for Live Roll Control. (Direct-current Motor with Three-Point Control.)

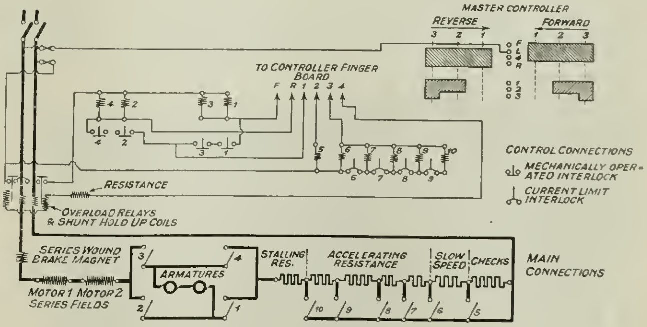

Fig. 6.—Diagram of Connections for Manipulator Guides. (Two Direct-current Motors with Three-Point Control.)

This manipulator consists of a pair of sliding heads on each side of the main rolls, the heads receiving their motion by means of racks and pinions, as shown in Fig. 10. Each head is about 20 ft. long, and is fitted with a renewable wearing face about 4 ft. longer than the main head, and the heads on the entry and leaving sides of the main rolls are registered with another by means of the long shaft carrying the pinions. This fact, coupled with the great length of the heads enables this manipulator to be used as a guide for both the entering and leaving sides of the mill, so that the piece is kept as straight as possible.

One of the heads carries a pair of fingers, which are used for lifting one edge of the piece in order to tilt same into the required position, the fingers being lifted by the action of bell crank levers coupled to a rotating crank. These fingers are shown clearly in Fig. 11, together with the operating motor and gearing.

Taking the control of the guides into consideration first, it is apparent that the two guides may come hard up against each other, or against the ingot, and provision must be made to guard against this contingency. This provision may take the form of a slipping clutch between the motor and the guides, but in view of the severe duty and dirty location, a "stalling" resistance is advisable also in order to limit the torque and current to a safe value.

It will be evident from Figs. 10 and 11 that this manipulator lends itself to an electric drive for the guides, as all the driving mechanism is as high as possible, and the heads are operated through pinions. This feature will probably lead to more extensive electric operation, as the further hydraulic pipes, &c., can be kept away from the mill the better.

Fig. 6 shows a suitable diagram for the direct-current equipment, whilst Fig. 4 represents a corresponding equipment for the alternating-current system, as this equipment automatically limits the torque available from the motor. The controller, however, must be far more generously designed for this duty than for live roller work. The motor is required to be under rapid control, and therefore a powerful solenoid brake should be fitted. This is not shown on the diagrams, as shunt or series brakes may be used; it will be noted that Fig. 6 is practically a copy of Fig. 5, with the addition of a permanent resistance between the last contactor and the motor, an increased number of accelerating switches, and an overload relay which opens all contactors, and compels the operator to return the control handle to the off position to reset the relay. Two motors are shown coupled in series in order to provide the requisite torque at a low speed.

Tilting Fingers.

The requirements for the control of this part of the manipulator are somewhat rigid, as damage might be easily caused by improper operation or neglect, and it is thus necessary to introduce a certain number of automatic features in order to secure satisfactory operation.

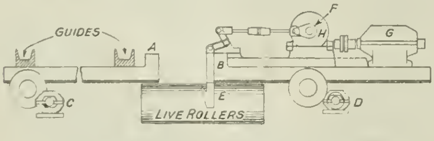

Fig. 7.—Sketch of Manipulator Mechanism.

In a recent equipment in which the writer was concerned, the following conditions were laid down as desirable:—

1. The fingers must return automatically below the floor level, unless the tilter is under the control of the operator.

2. The direction of motion of the fingers must correspond to the direction of motion of the controller handle.

3. The fingers must be capable of stopping at any portion of the travel, and must be capable of running slowly or rapidly at will in either direction.

In order to visualise what these conditions entail, the following futher description of the operation of the manipulator is inserted:—

Referring to Fig. 7, *A* and *B* are the manipulator guides, which approach, or recede from, one another according to the directions of rotation of motors *C* and *D*. One of these guides carries the tilter fingers *E*, which are lifted or lowered by crank *F*, driven by motor *G* through worm and worm-wheel *H*. In the lowest position fingers *E* are below the rolls, and consequently below the ingot, whilst in the highest position they rise sufficiently to turn over the largest ingot passing through the mill.

Assuming an ingot to be in position and between the guides and the fingers to be suddenly returned to the lowest position, a quick stop must be made, as otherwise the crank would carry the fingers upwards again and the fingers would foul the ingot and serious damage might result.

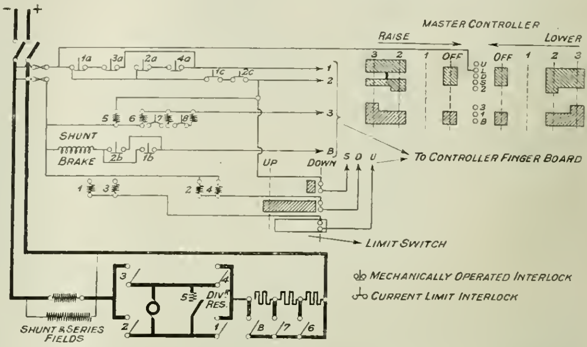

Fig. 8.—Diagram of Connections for Manipulator Finger Tilter. (Direct-current Motor with Shunt and Series Windings.)

The equipment proposed by Messrs. Allen West & Company, with slight modifications suggested by the writer, was ultimately adopted, and is illustrated in Fig. 8. In this scheme a limit switch is used to limit the angular movement of the crank to less than 180 deg. This is imperative in order to comply with the second condition given above, as either direction of rotation from "dead centre" will give the same motion to the fingers. In the off position of the master controller special connections are provided through the limit switch, so as to return the fingers to the lowest position, and an additional contact is provided on the switch, so as to put a diverter across the armature, and slow down the motor just before the main circuit is opened, and the solenoid brake applied. The master controller is fitted with a spring return to the off position.

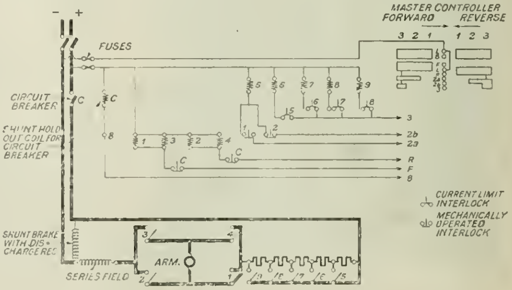

Fig. 9.—Diagram of Connections for Swinging Table. (Direct-current Motor with Shunt Brake.)

A compound-wound motor was adopted in order to secure a definite action under all circumstances, and the action of the controller is as follows:—

First Step.—Fingers held in any position.

Second Step.—Fingers raised or lowered slowly.

Third Step.—Fingers raised or lowered quickly.

Acceleration under current limit control.

In order to follow the action the connections of the control and main circuits are traced out as given hereunder, notches

2 and 3 being given first in order to better indicate the effect of notch 1.

Upward Motion.—Fingers at Bottom Position.—Second Notch.—Fingers *U*, *S* and 2 energised, and fingers 1 and *B* connected, at master controller. Contactors 1, 3 and 5 close. Interlocks 1*a*, 3*a* and 1*b* close, completing shunt brake circuit, via fingers 1 and *B*. Interlock 1*c* opens, disconnecting finger 2 from line direct except through controller.

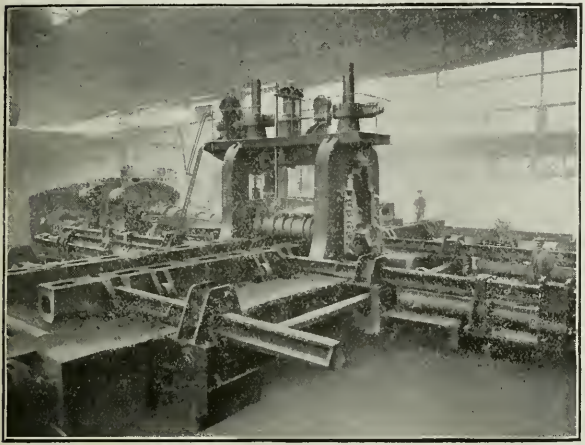

Fig. 10.—View of Manipulator.

Motor rotates slowly after brake lifts. The limit switch breaks the circuit *S* after the fingers appear above the floor, but the diverter contactor coil is held in through finger No. 2.

Third Step.—Finger 2 disconnected from line and finger 3 connected to finger 1 at controller. Contactor 5 opens and contactors 6, 7 and 8 close in order named, the two latter under current limit control. The motor speeds up and runs until limit switch breaks circuit of coils 1 and 3, thus breaking circuits of contactor coils 6, 7 and 8, and shunt brake coil, at interlocks 1*a* and 3*a*, and re-establishing the circuit of contactor coil, No. 5 at interlock 1*c*, resulting in a quick stop by dynamic and friction braking.

First Step.—If the handle is brought back to the first notch, the same effect is produced as by the operation of the limit switch, except that the circuits are first of all broken at the controller instead of at the limit switch and reverser contactor interlocks.

Spring Return to Off Position.—Assuming that the fingers are not below the floor level, the action of the control apparatus, should the operator leave his post, is as follows :—

Controller fingers *D* and *S* are energised direct from the line, and fingers 1 and *B* are connected together. Contactors 2 and 4 therefore close, and by the operation of their interlocks (2*a* and 4*a* and 2*b*) complete the brake magnet circuit. The motor, therefore, revolves, lowering the fingers until the limit switch approaches the end of its travel, when fingers *S* and 2 are connected by the short contact on the switch. This connection closes contactor 5, completing the dynamic braking circuit, and bringing the motor to a dead slow speed. The final break of the limit switch contact opens the reverser contactor circuits, and so applies the solenoid brake.

Downward Motion.—This motion is a repetition of the motion on the upward movement, and it should be noted that on notches 2 and 3 the finger *S* is energised. This effectually prevents the tilter fingers from being driven under the floor at too high a speed, should an ingot be assisting the downward movement, as the action of the limit switch brings the dynamic brake into play at the proper moment as described above.

Screw Down Gear.

This motor is one which receives the most rough usage in a steel works, as the operation has to be finished in a very limited time, and is repeated several times per minute throughout the day. In addition, accurate stops have to be made, and provision effected against the motor being damaged at either limit of travel.

A similar equipment to that shown in Fig. 6 for the manipulator guides would be satisfactory for a direct-current equipment, and similar to Fig. 4 for an alternating-current motor ; solenoid brakes are required in each case. Figs. 15A and 15B show an equipment designed for dynamic braking in the off position, but it will be noticed that a compound wound motor is essential for this scheme, and as a stalling resistance is advisable in any case in order to prevent overrunning, the writer favours stopping the motor by "plugging," so that a series-wound motor can be used.

Swinging Table.

If a three-high mill is installed, then the ingot must be lifted to the upper rolls on every alternate pass, as the lower and middle rolls are used for one pass and the upper and middle rolls for the other pass. This enables the drive of the main rolls to constantly run in one direction.

In order to accomplish this result, a short section of the approach rollers is mounted on a movable table on each side of the mill connected to a motor-driven crank. The control of this motor is very similar to that for the ordinary approach table, except that it must be possible to hold the table accurately in position whilst the ingot is in the rolls, and a diagram of connections which has proved satisfactory in actual practice is shown in Fig. 9. It will be seen that a shunt brake is used in this instance.

If a shears is installed to cut down the ingot or bloom after the first few passes, additional rollers may be required, and the measuring gear may be motor-driven. The control for the former is identical with that for live rollers, and for the latter, a similar equipment to the screw down gear is quite suitable.

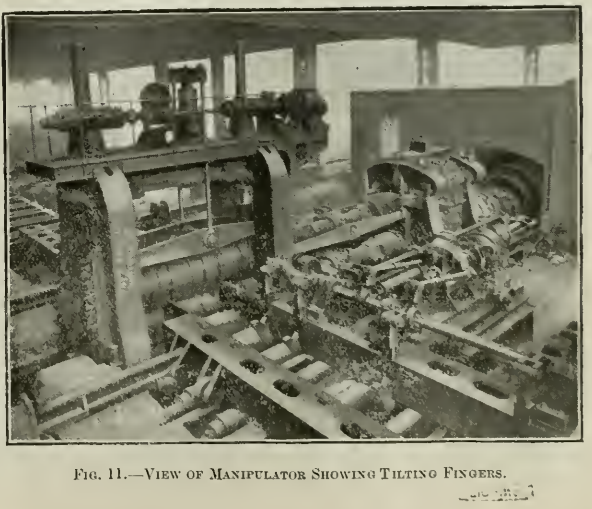

Fig. 11.—View of Manipulator Showing Tilting Fingers.

Skids.

To transfer the piece from one stand or roller path to another skids are utilised. These consist generally of fingers projecting above the mill floor, and mounted on ropes running in races across the area to be skidded, and may be of two types, viz., (1) uni-directional, (2) reversing. Both are reversing in the sense that the motor has to be reversed in order to skid another piece in the following passes, but in the former the skid finger is capable of passing underneath obstacles on the return journey, whilst in the latter the fingers are raised mechanically by a support, extending the whole length of the skidway, pivoted on swinging levers and operated by a crank in a similar manner to the manipulator fingers.

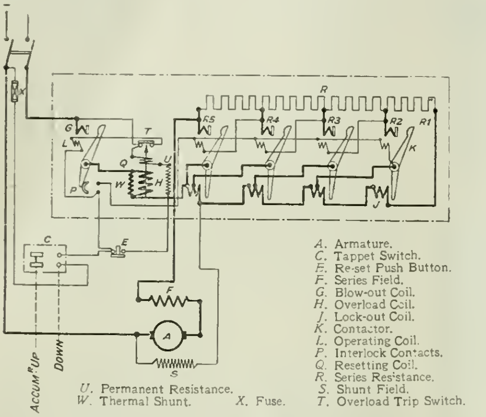

Fig. 12.—Diagram of Connections of Single-Pole Non-Reversing Contactor for Use with Compound Motor Driving Hydraulic Accumulator, showing Push Button, Reset O.L. Relay and Tappet Operating Switch.

There is not the same necessity for automatic operation with the skid fingers as with the tilter fingers, and the scheme of control connections recommended would be similar to that for the manipulator guides in the case of the skid rope motor, whilst a live roller equipment would be suitable for a skid finger lifter if the motor was fitted with a powerful solenoid brake.

The permanent resistance in the skid rope motor will reduce possibilities of broken ropes, wheels or fingers. The ingot having been rolled into its final form is then passed over the run out table to the finishing banks where it may be mangled and then sheared or sawn to finished sizes.

The control apparatus on plate mangles is generally of a similar character to that on the live roller gearing, and does not need further mention.

The motors driving shears and saws are constantly running whilst the machine is in use, and the control gear does not differ for similar machines in other industries. Large flywheel effect is a desirable feature for shears, so that direct-current motors should be compound-wound and altrnating-current motors with face-plate starters would require a rotor resistance to give the necessary drop in speed. For hot saws very little compounding is required, and Fig. 13 shows a suitable form of control using contactor gear.

Remote and automatic control is of distinct advantage with machines of this class in order to restart the instant power is available after a temporary shut down.

Whilst there are many motors and auxiliaries which have not been described, the cases described above cover most of those omitted with the exception of hydraulic pumps and air compressors.

Hydraulic Pumps and Air Compressors.

With regard to the former, there are three chief methods of control covering two types of pumps—*i.e.*, centrifugal and ram pumps. The centrifugal pump has the great merit of dispensing with the accumulator and consequent fluctuation in pressure caused by the sudden movement and stoppage of the large mass essential in big accumulators; the pumps are small, comparatively efficient at full load, and cheap, both in first cost and maintenance, and show to the greatest advantage where the maximum demand does not matrially differ from the average. The pumps must be kept running all the time the hydraulic plant is in use, and as the running light load is roughly 30 per cent. of the full-load rating (for constant speed) the efficiency becomes very low if fluctuations in demand are great, as the pump must be capable of dealing with the greatest demand providing an accumulator is not installed.

The method of control adopted is to pass to waste from the high pressure main sufficient water to keep the impellers from overheating, but in the writer's opinion for direct-current plant, the speed should also be varied automatically to maintain a constant pressure. This would result in a decreased no-load loss amounting to probably 8 to 10 per cent. of the full-load rating of the motor, and the overall yearly efficiency would be increased by nearly 3 to 4 per cent.

The control of ram pumps is carried out on somewhat different lines, and depends upon the position of the accumulator, one method utilising the movement to control a bypass between the pump delivery and suction pipe, and the other method consists of operating the controller, which must be of the automatic type, by means of tappet switches opened or closed by the accumulator.

It is obvious that, for centrifugal pumps and for ram pumps controlled by by-pass valves, a single starting panel consisting of ammeter, switch and fuses or their equivalent, and a starter is sufficient, and that speed regulation by means of resistance in the field circuit of direct-current motors may be added if required, the adjustment to suit the loads being made by hand or by automatic means. For alternating-current motors it is doubtful whether any real advantage is gained by introducing resistance into the rotor circuit in order to slow down the pump.

For the control of large motors, say, 40 H.P. and upwards, a good arrangement is to have an automatic starter operated by pilot switches worked from the accumulator, and Fig. 12 shows a satisfactory diagram for a direct-current motor.

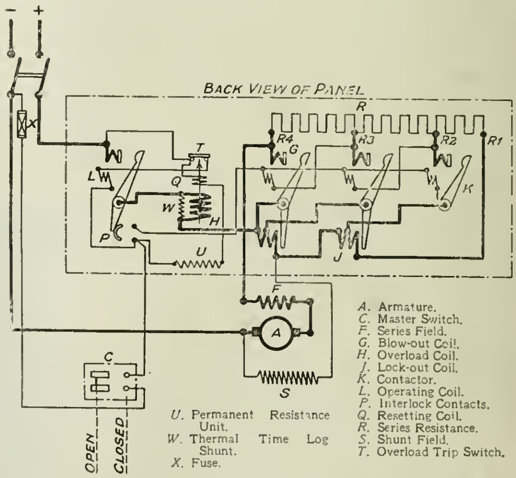

Fig. 13.—Diagram of Connections of S.P. 4-Point, Non-Reverse Contactor Panel, for use with Compound Motor Driving a Hot Saw, showing O.L. Relay and Hand-Operated Master Switch.

The closing of the tappet switch closes the main circuit-breaker, and *R*2, *R*3, *R*4 and *R*5 are short-circuited in turn under current limit control, and the motor runs at full speed until the accumulator opens the tappet switch, and all contactors drop out owing to the control circuits being broken.

For large pumps a combination of both methods is a decided advantage, the pump being unloaded before being stopped and started. Where large alternating currents motors wound for direct connection to high tension and circuits are used it it is not advisable to continually break and make the stator circuits, and the motor should be designed to carry the magnetising current with the rotor stopped without undue heating.

The control of motors driving air compressors is very similar to that for the control of ram pumps in conjunction with accumulators, the tappet switches being replaced by relays operated from contacts fitted to a pressure gauge. The compressor is also generally fitted with "unloading" valves so that the motor only has to start up against a light load.

Ladle Crane Control : Main Hoist.

Reference has been made in a previous paragraph to the potentiometer system of control for the lowering motion of a hot-metal crane, as this system has been found to be at least as reliable and infinitely smoother in action than the best forms of mechanical brake available.

With potentiometer control, on the other hand, the speed of descent is definite on each notch of the controller, and is practically independent of the weight on the hook. The retardation of the load from full speed to a creeping speed is obtained by electrical braking, whilst the stopping of the load from a slow speed is effected by dynamic braking, and the solenoid brakes. In connection with the latter, ample provision should be made so that should one fail the remaining brake or brakes will hold the load.

The control itself consists of separately exciting the "series" field through a suitable resistance, the armature being in parallel with the field and a portion, or occasionally the whole, of this resistance. The armature is generally provided with a resistance in its own circuit in order to limit the current in the strongest braking positions.

The speed may be varied by altering the value of any of the resistances, and the braking power may be either dynamic or regenerative, according to requirements. Each application of this system requires careful consideration, and Mr. Jackson's article referred to above will prove useful to those interested.

The solenoids for the brakes should preferably be of the series type, and connected in the field circuit.

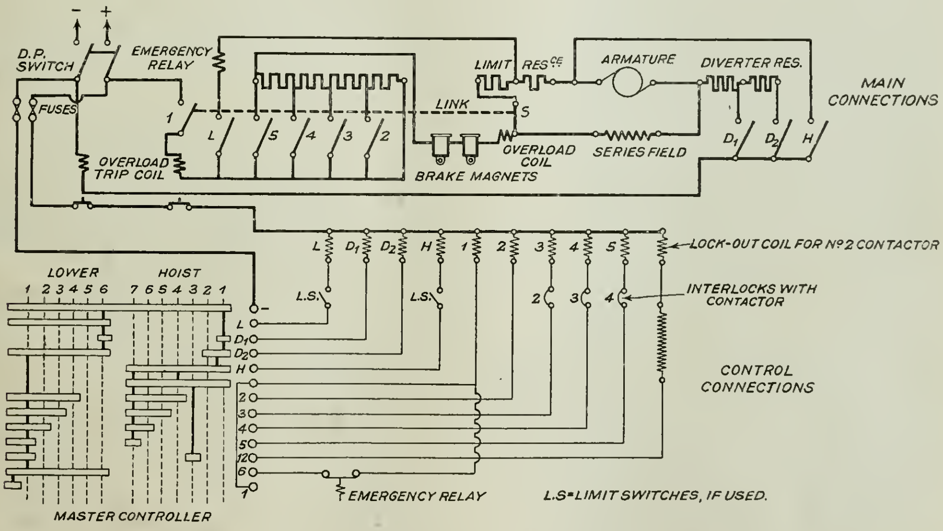

Fig. 14.—Diagram of Potentiometer Control.

The mechanical brake, as fitted to the majority of ladle cranes, is arranged so that the brake is always on when the motor is stopped; when the motor starts to rotate, the brake is released and the weighted hook is free to rotate the barrel and gearing up to the limit of speed of the driving motor.

These brakes have been brought to a high state of efficiency, but are necessarily subject to heavy stresses and require adequate and constant supervision. This supervision is difficult to provide for, as the time available for a thorough examination is strictly limited and generally insufficient. It is also apparent that this form of brake is deficient in speed control for the following reason : The driving motor has only to rotate the gearing in order to permit the mechanical brake to be released and consequently the torque exerted by the motor is very slight, so that the speed regulation by plain rheostatic control is defective even on the first few notches.

The load is thus allowed to attain a considerable speed, and the return of the controller handle to the off position applies the mechanical brake and throws a severe shock on the crane structure.

Fig. 14 shows in diagrammatic form a suitable scheme of connections, the actions of the equipment being as follows :—

First Notch.—Passing from the off position, fingers L, D2, 2, 3, 4, 5 and 6 are energised and finger 1 is energised temporarily, but the connection is broken on reaching the first notch. This action closes the respective contactors and puts the series-field with the brake solenoids and diverter resistance in series across the line ; the armature, and a portion of the limiting resistance, is in parallel with the brake magnets and series-field, but is in series with the diverter resistance.

This connection ensures a powerful field and allows a torque sufficient to overcome the friction of the gears and barrel, with an empty hook or light load. If the load is sufficient to overcome the motor, the armature current reverses and strengthens the field current from the line, producing a powerful braking torque. This torque exists even if the line current is suddenly cut off, the armature speeding up slightly until equilibrium is restored.

It has been pointed out that finger 1 is energised temporarily, and this course is adopted, as an "emergency" relay is placed in the armature circuit. This relay is used to break the control circuit in the event of failure of current in the armature circuit from any cause (*e.g.*, broken collectors), and consequently it is necessary to complete the control circuit by a temporary circuit until the armature main circuit is established and the emergency relay in operation.

The relay should be fitted with a dash pot to retard its action so that it will not operate during the reversal of current in the armature circuit when the load over-runs the motor. This device is somewhat of a refinement and may well be dispensed with in future installations.

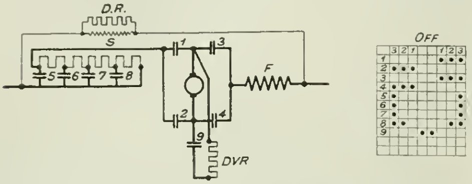

Fig. 15a.—Key Diagram of Connections of Single-Pole Reversing Contactor Panel for Compound Motor-Driving Screw-Down Gear, having Plain Series Control with Rheostatic Braking in the "Off" Position.

The failure of the field circuit is guarded against by the use of series-wound brake magnets placed in the circuit.

Second, Third, Fourth and Fifth Notches.—The resistance in the field-circuit is increased by the successive opening of contactors 5, 4, 3 and 2, through the consecutive de-energising of fingers 5, 4, 3 and 2 on the master controller. The speed of the armature is consequently increased before the same condition of dynamic braking is restored.

Sixth Notch.—On this notch, finger D is energised and the corresponding contactor closed, causing an increase in both the field and armature currents. The latter increase more than counterbalances the effect of the former, and an increased speed is required before the balance of the circuits is established.

Hoisting.—The hoisting connections are similar to any plain hoisting controller with the addition of two slow speed points effected by a diverter resistance arranged in parallel with the armature. On these first two notches a portion of the series resistance is cut out to provide a moderate torque, but when the third notch is reached this portion is again cut into the circuit by a special shunt-wound lock-out coil which prevents the contactor from closing until the fourth notch is reached, when the contactor can close immediately the current dies down to a suitable value. The fifth, sixth and seventh notches provide for acceleration under current limit control.

Stopping.—When the controller hand-wheel is returned to the off position, contactor *S* is closed by the opening of contactor 1, to which it is mechanically connected, and establishes a powerful dynamic braking action through the limiting resistance. This contactor *S* is provided with a strong series-wound closing coil, which comes into operation in the event of an excessive current in the field-circuit.

This form of control is commercially impracticable with alternating-current motors at the present stage of development, and the writer feels that a 220-volt direct-current plant is the best system for all-round use on steel works auxiliary machinery, although the development of special apparatus, giving a reversible constant torque at varying speeds from a constant running motor, may make an alternating-current system more desirable in the future.

Wiring.

It is of no uncommon occurrence to find that the motors and controllers for the mill auxiliaries have been selected with admirable care and foresight, but the same does not hold good unfortunately, for the wiring connecting these parts together, and to the distribution fuse board.

It is not an easy matter to find suitable runs through the massive foundations required for a large mill, especially where three or four stands are employed with the elaborate skidways and roller run-outs, but attention to this point at an early stage is well repaid in the maintenance cost during operation.

Where a crane is used over the mill and control pulpits it is inadvisable to use overhead wiring, whilst, if placed underground, the live roller tracks must be crossed as a general rule.

In order to guard against overheating from the pieces or dropping scale, the cables should be carried well below mill floor level, and be of a non-perishable nature with strong protection against mechanical damage.

Probably the best method of connecting up the motors is to instal a terminal box within a few feet of the motor and connect same to the motor with V.I.R. cable; the terminal box would be connected to the controller by means of paper-insulated lead-sheathed and wire-armoured cable carried underground on iron cleats, suitable shields being fitted above the cables where they cross the roller tracks in order to prevent dropping scale from resting on or striking the cables.

The cables should be easily accessible for replacement or inspection throughout the length under the flooring, and the same remarks apply to the motors, special attention being given to the holding down bolts being free from any gearing, bearing brackets or foundations, so that the removal of the motor may be effected in a minimum of time.

The extra expense of flexible couplings between motors and reduction gearing is well warranted from the resulting decreased maintenance costs.

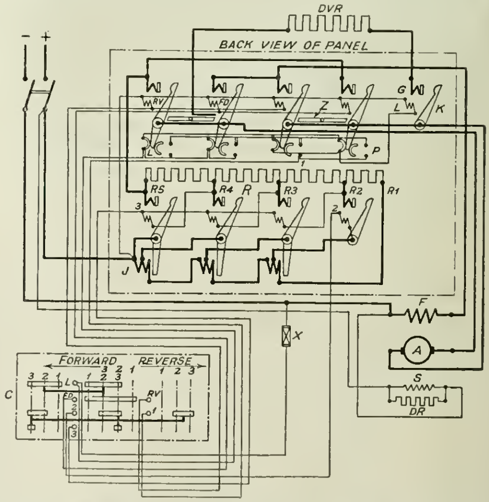

Fig. 15b.—Diagram of Connections of Single-Pole Reversing Contactor Panel for Compound Motor Driving Screw-Down Gear, having Plain Series Control with Rheostatic Braking in the "Off" Position.

A.	Armature.	*K.*	Contactor.
C.	Master Switch.	*L.*	Operating Coil.
DR.	Discharge Resistance.	*P.*	Interlock Contacts.
DVR.	Diverter Resistance.	*R.*	Series Resistance.
F.	Series Field.	*X.*	Fuse.
G.	Blow-out Coil.	*Z.*	Mechanical Interlock.
J.	Lock-out Coil.		

In conclusion, the writer wishes to express his appreciation of the kindness of the following firms for permission to use the diagrams attributed to them, viz.: Messrs. the B.T.H. Company, for diagram No. 1a; Messrs. Davy Bros., Ltd., Sheffield, for Figs. 10 and 11; Messrs. Allen West & Company, Ltd., for diagram 1b and 1c, 12, 13 and 15a and 15b; and Messrs. the Electric Control Company, Ltd., for Fig. 4a. No illustrations of contactor controllers are included in this article, as it is assumed that all readers are fully acquainted with the appearance and construction of this type of controller.

Developments in Lifting Magnet Practice.

By F. N. PICKETT.

Summary.—The lifting magnet has proved to be one of the most efficient devices in the saving of time and labour, where iron is handled in large quantities. In the present article the use of this implement is described in various applications, including the handling of pig iron, steel rails and plate. Interesting problems arise in adapting the lifting magnet to these various purposes.

ONE of the results of the war has been the undoubted stimulation of the lifting magnet industry in this country. Writing in "The World's Work," in January, 1919, Mr. Henry Earle Fish describes how, previous to 1914, a very large part of the lifting magnet business in this country went to Germany, and that all the high-efficiency magnets were of foreign manufacture, either German or American. To-day the English magnet of the high-efficiency type is probably, for any given size, the most powerful magnet in the world, and not only is it powerful, but its dead weight in proportion to its lifting capacity is also less than in the older types.

PIG IRON MAGNETS.

The lifting magnet in conjunction with the electric crane may truthfully be described as one of the greatest time and labour-saving devices in iron and steel works to-day; although, if full use of its wonderful possibilities are to be made, the methods of handling pig iron at the blast furnaces in this country will need re-organisation. The older system was based on slinging pig iron in chain slings placed by hand, and the trucks and other accessories have been developed to meet this system. Another point, and one in some instances controlled by ground space available, is that the various grades of pig iron are usually arranged in carefully-built stacks. This arrangement leads to a neat stockyard, but is undoubtedly very expensive, entailing the services of many groundmen and stackers. There is no doubt that with the greatly increased rates demanded by these men, some labour-saving device will have to be installed.

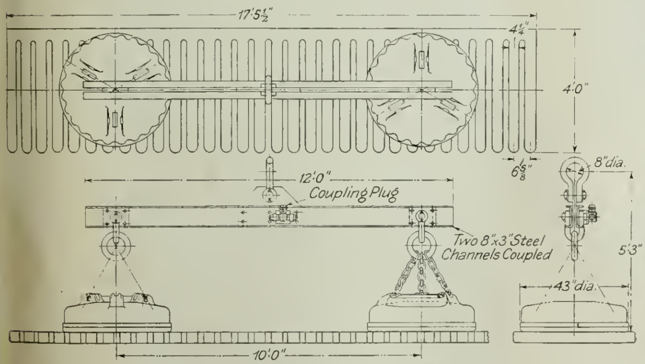

FIG. 1.—ARRANGEMENT OF TWO TYPE C43 LIFTING MAGNETS ON BEAM WITH COMB OF PIG IRON.

Various schemes for utilising lifting magnets have been suggested and tried, and it is proposed to mention one or two.

The first point of handling is at the pig bed, and one method of dealing with the "comb" is to lift it bodily by means of two or three magnets mounted on a beam, and to convey it to a pig breaker where the individual pigs are broken off mechanically, and the "sow" is also divided up into pieces (*see* Fig. 1). One of the principal objections to this method of handling is due to the fact that a considerable amount of sand is taken up on top of the comb, and causes trouble at the breaker and elsewhere. Slinging the comb on its edge gets rid of some of the sand, but if the comb breaks, as it is always liable to, several journeys are necessary and slingers have to be always available in case of this occurring.

Requirements of the trade call for many grades of pig iron to be broken on the bed, particularly Cleveland iron, and in this case a very cumbersome and heavy magnet scheme would be necessary to deal with a complete broken comb, including the sow, in one lift.

It would appear, therefore, to be a better proposition to cause a large (62 in.) circular magnet to be swept over the broken pig, and the pig thus lifted is then conveyed and dropped into an ordinary truck. This method serves the double purpose of ridding the individual pigs of sand (since each pig jumps to the magnet face with a distinct rap) and of economical and quick handling, since a high-efficiency magnet will lift up to as much as two tons of pig per lift, and rarely less than one ton. This method is illustrated in Fig. 2.

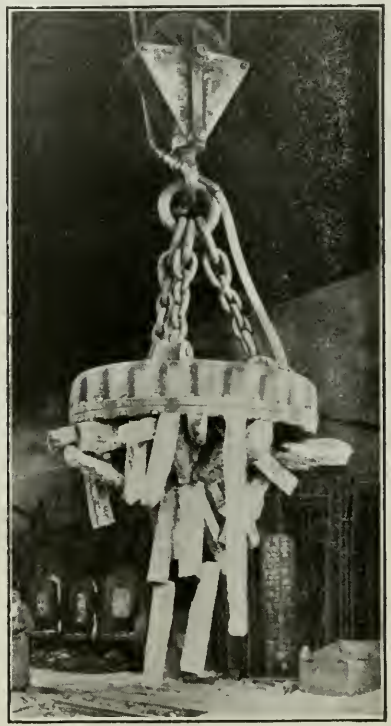

FIG. 2.—LIFTING PIG IRON BY A CIRCULAR LIFTING MAGNET.

Either of the methods outlined will show great economies over manual handling of pig, where it is a case of one man one pig, and where it is necessary to see that the whole comb is at such a temperature that a man can handle it comfortably. Any temperature below a black heat is good enough for a better-class modern magnet, which is of fire-proof construction.

After leaving the pig bed the trucks of pig iron are either despatched to their destination or are taken to the stockyard, where a magnet, usually a 52 in., mounted on a 5- or 7-ton steam jib crane, unloads the pig iron on to a dump, there being different dumps for different grades of pig. It should be observed that the height of the dump may be up to the limit of the height of lift of the crane jib with the magnet attached, so that actually space is saved, since with the more usual method of stacking by hand, it is not advisable to go beyond the height at which a man can conveniently work from the ground level.

When any of the particular grade of pig is required, the crane and magnet simply lift the iron from the dump into the trucks, and groundsmen and stackers are entirely dispensed with.

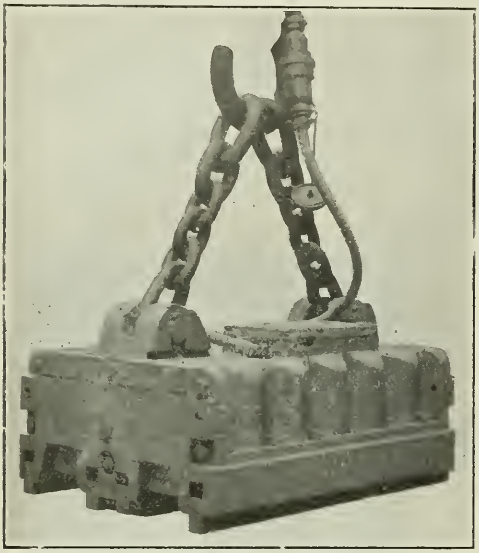

Fig. 3.—Rail Lifting Magnet.

Although a steam crane has been mentioned for the stockyard, it will be obvious that a fast electric overhead travelling crane would give even better results in spite of its higher first cost. The steam jib crane is, of course, fitted with its own turbine-dynamo set, taking steam from the crane boiler for energising the magnet, while the overhead crane would preferably be electrically driven.

In cases where the pig iron has to be loaded into ships or barges, the lifting magnet will effect extraordinary economies, even with the slow operating jib loco cranes which in some instances are in use to-day.

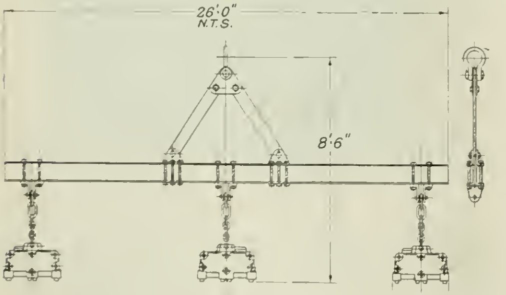

Fig. 4.—Arrangement of Three Type R24/24 Lifting Magnets on Beam Suspension.

With a modern transporter and magnets, really remarkable loading times may be obtained, and it is rather a commentary on English methods when one considers what is being done in this connection in Germany and the U.S.A. In the latter country it is an every-day performance to load or unload, from or on to dumps, from 1,900 to 2,000 English tons of pig iron, with two 62-in. magnets in 10½ hours. The magnets are, of course, mounted on fast ore handling transporters, but, as far as the writer is aware, we have nothing in this country to even compare with these speeds, even after making allowances for the fact that a large amount of American pig is machine cast, while practically all English pig is sand cast.

In the steel foundry the magnet may be said to have come into its own. There are very few of the larger steel-works in this country where lifting magnets are not in use, and there can be little doubt that the magnet crane for loading charging boxes, and the electric charging machine for charging these boxes to the furnaces, have contributed to the increased output of steel observable during the war. Incidentally these labour-saving devices have also been the source of greatly increased earnings amongst the furnacemen, and this may to some extent account for the favour with which they are viewed by the men.

Rail Magnets.

The success of the lifting magnet in handling the raw material of steel-making has led to many attempts to use them in connection with the finished steel. For rails, bars, &c., the magnet has certainly been successful, but has led to the development of special types of magnets. These rail-lifting magnets are usually rectangular in shape, and have either two or three polar faces as shown in Fig. 3.

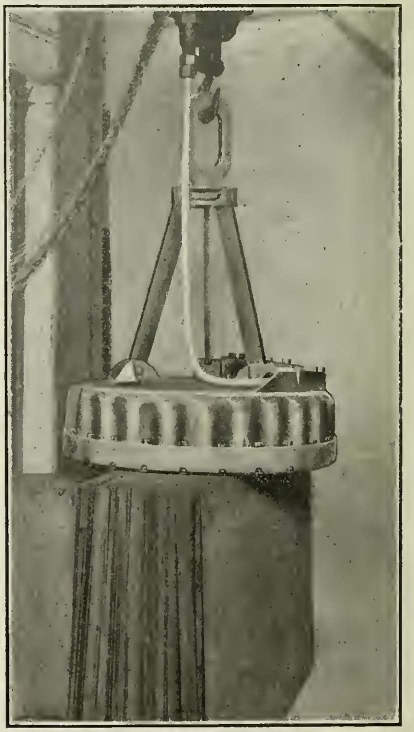

Fig. 5.—Lifting Plates.

In connection with the three-pole rectangular magnet a very interesting modification is that of the mobile finger pole face. This type of magnet was designed primarily for lifting rails. Rails are rolled on their sides and come from the mill on to the rail banks on their sides. It was found to be difficult to lift some sections of rails with the ordinary plain pole face on account of insufficient area of contact, and it was to improve this factor that the mobile fingers were added. The fingers are quite loose in the slots, and merely take up a position to suit the particular load to be lifted. The illustrations are self explanatory, and it is interesting to note that this type of magnet has had a really extraordinary success since its introduction.

The usual method of application of this magnet on the rail-bank crane, is to mount two, and in some instances three, of these magnets on a beam, as seen in Fig. 4. Such a combination will deal with any desired weight of 60 ft. length British standard rail, 120 lbs. per yard, and is also used to deal with structural shapes, angles, channels, &c., where these are rolled

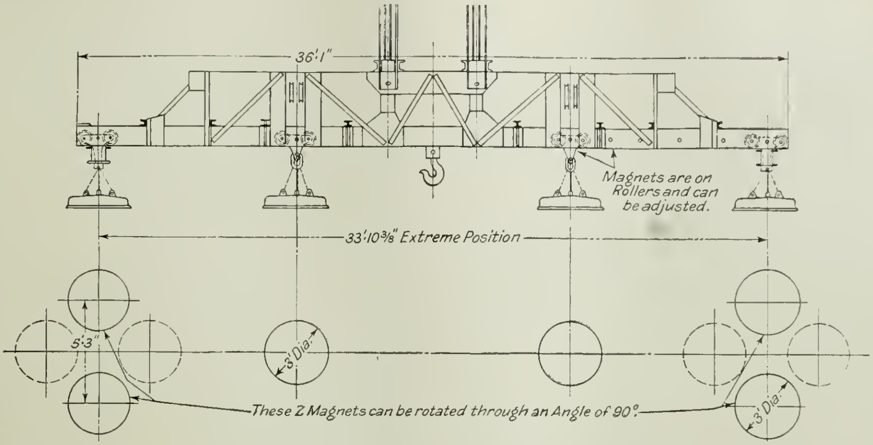
36'1"
Magnets are on Rollers and can be adjusted.
33'10⅜" Extreme Position
5'3"
3'Dia.
3'Dia.
These 2 Magnets can be rotated through an Angle of 90°.

Fig. 6.—Arrangement of Magnets on Plate Loading Crane.

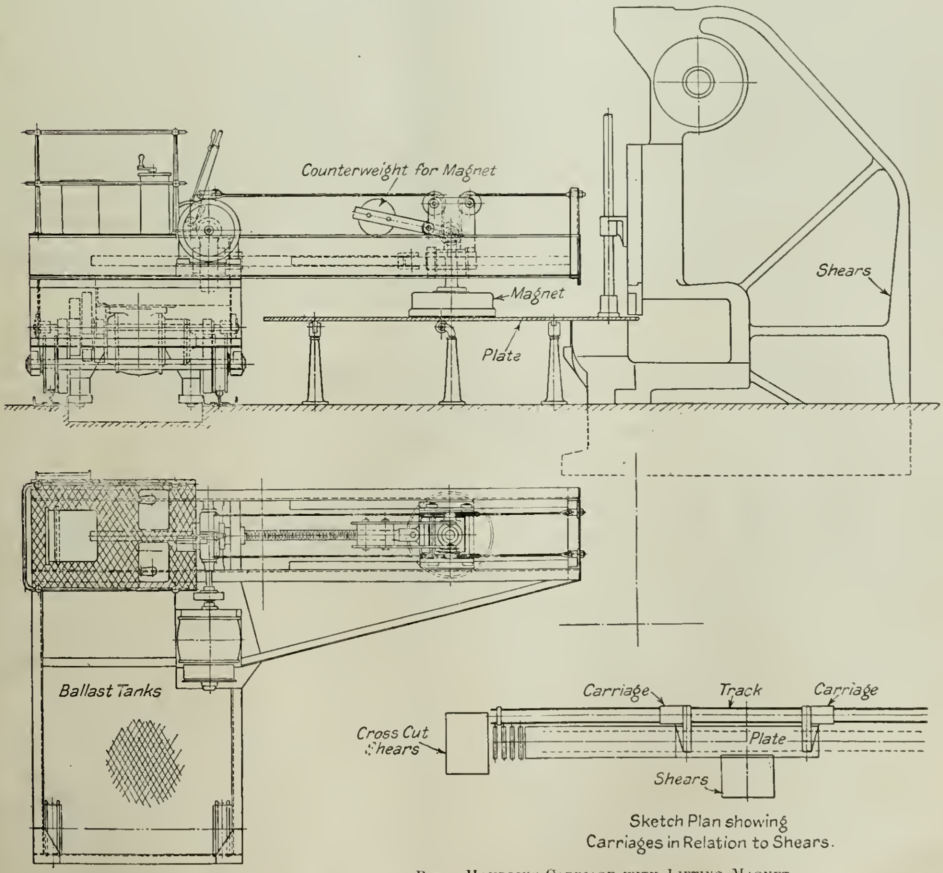

Fig. 7.—General Arrangement of Plate Handling Carriage with Lifting Magnet.

on the same mill. These magnets are made in lengths of 24 in., 36 in., 48 in. and 72 in., but all have a standard width of 24 in.

PLATE-HANDLING MAGNETS.

It is in connection with plate handling that most of the development work during the war has taken place, and the demand for ship plates has been so insistent that the utmost was demanded from every plate mill in the country, and new plate mills have been erected on a hitherto unheard of scale.

There are two distinct problems in dealing with plate handling. The first is to "slide" the plate, and the second is to transport it bodily, *i.e.*, to lift and convey it from one point to another.

Hitherto the sliding of the plates as they come from the rolls to the shears, has been accomplished mechanically, or by manual means, or by a combination of both. If a plate always came from the rolls in a perfectly defined path, mechanical means for sliding it would be easy, but unfortunately plates sometimes come out askew, and in such a manner that the mechanical dogs, or other devices, are actually prevented from operating, and considerable time and trouble is spent in getting the refractory plate to the shears.

Plain manual handling entails a large amount of labour particularly when large plates are dealt with.

Magnetically the problem is complicated by the fact that, although a single large magnet would lift in weight the equivalent of a plate (usually not exceeding 2½ tons), the amount of sag on the plate is so excessive that the plate simply "peels" off the poles of a single magnet. If it were possible to turn the plate on edge, and if it were convenient to the mill hands to have it conveyed in this position, a single magnet could deal with the largest plate with ease, but it is almost invariably necessary to handle the plate on the flat.

The first attempt to solve the problem, so far as the writer is aware, was by means of plant installed at a large steelworks in South Wales. This method of dealing with plates is illustrated in Fig. 6, and as will be seen, consists of an overhead crane fitted with a rigid mast in place of ropes and hook. At the end of the mast is a beam on which are mounted no less than six circular magnets. These magnets which are each about 32 in. in diameter, are arranged in such a manner that they may all lie longitudinally along the plate, or in the case of wide plates, two magnets at each end of the beam may be swivelled round to lie transversely across the plate. The crane has the usual motions, hoist, long travel, and cross traverse, and in addition the mast may be swivelled.

With this crane, a plate is picked up and conveyed to any other point within the area served by the crane, and it might be stated that the combination has been in use for the last eight years, and has proved in every way successful. The only objection to it to-day probably would be on the score of expense, although this would be offset by the economies effected by its use.

A scheme proposed by the Wellman Smith Owen Engineering Corporation, embodying magnetic handling of plates, is of more than usual interest. As will be seen from Fig. 7, it in some respects resembles a ground type charging machine, consisting as it does of an undercarriage running on rails parallel with the roller tables and cooling banks. Mounted on this undercarriage is a projecting arm, at the end of which is mounted a lifting magnet which, by suitable means, may be raised or lowered on to or off a plate; electric motors are provided for long travel, and for traversing the projecting arm, and the dead weight of the magnet is counter-balanced. The plate may be lying on an ordinary rail bank, but the inventors of the system state that "castors" are preferable.

For long plates, two machines are used, and by manipulation of the two machines, after the magnets have been lowered on to the plate and excited, the plate may be moved in any direction, longitudinally or traversely, or may be swivelled.

The operations may be carried out at a very high speed, and as the plates are not actually lifted, but only slide, the magnet need only be a small one.

This very promising machine is the invention of a well-known steelworks engineer, and is undoubtedly a valuable addition to the plant which a steelworks engineer has available for the solution of what is a very difficult problem.

The use of lifting magnets in the iron and steel industry is in the future likely to be considerably extended, and it is a matter for congratulation that both in design, construction and specific performance, the British made high-efficiency magnet will compare with any other magnet in the world.

The Worries of the Steel Works Electrical Engineer.

BY ONE OF THEM.

AMID the welter of re-organisation and the marshalling of forces to meet the competition with which we are threatened and to satisfy the urgent demand for increased output, a survey of the general situation in so far as it affects the steel-works electrical engineer appears to reveal one shortcoming of contemporary British initiative and enterprise in a very startling manner. This is the absence of all effort towards uniformity and the standardisation of everything pertaining to the electrical equipment of the modern steelworks. The steel-maker is being persuaded to embrace electricity more and more extensively, but the movement is one beset with difficulties and problems innumerable. Unfortunately, so far as the electrical manufacturer is concerned, individualism appears to be the determining factor with all its concomitant deficiencies. It may be a satisfactory tendency to the producers of electrical equipment, but it is decidedly harassing to the electrical engineer inasmuch as it is tending towards bewildering confusion. The limit of tolerance is being rapidly approached, even if it has not already been reached, and unless reforms in thought and action are promptly effected the application of electricity to this key industry is likely to suffer pronounced retardation, when it should receive every encouragement and all possible stimulation.

Why is no attempt being made to secure some semblance of order and standardisation in regard to electricity supply? Let the electrical manufacturer put himself in the place of the steel-works electrical engineer and he will quickly realise that the effective resolution of this issue alone renders the formation of the League of Nations child's play in comparison. At the moment the whole gamut of systems are being vigorously exploited. One merely pays one's money and makes one's choice. Consideration of this problem reveals that there are available direct current, alternating current, single-phase, two-phase and polyphase systems—all being pressed home with vigour.

Nor is this all. If one decides to adopt direct current, three voltages are immediately proffered for selection, namely 110, 220 and 440 with the whole range of intermediate variations. On the other hand, should preference for alternating current be extended then the outlook becomes a thousand times more bewildering, because there at once crops up the settlement of voltage which may be anything up to 3,000, plus the worries incidental to the decision of frequency.

Is it impossible for the electrical manufacturers and supply authorities to have a round-table conference to decide measures of standardisation? If some simple arrangement in this connection could be made the task of the electrical engineer would be very materially facilitated. Incidentally, one might then be able to obtain a standardised product at a reasonable price.

In the United States of America the significance of this issue appears to have been appreciated. The Iron & Steel Electrical Engineers' Association have attacked it in grim earnest and apparently have forced a definite decision, because we learn that 220 volts direct current is to be the standard steel works supply and voltage in future.

Then how about mill-motors? Have we grappled with this issue with the determination which the situation demands? Why was it necessary during the war for British firms to turn to the United States' manufacturers for equipment for the auxiliary drives in our steel works? Again, do the home manufacturers of such plant realise what we had to pay for the equipment of this character purchased in America? We became solely dependent upon the United States for our needs in this connection, and, so far as prices were concerned, we merely had to pay the price requested with the best grace we could muster.

It would be interesting to know if the home firms are really making adequate arrangements to build such machines now that the war is over, and to supply them at a severely competitive figure, or are the Americans to be permitted to maintain their hold upon this market? It must be conceded that one or two British firms have entered the manufacturing lists and their efforts certainly appear to be full of promise. But such competitive mill motors will be regarded with decided misgiving unless the facts that they are equal in every way to, and quite as reliable as, the American product, which has proved its worth, are driven home in the most convincing manner.

One cannot refrain from wondering why some of our manufacturers, who are prepared to build and to supply mill motors, do not emulate the practice of the motor-car industry and submit one of their individual motors to test to destruction. The test should be carried out by some unbiassed organisation of unassailable standing, and the results should be published far and wide. Such action would do more to convince the steel-works' electrical engineer of the capability of the British mill motor to stand up to its work than interminable academic assertion. It is performance which tells.

While on the subject of mill motors there is another issue connected therewith, equally in need of similar definite settlement. Cannot the manufacturers, through their organisation, standardise such incidental yet vital factors as fixing centres, half-couplings and revolutions per minute?

Then there is the switch and control gear. These factors are equally in need of prompt adjustment. One is constrained to ask if electrical equipment makers are fully alive to the fact that a ladle crane, which may cost anything up to £11,000, carrying a ladle of steel worth £1,000, may be jeopardised by the failure of the electrical equipment. If they are cognisant of this fact one would like to know why they render the operation of their contactor control gear dependent upon the sound contact of an interlocking contact comprising a small copper disc bearing by little more than its own weight upon two tiny posts. Contactor gear is absolutely essential to the efficient performance of steel works plant. Yet if the general manager only knew what flimsy relays and devices are introduced in contactor circuits, and that costly plant and delicate operations are absolutely dependent thereon, the writer ventures to hazard that the general manager would never sleep at night.

Resistances supplied to steel working machinery are deplorable. One would like to know why they are not made absolutely unbreakable. Surely such is not beyond attainment. While attacking the problem of durability and unbreakability, efforts might be concentrated upon the reduction of dimensions and weight, by the observance of more enlightened and scientific methods of ventilation. The cab of a modern charging machine is a source of endless amusement to the progressive well-trained electrical negineer. To the mind of the writer it resembles nothing so much as an excessively decorated Christmas tree—an effect due entirely to the bulk of the resistances.

The writer would also like to know if anyone has yet seen a really satisfactory main switch. I mean satisfactory in the steel works sense and to the service which such utilisation entails. Certainly the majority of those which have come under my notice are flimsy beyond words. They are utterly unreliable and after a few months' service are absolutely useless. A well-designed reliable and durable main-switch is urgently required, and this is a phase of endeavour upon which inventive and designing skill might very profitably be expended.

No survey of the deficiencies incidental to modern British electrical equipment designed for duty in the steel works would be complete without attention being drawn to wiring and trolley wires. The electrical engineer responsible for the operation, maintenance and efficiency of the electrical equipment in the contemporary steel works cannot suppress the thought that the wiring and current collecting devices on cranes of British construction are seriously at fault. With but very few exceptions cranes which have come before the writer's notice, and of which he has had experience, have had to be re-wired within 12 months of commencing service. In some cases the trolley wires and collecting shoes have also had to be re-designed to supersede those already installed because the latter have demonstrated their incapacity to stand up to their work or to give the desired performance. These items are of far-reaching significance, and yet are invariably neglected. They appear to be regarded as after-thoughts to be considered and fulfilled when the crane has been built, whereas they should really be considered as indispensable preliminaries, demanding as much care in design and provision as every other individual part of the plant.

The writer has not ventured to point out these defects and shortcomings incidental to British effort to equip steel works in any spirit of carping criticism. They have been emphasised essentially to bring home to the British manufacturer the shortcomings in his work, which possibly have never previously been appreciated seriously, with a view to their elimination. Perfection cannot be attained unless deficiencies are indicated and actual operation alone is able to extend constructive material and data of any real value. One has only to recall what British firms have achieved in connection with central station and railway traction apparatus, which is second to none in the world, to realise that the British electrical equipment manufacturer is capable of rising to the occasion.

The probability is that our home firms have not yet grasped the fact that the steel industry constitutes one of the most promising and remunerative fields for the activities of the electrical equipment manufacturer. It is the most important and progressive industry in these islands to-day. The foreigner is cognisant of this circumstance and accordingly is making every effort to meet the needs which have arisen. The applications of electricity to the steel works are illimitable, and it must not be forgotten that, at the moment, considerable development, expansion and improvement are being displayed by our steel-makers who are fully alive to the competition lying ahead. The electrical manufacturer would find it to be well worth his while to devote every attention to the problems incidental to the issue, and to spare no effort to provide the steel works with the precise equipment which it demands. Simplification and standardisation constitute the true solution to the issue, and the firm or firms which attack the questions to which attention has been drawn, in grim earnest, and in compliance with the peculiar and highly specialised requirements of the steel industry, will not fail to reap a rich reward. If this wail succeeds in consummating this end, which is the one the writer has in view, it will not have been voiced in vain.

An Electrically Heated Crucible for the Squirting of Metal.—A recent French patent taken out in the name of Mr. R. Huybrechts describes an apparatus for use in projecting melten metal through a narrow aperture by the pressure of pre-heated gas. It is of great importance that the gas used as the source of pressure should be warm before it comes in contact with the metal. This is accomplished by causing it to pass through an insulated chamber, warmed by the passage of an electric current, on its way to the point where pressure is applied.

The Electrician.

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Electricity in Steel Works.

There is probably no field in which there is greater variety and at the same time a greater number of difficult problems to be solved than in the electrical driving of steel works. The work is extremely heavy and it is of an exacting kind. Nevertheless, electrical applications in this field have made rapid progress. This is not so much on account of first cost, but rather through the advantages of easy control and great flexibility. It has been possible to do things electrically which were practically impossible by the older mechanical means of belts and shafting driven by steam plant.

It will be realised how severe is the service demanded when it is stated that mill motors have frequently to be reversed 10 to 15 times per minute and, notwithstanding this fact, that the powers exerted are often very considerable. It is essential, therefore, that the mill motor should be a very robust piece of machinery; and indeed this remark applies to steel works equipment generally, for anything in the shape of considerate handling is not to be expected. It may also be said that the work is equally arduous in charging machines, which have taken the place of so much labour in connection with furnaces, and on which operations are carried out with great rapidity. Considering the capital involved, it is essential that the steel works should be kept running without anything in the nature of a breakdown. Thus it is of prime importance that the electrical plant should be reliable. We fear that equipments that have been supplied have not in all cases filled this requirement. Indeed, in our present issue, in which we publish a number of articles on the equipment of iron and steel works, is a short contribution voicing the complaint of the steel works' electrical engineer, and this is briefly to the effect that British manufacturers have not always taken into consideration the exacting nature of the performance and the desirability for absolute reliability. We hope that this complaint will be duly noted and that there will be no need for its repetition in any future issue we may publish on this interesting subject.

One of the most rapid developments during the war in connection with steel works has been the adoption of electric furnaces much beyond what was expected in pre-war days. In this connection it must be remembered that war conditions were very special conditions, and it does not necessarily follow that the electric furnace in days of peace will fulfill the requirements so easily as was the case in the years of war. In another column we publish an article on this subject by Mr. J. W. Naylor, who has the advantage of writing with the knowledge of the practical user. We commend this article to all who are interested in this particular subject. It will be found that Mr. Naylor is distinctly uncertain whether the electric furnace will fulfill its expectations in the years to come. As always happens in such cases of competitive working, competitive methods of steel production are being improved, and any comparisons that are made should now be drawn between electric furnaces and the improved competitive methods.

Although the electric furnace is likely to maintain its position where special steels of a more or less expensive character are required, this will not be so easy along more ordinary lines. It is no doubt difficult to say exactly how far we may expect progress to be made. In the United States it will be remembered that steel rails (which are certainly not a special product) are produced electrically of a superior character by means of the electric furnace, and this was done before the war. Quality may thus account for preference if it is not too costly.

Whatever developments may arise it may certainly be said that high price of electrical energy in furnace working must be a handicap. During the last year or two the cost of electrical energy has risen heavily. According to Mr. Naylor's article, electrical energy at Sheffield for the smaller furnaces would cost about 1d. per kilowatt-hour. On the other hand, in Rotherham, which is close by, the cost per unit is stated to be 0·5d., and on the North-East Coast 0·3d. for similar service. We are not concerned particularly with the exactness of these figures. The important point to bear in mind is that if such applications are to continue it is essential that the cost of electrical energy should be low. Not merely has the cost of electric power risen, but that of other materials required in furnace working are also much more costly than before the war. On the question generally it may be said that the future of the electric furnace probably depends upon the elimination of certain difficulties and on improvement in design, and that in the working out of these problems the combined efforts of the furnace designer, the electrical engineer, the chemist and the steel maker are essential.

Reviews.

French Technical Words and Phrases. By John Topham. (London: E. Marlborough & Company.) Pp. 318. Price 5s. net.

The third edition of this booklet has been revised, and many new terms introduced. It contains both English-French and French-English sections, and the user will find in it many special and technical terms which would certainly not be found in the ordinary dictionary. In particular it will prove very useful to the engineer, scientist or technical man, while naturally it cannot be expected to contain a complete glossary for any particular industry. In the Appendix are a series of tables relating to money, weights and measures, numbers, sizes of paper, &c.

The Theoretical Principles of Wireless Telegraphy. 4th edition (London: "The Accountant.") Pp. 55. 1s. net.

We have received a copy of a publication under the above title by "I. R.," which purports to be issued by the "Whizz Publishing Company." We understand that it is a revision of a skit on the typical wireless text book, and was prepared by the author, while in the Royal Engineers. Four editions have been printed within a year. The humour has thus been well received, and some of the items, such as the hits at the presentation of simple and more complex formulæ, and the imitations of the somewhat obvious or unintelligible which alternate in some text books, are amusing. It may be because we are getting old, but some of the other jests (such as the confusion of "currant" and "current") struck us as rather threadbare; others would clearly only be fully appreciated by those who have been engaged in the wireless service. Some of the fake advertisements at the end, notably the mind-training notice of "The Brayne Wave Company, Ltd.," are ingenious.

Overhead Electric Cranes in Steelworks.

By JAMES SMITH, M.I.Mech.E.

Summary.—The author deals with the application of various types of crane in steelworks. These include overhead travelling cranes, lifting magnets, and various kinds of charging machines.

In view of the necessity for increased production and economy of labour, craneage and handling facilities in the steelworks are becoming more and more important, almost daily. The different types of crane adapted for this or that special service throughout the works constantly becomes more diverse, and the subject of this article must necessarily compress into a comparatively small space a description which covers a very wide range of apparatus.

The best way to get a comprehensive view of the various types of apparatus now comprised under the heading of cranes will be to divide our subject into two sections. One section dealing with ordinary cranes of the overhead pattern, and one section dealing with charging machines.

If we describe an overhead crane as being provided with the usual hoisting ropes loosely suspended, and carrying the hook or hooks; and a charging machine as a form of crane, but having no loose suspension (in other words, being rigid throughout), we shall have a definition which will serve for the classification of the two types in a general way. This possibly allows some overlapping, as for instance, in the case of certain stock-yard and guided ladle cranes, but it will serve as regards following the subject generally.

I. Overhead Electric Travelling Cranes.

The general features of electrically-driven overhead travellers are far too well-known to need a detailed description here, and we shall content ourselves with a general survey of the services for which these are required in steelworks, and the differences in design which have been made in order to meet each service.

Perhaps the greatest extension in the use of the electric overhead crane in steelworks of later years is due to the increasing use of electro magnets. For this service the overhead crane is particularly adapted, and cranes for this service may now be seen in almost all modern steelworks for the purpose of handling the scrap from the wagon and handling the pig and scrap iron into the charging boxes for feeding the open-hearth furnaces. These cranes generally work in the open yard; as scrap-yards are seldom roofed over. As a general rule, these magnet cranes fill the boxes standing on a projection of the open-hearth plant, from which position they can be reached by the charging bar and picked up so that the contents may be charged and the empty box replaced for filling again, with a minimum of handling.

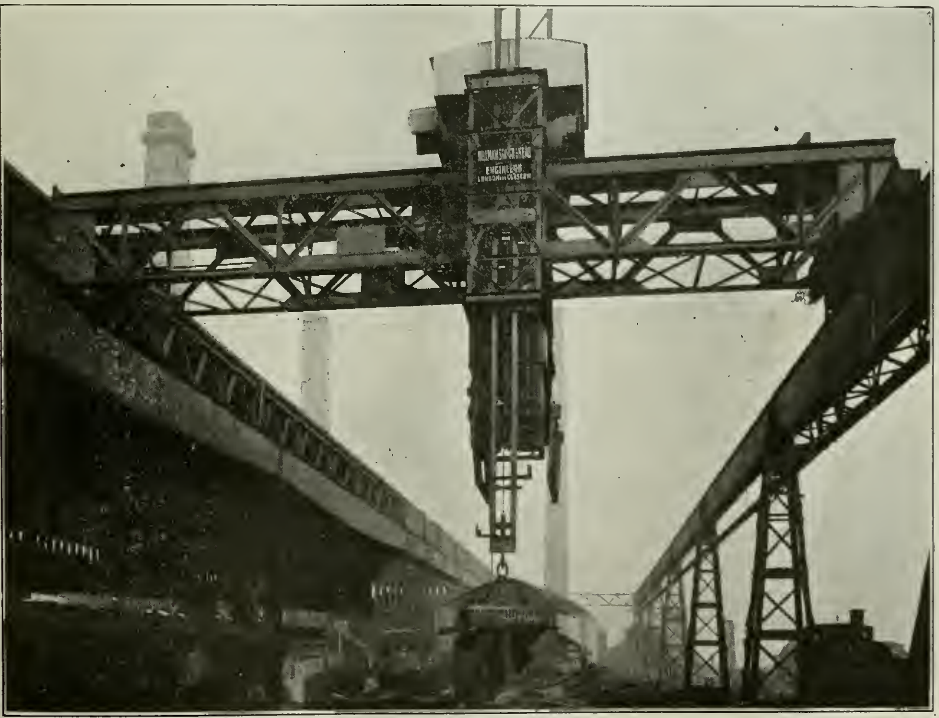


Fig. 1.—Special Guided Form of Scrap-handling and Charging Box Lifting Crane.

A form of magnet crane which, however, might be considered as a type of charging machine also, on account of the fact that the lift is guided, is shown in Fig. 1. This crane or machine is equipped with two independent hoists, each one guided and operated from the same trolley. Of these hoists, one is for handling the magnet itself and filling the charging boxes from the scrap and pig in the yard, and the other hoist is for the purpose of lifting the boxes three at a time from the ground level up on to the charging stage.

Several of these cranes have been built for modern stock yards, some of them with an arrangement by means of which the hoists can be run in between the chimneys of the open-hearth furnaces to load the boxes at the back of the platform. The best arrangement however, is to place all chimneys at the back of the stock yard, and have the charging boxes placed actually beneath the span of the crane itself.

Steelworks are usually laid out with the tracks of the various cranes running in parallel lines, but of recent years it has become the practice in several large American steelworks to have one track crossing all the others at a greater height, upon which a crane of suitable capacity is arranged, so that any of the other cranes may be brought beneath it for repairs. This is generally called a "Transept" crane, and with very little extra expense the buildings can be usually adapted for its accommodation. Of course, it is not so easy to make an arrangement of this kind in an existing works, but many of the new works can have the extension installed, and it will generally prove a great advantage.

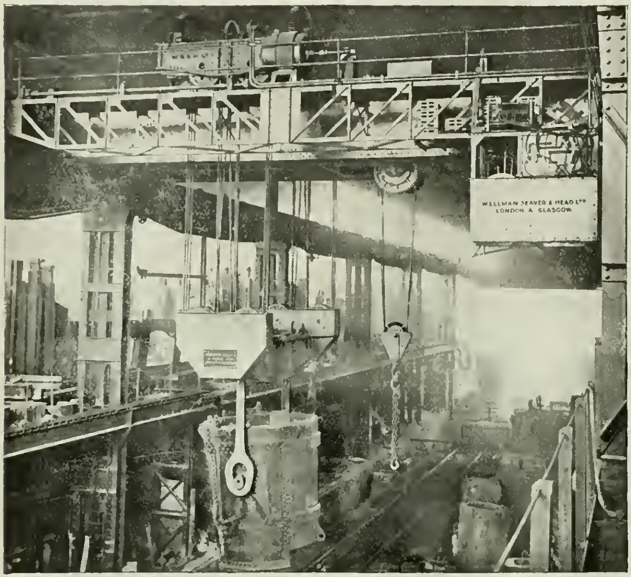


FIG. 2.—LADLE CRANE WITH INDEPENDENT AUXILIARY TROLLEY.

Not infrequently the open-hearth charging machine, if of the overhead pattern, is equipped with a loose suspension hoist or trolley at one end of the girders for carrying out repair work to the furnaces. This is a good arrangement, but special provision has to be made to see that the machinery of the trolley is well protected from the heat of the furnaces, because the trolley has to stand at one end of the girders, usually over the furnaces, and not being frequently used, it very often happens that the lubricating oil is dried up and the gear covered with dust by the time the hoist is put into use.

Passing to the next service, we come to the pit side. Here cranes of the loose-suspension type are required for various work, such as handling the ingot moulds in the casting pits, clearing away the slag, and sometimes for stripping the moulds from the ingots, although special machines for this service are recommended.

In the same bay is generally arranged the main casting crane, and when hot metal is charged into the furnaces it is usually charged from the tapping side by means of ladle cranes which pick up the incoming ladles with the molten iron, and serve the furnace by means of filling spouts attached to that side.

This practice of charging hot metal is now becoming very much more common where there are blast furnaces attached to the steelworks, and it is not always done from the tapping side, but occasionally from the platform or charging side, in which case it is usual to arrange the charging machines of the ground type, and have the ladle crane passing over them so that the two work independently.

In all cases of ladle cranes, the great point to be aimed at in the design is substantial construction and security from breakdown, so that the hot metal may be handled without danger to life, and the risk of having the cranes fail whilst the ladle is in the slings, in which case, of course, there would be a risk of the metal solidifying in the ladle and causing loss.

It must be borne in mind that cranes for this service, and indeed for general service throughout the steelworks, have to work practically night and day throughout the year, and that any failure may cause interruption to the working of the process of making steel and thereby considerable loss as well as interference with the uniformity of the output in quality. Accordingly every precaution has to be taken to ensure reliability in working, and also that any parts subject to wear shall have a reasonably long life and give ample indication of usage before needing actual replacement.

It is usual in all ladle cranes to arrange the ropes for the suspension of the ladle on the outside of the main girders, and to have these ropes reeved in separate series, so that if one rope gave out, the ladle would be held securely suspended until such time as it could be lowered away and another rope put on in place of the damaged one. Elaborate precautions are taken to secure this in practice, and they are so successful that one seldom hears of an accident due to the dropping of a ladle of molten metal.

Apart from the proportions of gearing and other elementary details which require extreme care in the design of such important cranes as ladle cranes, one of the principal features in design is that of the brakes for lowering the load.

A common system is to employ the "Weston" or load-

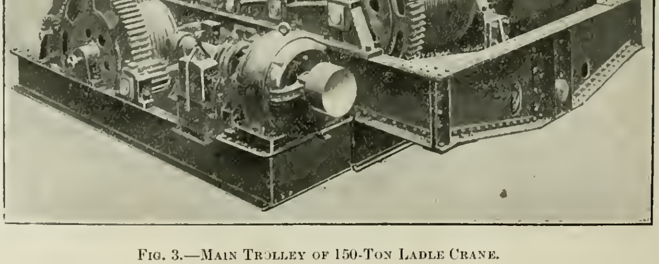


FIG. 3.—MAIN TROLLEY OF 150-TON LADLE CRANE.

brake on the second motion shaft, and a solenoid brake on the motor shaft. Recent developments however, tend to the employment of potentiometer control for lowering the load wherever direct current is installed. By means of this system, which is a development of the old dynamic system of braking, it is possible to get absolute security with a graduated speed of lowering unobtainable by other means.

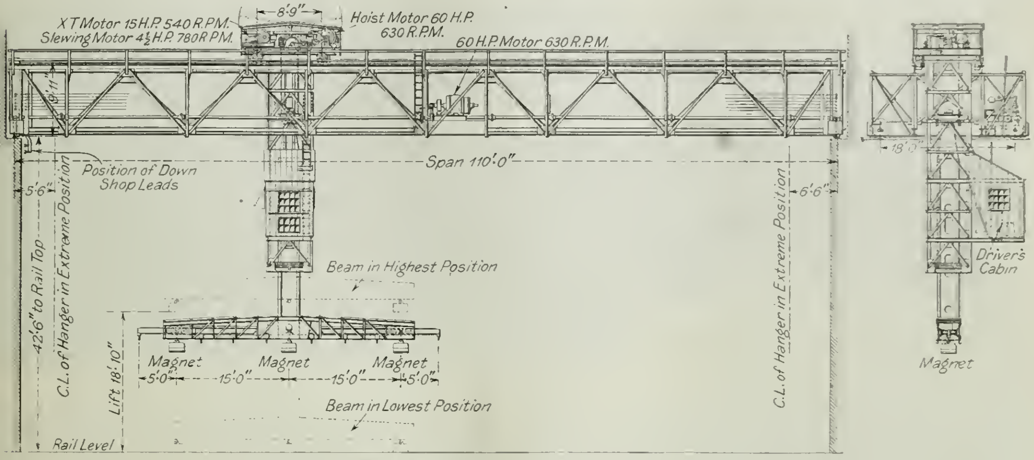


Fig. 4.—5-ton Bar Bank Magnet Crane with Guided Hoist and Slewing Motion.

Examples of a typical form of ladle crane and arrangement of trolley are shown in Figs. 2 and 3.

We should not leave this type without a description of a new feature which has been recently added. This consists of a safety shield in front of the driver. This shield is in the nature of a shutter which normally rests in a position below the operator's line of sight, and is supported by pulleys and balanced by weights, which are sufficiently heavy to raise the shutter quickly when necessary. The shutter is prevented from rising by a foot-pedal and bolt, which in the course of ordinary working secures the shutter in the lower position. Should an accident happen, as for instance, the splashing over of the contents of the ladle, the driver depresses his foot pedal, and the safety shutter immediately flies up into position to shield the operator from the sparks.

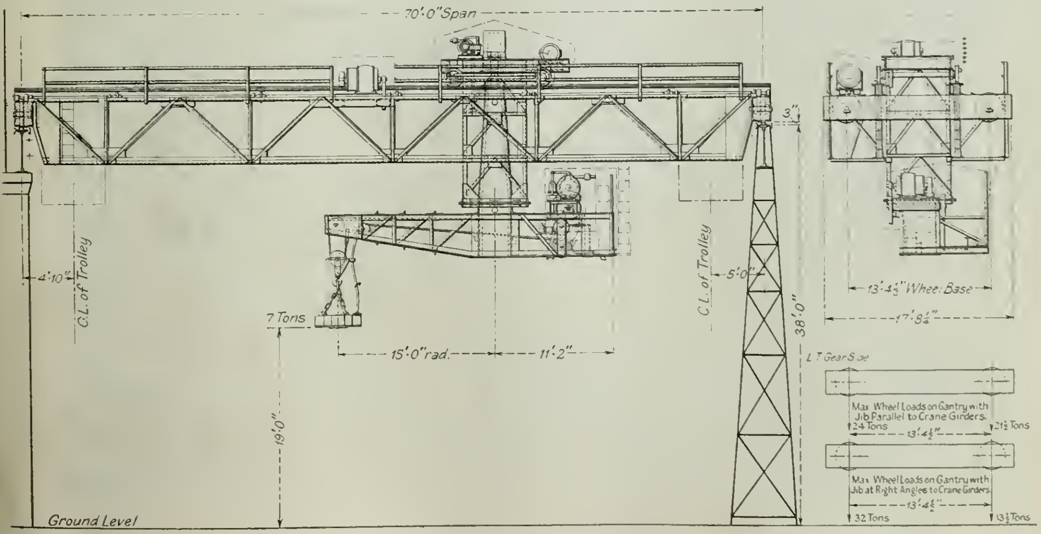


Fig. 5.—7-ton Electric Underhung Jib Crane Equipped with Lifting Magnet.

At the height at which the operator is situated there is generally plenty of time for him to bring the safety shutter into operation, and thereby exclude the hot metal from his cabin, which otherwise would splash in, possibly burning the operator and setting the cabin on fire or doing other damage to delicate mechanism.

We may pass over the ordinary form of overhead crane adapted for general utility service throughout the works, leaving till later some mention of the improvements which have been incorporated in overhead cranes as a rule, and pass now to the consideration of finished-product cranes. These may be in the nature of magnet cranes lifting the finished products into the trucks for operating over the bar bank, or they may be fitted with a lifting beam and engaging hooks for raising the hot material and placing it in a position for cooling. They are generally of long span and have more than a single suspension of hoisting ropes so as to engage opposite ends of a traverse beam upon which the magnets or engaging hooks are fixed.

It frequently happens that such cranes have to work in the open, in which case they are enclosed as regards the gear and operator's cabin. Cranes for this service are generally arranged to be fairly rapid in operation, so as to clear away the rolled material and avoid conjestion at the outgoing side of the mill. In certain instances these cranes depart from the principal of loose suspension and are fitted with rigid suspension, so that the finished products may be slewed round for loading into trucks at right angles to the position in which they leave the mill. An example of this kind is shown in Fig. 4.

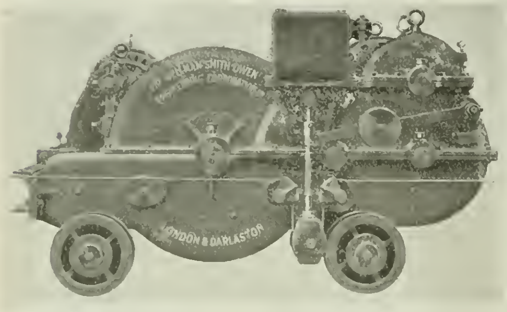


Fig. 6. New Form of Totally Enclosed Trolley for Overhead Crane.

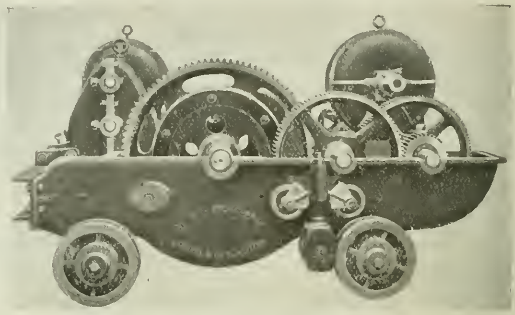


Fig. 7.—Enclosed Type Trolley with Covers removed from Hoisting Gear.

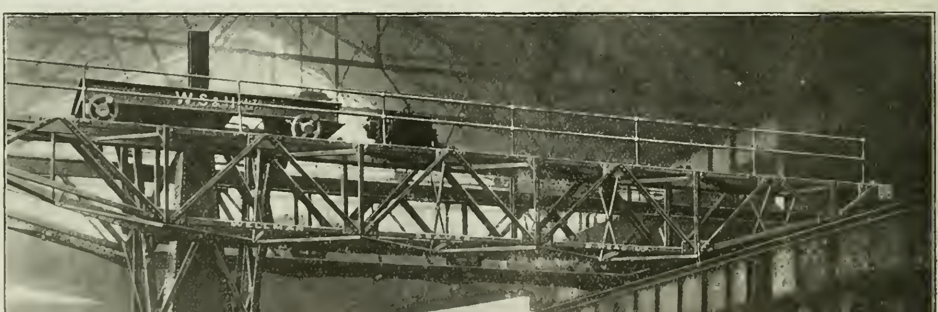


Fig. 8.—Overhead Slewing Type of Open Hearth Charging Machine.

Cranes for serving the mills sometimes depart very considerably from the ordinary form, because of the conditions to be met with in the mill buildings.

Quite recently cranes of 50 tons capacity and of spans up to 120 ft. have been designed and built for service over the mill, and are, perhaps, the heaviest long span cranes in existence in this country. The object, of course, is to serve the full width of the building along the whole length of same, and as such a building must necessarily be kept clear of columns to secure efficient working, it will be seen that nothing less in span could well be arranged.

Such cranes have to stand by for a variety of services. Not only must the rolls be changed from time to time at the mill, but occasionally one complete housing has to be lifted or a section of the roller track taken up in order to facilitate quick renewal and to keep the mill standing idle as little as possible consequent upon a breakdown or change in the work to be undertaken.

The old practice was to have a slow crane for occasional service only over the mill, but later practice is for the installation of higher speed cranes, which can take on any general service which may occur. Some steel makers consider the capital expense involved in the installation of high-speed and high-capacity overhead electric cranes over the mills to outweigh the advantages, but the reverse is proved to be the better policy, in these days of high output and reduction of labour costs.

Fig. 5 shows a type of crane which is becoming more popular in steelworks of recent years, owing to the fact that it can save changes in handling from one bay to another. This is known as the underhung jib type electric overhead travelling crane.

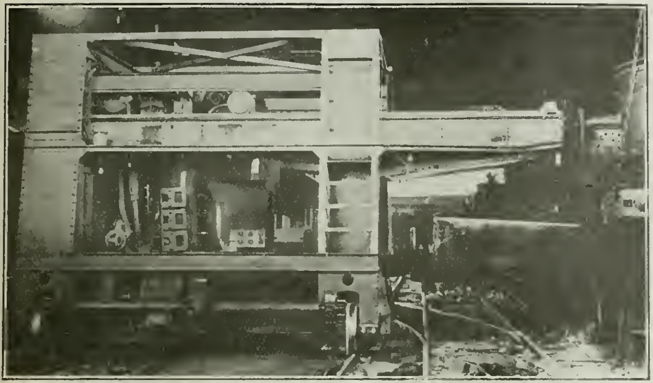


FIG. 9.—HIGH GROUND OR PLATFORM TYPE OPEN HEARTH CHARGING MACHINE. NON-SLEWING PATTERN.

We now come to the consideration of the more ordinary forms of electric overhead travelling cranes. Considerable improvement has recently been made in connection with the detail of these. Figs. 6 and 7 show a modern style of trolley, especially adapted for the lighter services, that is to say, from 2½ to 15-tons capacity. The special features are the total-enclosure of all gear, one side of the trolley forming a gear case within itself, provision being made from the outside for adjustment of brakes and other wearing parts. This enclosing of the train of gears along one side of the trolley permits of both wheel and pinion being arranged in pairs between bearings, so that there are no overhung wheels; and the bearings, being close together, can be bored through in one operation, thus ensuring perfect alignability from the start. This permits the design of the gear to follow along better practice, employing somewhat smaller pitches and wider faces, since a perfect contact along the whole of the pitch line of each pair of wheels can be ensured.

All materials are flexible. In the old design, with the shaft running right across the trolley, it was impossible to ensure a perfect line of contact between the wheel and pinion for all conditions of loading. If the gear was originally lined up true before the load was applied to the trolley, then when the full load was on, the relative position of the bearings would alter so that under full load conditions the teeth would probably be bearing harder on one corner than on the other.

For this reason engineers have, in the past, determined certain proportions between pitch and width of face which could not be departed from with security. In the new form of gearing, however, with bearings perfectly in line, any flexibility would be taken up by the gear case as a whole, so that both wheel and pinion would move together and without altering the contact along the pitch line.

The advantage of somewhat finer pitches and increased face width of tooth are apparent. The pressure per inch of pitch line is greatly reduced, providing a stronger gear and also a very much extended length of life, since the width of the gear determines the life of the same as well as the actual strength.

Overhead cranes, especially in steelworks, have invariably to work close under roof principals and in positions where all the dust accumulates and is shaken down into the gearing. It is therefore a very great advantage to have all the gears enclosed, apart altogether from the question of alignability of gearing.

Ample provision is made everywhere for inspection of the gears during work, and for removal of the enclosing covers whenever it is necessary to get out a pair of wheels for renewal.

These crane trolleys have been standardised especially for the arduous service met with in steelworks, and if all the advantages offered were fully appreciated to-day there is little doubt that no other form of crane gearing would be accepted by the up-to-date works.

With reference to the improvements recently effected in electrical equipment for overhead cranes, perhaps the most remarkable advance is in the direction of dynamic braking on the hoisting motor. On all the best cranes for work's service, the potentiometer form of braking, as it is called, is found. This consists of the arrangement of a diverter resistance, admitting a portion of line current in parallel with the armature when lowering, and thus avoiding the necessity of building up the field when lowering the load under gravity, and running the motor as a dynamo.

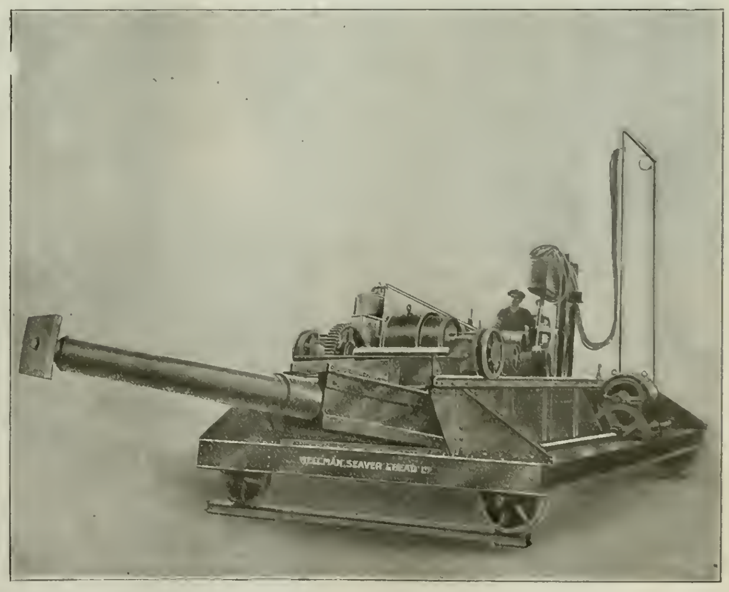


FIG. 10.—LOW GROUND OR PLATFORM TYPE OPEN HEARTH CHARGING MACHINE. NON-SLEWING PATTERN.

Other improvements are in connection with the fuse board.

It is more generally accepted practice now in steelworks service to do away with the ordinary knife switch and fuses, and install in place thereof a pair of contactor-breakers and interlocking connections for all controllers, so that it is impossible to reset the breakers whilst any of the controller handles are in the closed position. In the event of an overload, the contactor breaker comes out and remains out until all handles are brought to the "off" position, when it immediately resets itself.

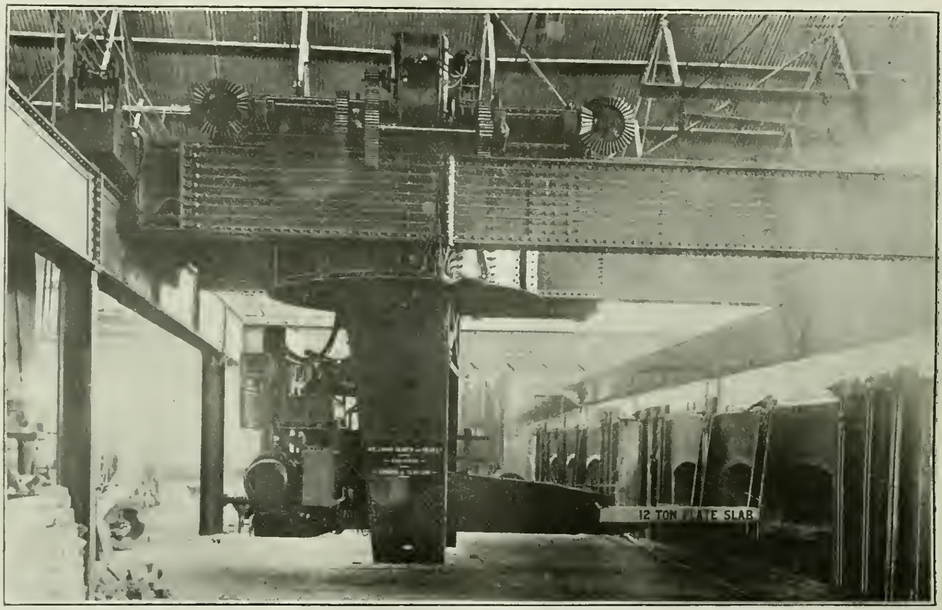


Fig. 11.—Overhead Slewing Charger for Horizontal Reheating Furnaces. Peel-Grip Pattern.

An additional security device is provided by a push button, which can bring out the breakers at any moment by completing a circuit operating the shunt coils. This safety switch is usually attached to the top of one of the controllers, so that the operator can put his finger upon it immediately in the case of accident or danger.

II. Charging Machinery.

It is only a few years ago that charging machines were adopted in steelworks, and the large number in use to-day marks one of the most considerable advances in steelworks practice.

Many years ago it was thought impossible to charge the open hearth and reheating furnaces, except by hand apparatus, whilst the soaking pits were served generally by ordinary electric overhead cranes, a man standing upon the ground to guide the dogs into the pit and fix them on the ingots.

To-day all this is changed. Due to the genius of an American engineer, Mr. S. T. Wellman, the problem of charging open-hearth furnaces mechanically was solved, and it very soon became apparent that the charging of the reheating furnaces was a comparatively simple matter. Accordingly a suitable type of charging machine for each particular kind of furnace was rapidly developed, and to-day it may be said that there are very few furnaces in which the charge cannot be efficiently handled by mechanical means.

There is, perhaps, no branch of industry in which mechanical handling is more welcomed by all parties, since the work devolving upon hand labour where machines are not in use is of the most arduous and exacting description, due to the heavy labour and the excessive heat in which the men have to work.

Taking first the case of the open-hearth furnaces, it is pretty generally known that the work of charging all cold material is done from a platform arranged slightly below the level of the

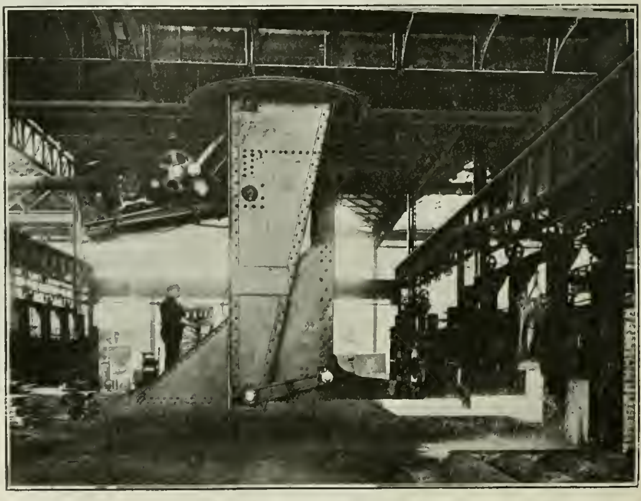


Fig. 12.—Overhead Slewing Type Reheating Furnace-Charging Machine with Horizontal Arm and Side Grips.

foreplate or bottom sill of the door of the furnace. Originally as the men approached the furnace with a piece of pig or scrap to be charged, this was placed upon a peel; the door was then raised, and the peel slid into the furnace and turned over to drop the piece of material into the hearth of the furnace.

The method to-day is as follows: By means of electromagnets described in the previous part of this article, the necessary material to be charged is put into a steel box, approximately 6 ft. long by 2 ft. wide. This steel box has a cast fitting at one end, suitable for engaging with the ram of the charging machine. When the boxes are filled with the necessary material required for the furnace, the function of the charging machine is to pick them up one at a time, introduce them into the furnace and turn them over in such a way as to distribute the material on the hearth in a convenient manner or melting. The machine then withdraws the steel box, setting it down in position for refilling.

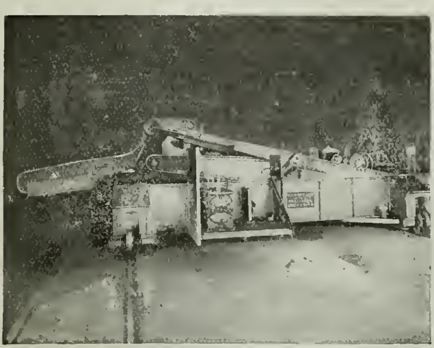


Fig. 13.—Ground or Platform Type Slab Charging Machine with End Grips.

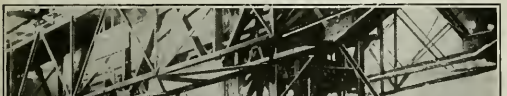


Fig. 14.—Vertical Ingot-Charging Machine for Serving the Soaking Pits.

A charging machine for this purpose may either be on the overhead principle, running on gantries similar to those for supporting an overhead crane, or it may be of the ground type, running on rails supported upon the platform itself. In either case the machines may be of the slewing pattern, capable of picking up the box at the rear of the platform and slewing it to the front for charging into the furnace, or they may be of the non-slewing pattern, in which case the boxes have to be brought up on bogies between the charging machine and the furnace itself.

An example of the overhead slewing form of charging machine is shown in Fig. 8.

An example of the platform or ground type machine is shown in Fig. 9.

It may be remarked, however, that Fig. 13. is of what is known as the high-ground type, which takes up less platform space.

A non-slewing machine of the low-ground type is shown in Fig. 10. This, whilst not so economical in width of platform cuts down the head room, so that where a hot-metal crane is used on the charging side of the furnace it is possible for the crane to pass more easily over the charger.

In all the open-hearth charging machines shown, the principle of elevating the bar and the box is the same, namely, by means of cranks and connecting rods attached to the rear end of the charging arm, so that the latter oscillates in its bearings and gives a sufficient lift to the head of the bar to raise one box clear of the next one on the bogie.

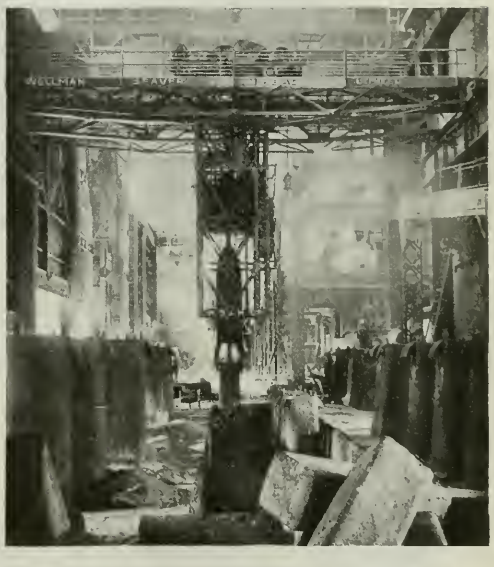


Fig. 15.—Combined Ingot Stripping and Charging Machine.

The bar is bored throughout its length for the locking rod which attaches the box to the charging arm, and the whole bar is rotatable about its own axis, so as to turn the box over in the furnace and empty the contents.

Coming now to other forms of charging machines, these may be divided generally into chargers for serving horizontal furnaces and vertical furnaces, or soaking pits. Examples of the horizontal form of charger are shown in Figs. 11 and 12.

These machines usually have motions of long travelling, cross traversing, hoist, slewing and gripping motions, all driven by separate motors.

Slab chargers for horizontal furnaces are not always of the overhead pattern, however, and Fig. 13 is an illustration of one running upon the platform or floor of the shop, similar to the ground type open-hearth charging machine. But, as a rule, it is better for machines of this type (that is, for serving reheating furnaces) to be arranged on overhead gantries where possible.

An important item in the design of these machines is the gripping gear. In fact, in all types of slab, bloom or billet charging machines, the gripping mechanism has to be most carefully proportioned, so as to be able to handle both cold and hot material without the slightest risk of the piece slipping out of the dogs. For this reason a very ingenious detail is fitted on the horizontal bars of charging machines, such as those shown above. The head of the bar is arranged separately from the fixed portion and turns upon a wrist pin, so that when the load is lifted there is a tendency for the head of the bar to rotate in the downward direction and put an additional pull into the tightening rod operating the dogs, this pull, of course, being in proportion to the weight of the piece lifted, and therefore automatically in proportion with the required pressure for holding the piece safely between the tongs.

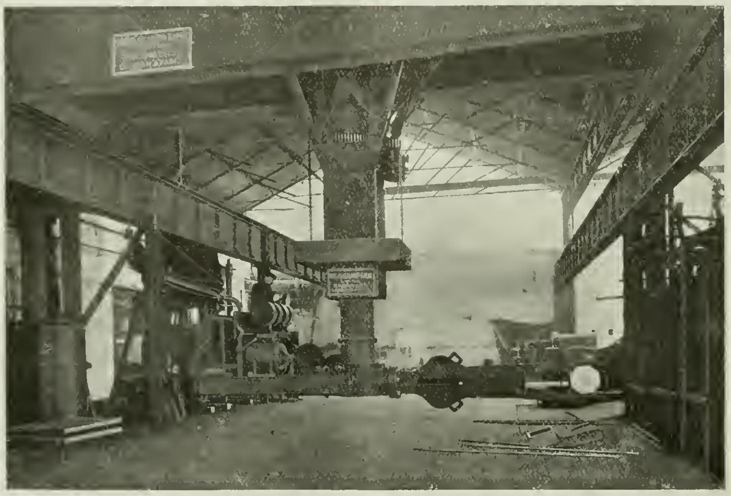


Fig. 16.—Special Charger and Manipulator for Wheel Blanks. Overhead Type.

A form of vertical charging machine, or ingot charger, for serving the soaking pits is shown in Fig. 14. Here it will be seen that a vertical mast, carrying dogs at its lower extremity, is arranged to slide and to turn within guides, so that the ingot may be lifted from the pit or furnace, slewed round and made to travel to its position in the mill chair.

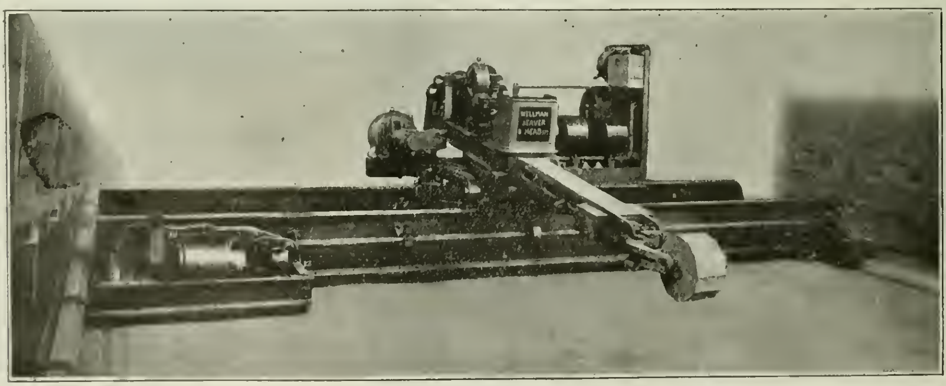


Fig. 17.—Wheel Blank Charger and Manipulator. Ground or Platform Type.

Some of these machines are fitted with a lid-lifting hoist, so arranged that when the machine is over the soaking pit, the lifting mechanism is in engagement with the lid of the pit, which is drawn upwards and slung to one side, and the tongs are vertically over the entrance of the furnace without further movement of the charging machine.

Another form of soaking pit charger is the combined machine, that is to say, combined with stripping gear, so that the machine is used for stripping the ingots from their moulds and afterwards taking them to the soaking pit. (*See* Fig. 15.) A machine of this kind is necessarily of a very heavy construction, since it is necessary to put a pressure of upwards of 100-tons on the head of most ingots in order to remove them from their moulds after the latter has been in operation for some time.

Other special forms of ingot chargers are illustrated in Figs. 16 and 17. Fig. 16 shows a special machine for manipulating wheel blanks. This machine has all the motions as on other reheating chargers, and in addition a rotating bar for placing the blanks under the press. Fig. 17 is a similar machine arranged to run on the ground.

The above description furnishes only a summary of the principle types of machines, of which there are many variations to suit particular circumstances. It is impossible to give space here for the mention and illustration of anything approaching the whole range of designs operating in our steelworks.

Electric Furnaces from a Steel Maker's Point of View.

By J. W. NAYLOR.

Summary.—In the present article a brief account is first given of the chief types of furnace at present in use. Consideration is then given to the lay-out, after which the author passes on to costs and various details which are of importance to the user. Certain lines of progress are indicated and attention is drawn to the competition of improved processes. It is considered that the best opening for the electric furnace, now that the special war conditions have passed away, is in the production of steel castings and light castings generally.

IN the course of the following remarks it is intended to touch shortly upon electric furnaces as a method of producing steel, and, after sketching out various types of furnaces and commenting on the advantages claimed either by their makers or users for each type of furnace or equipment, to follow on by notes as to the arrangement of the installation and points as to its "lay-out" for convenient and economical working. In conclusion, notes will be given on both estimated and actual running expenses and melting costs, the advantages gained by the process, and finally, the lines upon which further progress may be expected to be made.

The application of electricity to steel melting has been seriously considered only in recent years, because as a competitor with coal, coke and gas, it is expensive. When, however, it was realised that the necessary heat could be supplied in easily regulated quantities, free from gases contaminated with deleterious substances, thus rendering metallurgical operations possible which could not be performed by our older methods, and that not only could the melting of the crucible be duplicated but raw materials containing objectionable elements could be refined, and give a steel equal to the best quality known, then the use and development of the electric melting furnaces grew rapidly.

Up to the present, invention has only given us two methods of applying electric heat to the melting furnace:—

1. The generation of heat in the charge by means of induced currents in the induction furnace.
2. The application of the electric arc to the metallic charge.

Types of Furnaces.

There are six or seven well-known makes of furnace in operation in this country, viz.: the Héroult, Electro-Metals, Greaves-Etchells, Stobie, Rennerfelt, Snyder, Stassano, Kjellin, Chetwynd and Girod. Several more recent ones, however, are forecasted but not yet erected, as the Vom Baur, Sahlin and Booth-Hall, each having some features well worthy of attention. Of these installed, the largest number are Héroult, which was first in the field, claiming nearly twice the number of the next favourites, as shown by Table I.

Table I.—*Electric Steel Furnaces in the United Kingdom.*

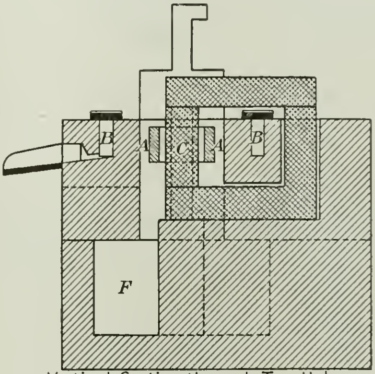
Make.	No. of furnaces	Total tons, sof.	Total k.v.a.	Nominal tons output per month.
Héroult	45	180½	43,220	13,760
Electro Metals	27	73	20,274	6,740
Greaves Etchells	26	64½	18,830	5,680
Rennerfelt	4	7	1,895	750
Snyder	6	9½	3,150	1,200
Special	2	2	750	280
Stassano	2	2	600	240
Stobie	5	45½	10,050	2,600
Total	117	384	98,769	31,250

The nominal output in tons per month is based on five days a week, four weeks a month, and the rated charging capacity of the furnace. The above figures are as given by Mr. R. G. Mercer, before the Iron and Steel Institute in May, 1919.

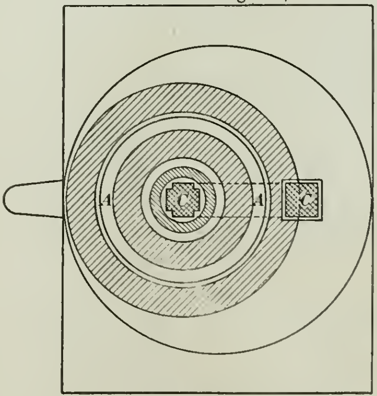
Of the total number of furnaces installed, over half are engaged in the production of ingots and the rest on steel castings. In this connection, and as might be judged, the size and tonnage for the former purpose considerably exceed the latter, whose average capacity is about 2½ tons, the former being 4 tons per furnace. From the electrical standpoint the kilovolt-ampere of the number of furnaces used for steel castings averages 700 and for ingots 950, but on a tonnage basis the figure is 285 as against 240, which shows that the kilovolt-ampere for furnaces used for castings is on the top side, as compared with those installed for ingot melting.

The electric furnaces working commercially at the present time may be divided into three classes:—

a. Induction.
b. Furnaces with a free burning arc.
c. Furnaces using the direct arc between metal and bath.



Vertical Section through Tap Hole.



Sectional Plan.

Fig. 1.—Diagram of Kjellin Furnace.

B = Annular ring or crucible for melting.
F = Air space for cooling primary coils A A.

The first-mentioned type *a*, is rarely used now except in Sweden where current is cheap, the Kjellin being the best known. Type *b* is represented by the Rennerfelt, and type *c* by the Héroult.

A short description of the three furnaces representing the three types is given below.

Kjellin.—This furnace (Fig. 1) was a most interesting proposition when first put on the market, owing to the melting conditions being as near as possible to those of the crucible furnace. The necessary heat required is produced by induced current, owing to the fact that the molten metal forms an annular ring, and is also the secondary circuit to a primary coil placed in the centre of the ring. It is owing to the metal being the secondary that the greatest disadvantage arises with this furnace, as it is necessary to hold in the annular crucible or hearth a third of the molten charge after each heat to allow of starting up again with a new charge. The advantage of this furnace is that there is no possibility of contaminating the steel by diffusion of gases through the walls of the crucible, as is the case in crucible melting. Steel of any required grade can be made in exactly the same way as the crucible process, *i.e.*, that the resultant ingots will be practically of the same composition as that charged.

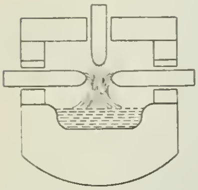


Fig. 2.—Diagram of Rennerfelt Furnace.

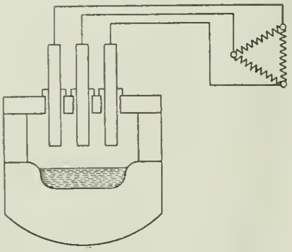


Fig. 3.—Diagram of Héroult 3-Phase Furnace showing Connections.

This furnace is based on the principle of the step-down transformer, used for reducing the voltage of high potential currents to low potentials suitable for electric lighting and other purposes.

The Rennerfelt, or free-burning arc furnace, is composed of a hearth or crucible with three small graphite electrodes suspended over the bath, two horizontal and one vertical, and the necessary heat is produced by a flame arc thrown on to the metal by the vertical electrode, this electrode having a greater diameter than the other two and also there is an excess of current, sufficient to force flame down on to the metal (Fig. 2).

In the 7 cwt. furnace which is used principally for re-melting steel making alloys, it requires only 75 k.v.a. of two-phase current, at 80 100 volts measured on the secondary side of the transformer.

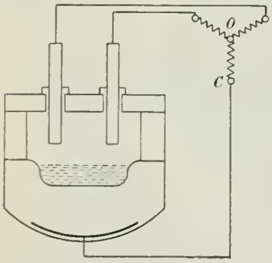


Fig. 4.—Diagram of Greaves-Etchells 3-Phase Furnace, showing Connections and Arrangement for Conducting Hearth.

The advantage of the Rennerfelt furnace is that owing to the flaming arc it is possible to burn in the hearth of the furnace by the flaming arcs without using coke or other medium to generate heat as in the arc-resistance furnaces of the Héroult type.

The Héroult Furnace.—The general type is a three-phase furnace consisting of a melting hearth made of basic material, with three electrodes suspended over the hearth connected to the outside terminals of three single-phase transformers (Fig. 3). The resistance between each pair of phases is equal to that of two arcs, so that the arrangement gives a balanced system. The advantages of this furnace is that it is easily controlled and the slag is maintained at a higher temperature than in the bottom electrode furnaces of the same type of arc resistance.

The Greaves-Etchells Furnace.—This furnace was designed in 1915 by two Sheffield engineers and has met with considerable success, both in Europe and America. The original object of the furnace was to overcome the superheat necessary to melt when heat is generated by electric arcs suspended over the metal, by means of a bottom electrode as well as by electrodes above the bath.

Some years ago Mr. H. Greaves, along with Mr. Etchells, discovered means which enabled three or two-phase current to be applied to a furnace with an unequal resistance in one of the phases, and still maintain a balanced load as regards power factor, and power on the primary phases. The connections of a three-phase furnace are shown in the sketch, and the length of the branch *OC* is varied according to resistance of furnace hearth.

The Electro Metals Furnace.—The furnace body in this case is of practically the same type as the Héroult and Greaves-Etchells, and, like the latter, in the smaller furnaces, it is provided with two electrodes suspended over the bath, and a conducting hearth; but it requires a two-phase current instead of three-phase, as in the Héroult and Greaves-Etchells.

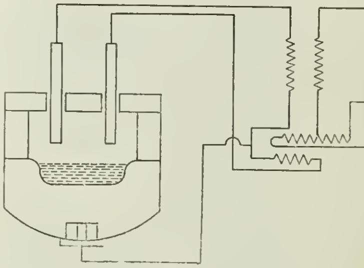


Fig. 5.—Electro-Metals Furnace, showing Electrical Connections for Using 2-phase Current and Arrangement for Transforming from 3-Phase.

The advantages claimed are that the generating plant and transmission are cheaper, and that the heat from the bottom stirs up the charge; also the arcs, not being in series but on separate phases, are independent of each other, and can therefore be regulated separately so that the control of current is more complete. Fig. 5 shows connections for a three-phase current and arrangement for transforming to two-phase.

Lay-Out.

In arranging the lay-out for electric furnaces the war has had a considerable influence in this respect both upon those erected for steel castings and for ingot steel making. In a few cases where new premises have been erected specially, a good deal of attention has been paid to ease of manipulation, and the shops are planned out on up-to-date lines; in other cases due regard has not been paid to these details, with the result that the furnace and its equipment have been placed in some odd corner or shop, cramped both for room itself and cramping any other operations in that shop or building, which adds to the cost in various ways and seriously impedes output and supervision. It is a distinct advantage to have an electric furnace in a Siemens or Bessemer department, taking the molten metal from these furnaces for refining, thus saving re-melting. By so doing, an exceedingly pure product is obtained at a small cost.

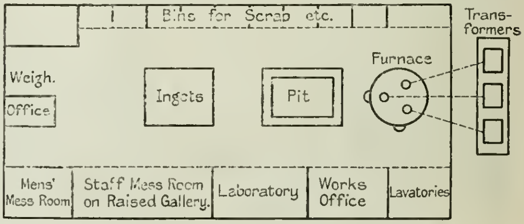


Fig. 6.—Lay-Out for Electric Furnaces.

With a good square or oblong piece of land or shop, the lay out could with advantage take somewhat the form shown in Fig. 6.

A deep two-stepped pit of ample proportions and depth is another essential. If pouring is by the Trumpet method the bottom plate should be of such a size as to allow sufficient room to get comfortably all round it.

The usual practice is to top-pour ingots direct from the ladle through the nozzle, or by means of a tun dish, and in this connection there is a difference of opinion as to the advantages of the use of an overhead crane as a casting medium or the use of rails over the pit with the ladle running on a bogie from the spout of the furnace. The latter has one distinct advantage in that there is no swing, as is the case with the crane.

An overhead crane, however, is essential. It should have such a radius that it can pick up the transformers, as well as the ladle from the heating-up stove or stand, the furnace roof, electrodes, ingots and ingot moulds.

Most furnaces are built of the tilting type on rockers, and rolled by means of a small motor independently of the heat-generating plant. As to cable connections from the transformers, these should be as short as can possibly be arranged, only allowing sufficient slack to accommodate the tilt of the furnace, and placed well out of the reach of men melting.

As to the transformers, it may be said that electric furnaces are still in their infancy, and that installations have been fostered by the urgency of increased production during the past five years. One of the early faults not at first realised was the limited capacity of the transformers supplied with the various furnaces. Steel makers are not electrical experts and have had to gain, and in most cases to pay for obtaining, their experience of what they require. Furnace designers have now come to the conclusion that the capacity of the transformers should be considerably increased, and in one particular case which came before the writer's notice, the 650 k.v.a. transformers originally supplied for a 3-ton furnace were replaced later with transformers of 900 k.v.a. capacity. This alteration cut down the time required for each melt by nearly 50 per cent. and also slightly reduced the current used, the natural consequence being a considerable reduction in the cost per ton of steel and in the cost of repairs.

Further, accommodation must be provided for the storage of electrodes, stoppers, nozzles for the ladle, raw materials (scrap, &c.), and refractories, spare transformers and parts of furnace, such as doors, door frames, electrode holders and general stores.

A laboratory and office should be provided, possibly the best position for both is on a balcony, away from the furnace and transformers, but so constructed that the chemist and metallurgist can have an uninterrupted view of the shop and of the furnace in particular.

Costs.

For a small ½-ton furnace, particulars of which I have before me, the makers in their estimate of cost (certainly three years ago) for wages, upkeep and repairs, power, moulds and depreciation state that the total cost should not exceed £6. 7s. 6d. per ton. But at the present time the cost works out at £10 per ton for furnaces from 10 cwt. to 30 cwt.

Owing however, to the continued upward move in the costs of current, labour and refractories, it is almost impossible to give more than a bare outline of the total present costs which, of course, again vary according to the different classes of steel produced.

In ingot melting, electric furnaces have given the results shown in Table II.

Table II.—*Results Obtained with Electric Furnaces.*

Sizes.	½ ton.	1½ ton.	3 ton.	6 ton.	7 ton.	10 ton.
Hours per heat	2½	4	5½	9	9	7½
Time per ton	4	3⅓	1¾	1¼	1	1
Tons per heat	½	1¼	2¾	8	8½	9
Heats per day (12 hours) ...	3	3	2 to 3	2 to 3	2	2
Tons per month	40	110	225	430	400	500

In specific cases, and for periods, the results obtained may be better or worse than the above, but there is no doubt that many firms are consistently obtaining more economical workings and better outputs than are shown by this average. Delays enter very much into the results of every furnace. It is somewhat surprising to look over one's own log book and to note how these mount up in the total each month. In some months, little may occur to vary the smooth working, and yet a shift is lost here and another there, first for delay in material and then for melting or furnace repair, so that a fair average of heats lost might be taken at 8 to 10 per week. Costs of running are dependent on, firstly, a proper and economical lay out, knowledge of the uses and abuses of the furnace and whether it is under or overpowered from an electrical standpoint; and secondly, on the furnace body construction itself and on proper attention being paid to the upkeep of same and to the maintenance of auxiliary parts in good order, and to special requirements as to the linings for melting.

General.—As in most other cases of plant, both general and special overhaul is needed. In the transformer house special attention should be paid to the free passage of air and ventilation, and if needed this should be supplemented by the introduction of an exhaust fan to keep the transformers cool. The switchgear should be thoroughly cleaned out, as the heavy duty performed in breaking the full load current rapidly carbonises the oil, which, collecting on the porcelain insulators inside the switch, together with small particles of copper blown off the contacts, may and do form a film of sufficient thickness to break down the insulation, damaging the switch itself: this may shut down the furnace for repair and probably cause damage to other installations connected to the same mains.

Continuous Working.

To obtain the maximum output of a furnace and the lowest basis of cost, it is very necessary that the furnace should be worked night and day, after once having been lit up, as current or other heat to bring a furnace up from cold is really so much waste, adding to the cost of the output, to say nothing of wages paid whilst warming up.

This latter item is now more vital than formerly, for if a day shift only is worked, and taking an average heat of 2½ hours for a ½ ton furnace, only two heats a day or shift will be obtained; whereas if two or three shifts were working, each shift would, in the absence of other trouble, get three heats each, and as wages are based in most cases on tonnage with a minimum wage, with a 47-hour week it will readily be seen how the expense will increase per ton of output by such loss of one heat a day. In other words, one shift a day would give 12 heats per week, whereas three shifts would give an average per shift of 18 per week, or 50 per cent. more at the same cost in wages; less cost in current, the same standing charges and a less cost of linings, seeing that they suffer less from variations of heat. In the case of a larger furnace, say, 3 tons, this effect is aggravated, and in the case of the still larger furnaces, taking up to nine hours per heat, it is imperatively necessary that continuous working should be carried on.

Delays.

The chief cause of delay through breakdowns is usually to be found in the tilting gear, the electrode feed gear, apart from occasional switch trouble, which has previously been referred to, and transformer trouble which was very frequent up to quite recent months. There is no doubt that the mains supplying current to electric furnaces were very severely tested and worked up to and beyond their full load capacity, and when this was first found to be the case, to switch off a few electric furnaces was quite an easy method of relieving the strain on the mains. Fortunately, the engineers in charge realised the loss of output and extra cost entailed by the adoption of this method, so that this practice was considerably altered, and the thanks of steel makers are due to these gentlemen for the consideration thus given As the bulk of the electric furnaces erected, at any rate in Sheffield, are now standing idle and probably not likely to be worked to anything like the same extent in the immediate future, overloading of the supply mains need not be again anticipated. The electrode feed gear, complicated by water coolers, of which few are satisfactory, has been a most prolific cause of trouble. Badly made electrodes, particularly those of amorphous carbon, which are big and heavy, needed better and stronger gear than was supplied, and it was no unusual occurrence for carbon in large lumps to be dropped into the molten metal and, being unnoticed, caused the whole melt to be spoilt. On the newer types of furnaces this difficulty is being rapidly got over by the re-designing of the gear, by giving a better lift, and more attention to the holding bands and general strength.

WATER COOLED ELECTRODE HOLDERS.

These should not really be necessary. They are a poor substitute for a remedy at the best. Quite a number have been designed, both simple and elaborate, adding more complications and, further, these are on a portion (the roof) which has already plenty of impediments. In only a few cases, and that only for a time, do they answer at all. Moreover, water only adds another element of danger.

The fact that the electrodes burn away mostly at and above the point of contact with the air seems to be generally accepted. The usual method is to have a water-cooled ring fitting closely round the electrode and lying on the roof of the furnace ; this to some extent keeps the electrode from being burnt. An economiser, which is probably the most efficacious means, is a cylinder built up to a height of about 18 in. above the furnace roof, having the electrode running through it. At the top, it is a good fit round the electrode where ordinarily there is no burning. With well-packed ports in the furnace, little draught is created : the good fit of the cylinder round the electrode creates a damping effect upon the flames, preventing them from coming through the furnace roof, and therefore they do not burn away the electrode between the roof and the cylinder top.

As the flames do not escape between the sides of the electrode and the furnace roof, more heat is consequently retained in the furnace and the melting is accelerated.

LINES OF PROGRESS.

Such improvements have taken place, of recent date, in melting by the Siemens-Martin process, both in the way of reduction of costs and also in quality of the output, that the operations of the electric furnace would seem to be relegated to the production of special steels of a high selling value, as the electric furnace could not possibly be a serious competitor, either in price or output, of the Siemens Martin process for the cheaper classes of steel.

The charge for electric current for furnaces in Sheffield is at the rate of 0·6d. per kilowatt-hour for the highest consumptions of electricity, and this now has pluses amounting to 60 per cent. thereon. On a small furnace it is hardly possible to use the minimum supply of current so as to obtain the lowest rate, and I should say, taking other things into consideration, that a 2-ton furnace is the smallest by which this minimum could be comfortably reached. At this rate the current would cost 1d. per kilowatt-hour, and although it may be granted that costs have also risen with other processes, yet it is generally accepted that this cost of current is prohibitive to the expansion of the use of electric furnaces. In Rotherham the cost per unit is 0·5d., and on the North East Coast the charge is 0·3d. per unit. In Scotland the writer has been informed that the cost per unit is considerably less than that figure, but in this case we believe water-power is used for the generation of the current.

Graphite electrodes formerly costing 6d per lb., are now in the neighbourhood of 1s. 3d., or more than double the original figure. In one specification I have before me electrodes work out at 2s. per ton of output for refining only, used in conjunction with a Siemens furnace, but 7s. 6d. per ton is about the lowest price for melting from cold scrap which can be heard of. Most of the estimates of the furnace designers are, however, not borne out in practice, inasmuch as for a ½-ton furnace the consumption is in the neighbourhood of 25 lb. to 30 lb. per ton of steel in the ladle.

Refractories have also increased in price very considerably, and it is an open question as to what advantages an electric furnace can show, as a general proposition, other than for the production of special tool steels as already mentioned.

As previously stated, the war gave a great impetus to steel production, and although cost was one factor, yet output was more important. The Basic and Acid Siemens furnaces could not be duplicated without considerable outlay ; moreover, a considerable time must intervene between the beginning of building and the moment when an output is obtainable, and even if erected, the steels which such furnaces ordinarily produce were as urgently needed as the more special steels. The electric furnace obtained its chance because it was able to be easily erected and to supplement quickly the smaller output of the crucible furnaces which up to that time had produced these steels.

The Siemens furnaces in the meantime have not been at a standstill, and improvements have been made there also, so it now becomes a question of the survival of the fittest. The deciding factors are quality and price. That the electric furnace can not compete with the Siemens as to price, at present there can be no question. The purposes for which the cheaper steel is required are just as well met by one as the other, even if it is taken for granted that electric steel is of a purer quality.

There is no doubt that for some few steels the electric process does give better results than either Siemens or crucible, but the tonnage required will not keep many of them going, and the Siemens process is steadily invading the production of steels which at one time were looked upon as the proper function of the electric furnace, viz., alloy steels for automobile and aircraft work.

By some it is claimed that electric steel is superior for high speed and the best carbon tool steel, compared with that produced by the crucible process. Each process has strong supporters, even in Sheffield, the home of tool steel ; but when it comes to practice, I wonder how many of the electric furnace supporters would pin their reputation to that steel against the steel produced by the old crucible furnace. Not many, I think.

It may seem a black future I have painted, but it is in the hands of designers and melters to solve the problems of that future.

Steel Castings.—For steel castings there is, I believe, a good future for these furnaces. Floor space, annealing, core drying, and various other factors have to be taken into account in this connection ; also the handy sizes and varieties of furnaces obtainable. These considerations lend support to this view when taken in conjunction with the generally admitted fact that purer alloy steels can be obtained ; and the ability to eliminate sulphur and phosphorus from the steel, and so ensure a good casting, further adds to the value of the electric furnace as a melting medium. At present, and especially for the motor trade, good castings are badly wanted. One firm I know have, during the last three months, had to reject 50 to 60 per cent. of those delivered to them on account of defects. It seems to me that, subject to being able to keep costs down to a minimum so as to compete with Tropenas and Siemens furnaces on this point, castings offer the brightest outlook for the electric furnace.

For ordinary melting from cold scrap the day of small furnaces is past. Ten tons will in a short space of time be looked upon as small, and possibly an uneconomical, furnace. When it is considered that in present-day furnaces the ratio of weight of body to capacity is 6 to 1 in the case of small furnaces and is 3 to 1 in the case of larger furnaces, a considerable amount of the heat is necessarily used in keeping the furnace and lining hot, and if in the near future the present 3 to 1 ratio in the larger furnaces is further reduced then that will in itself tend to reduce the cost of operation.

In design the ideal has not been attained as yet by any means. With this question the subject of refractories is closely allied. That linings will not last for ever is only natural, as the conditions are severe ; but if greater durability is to be secured this can only be attained by experimenting with new refractories, such as zirconia, &c.

The Hearth.—The melting hearths are of two main kinds, basic and acid, the latter not, however, having been much used for furnaces with bottom connections, though we have lately heard of experiments in this direction by the makers of the Booth-Hall furnaces which have, it is said, been successful. In building a basic hearth the first brickwork, next to the frame, is commenced with magnesite bricks, and it should be continued to a height which is considered safely above the slag line. Over that a mixture of two-thirds dolomite and one-third magnesite, heated to a good heat, so that it will mix thoroughly with hot tar, rammed solid with hot rammers to form the shape desired; or it can be built up gradually by additions of dolomite and "fluxing on" in the same way as building up the basic Siemens hearth. Research and experiment will, no doubt, in time evolve a much more durable heat resisting lining with less weight and thickness than is necessary at present.

In recent designs of electric furnaces considerable improvements have been introduced to prevent heat losses through badly designed doors, roof, &c., but even now there is considerable room for improvement. Apart from good design, careful management can save many units of current by excluding the entrance of cold air and the egress of flames through doors and badly fitting parts, due to refractories melting away, &c.

That a furnace will melt steel is one thing; that it shall melt it properly, quickly and at the least cost should be the aim of the furnace designers.

Economies.—Current is the heaviest item in the cost of melting. For some years to come the present charges are not likely to come lower; whether they eventually do so, under a unified system of generation and distribution, one can only speculate; but the possibility is that in time they will, given a businesslike, and not an officially stunted, atmosphere for the present proposed scheme. The various power companies are at present able to give a cheaper service than any Corporation or other body. Some of the reasons are obvious, and to business men generally the fear is that under any scheme of unification of control, these reasons may be greatly magnified.

The arguments for such control are based on research and economies, which seem very plausible and worth giving a trial, but most people pause in their unqualified acceptance of the whole scheme, as, whatever the result, once such a control comes into existence it remains, and so either helps or hampers industry.

The primary endeavour should, therefore, be to economise in current by

(1) Steady load on primary phases.

(2) Full load on transformers should be obtained without drop in power on increase of current.

(3) Better distribution of overload through surges when the electrodes are brought into contact with the charge in melting down (overloads momentarily of 50 to 75 per cent. may occur).

In comparing the kilovolt-ampere it is interesting to note that the average for ½-ton furnace is 250

1½ ,, ,, ,, 450
2 ,, ,, ,, 600
3 ,, ,, ,, 750; several are 850
5 ,, ,, ,, 800
6 ,, ,, ,, 1,200; one is 1,800
7 ,, ,, ,, 1,200 or 1,500 or 1,800

The other factors, from an electrical point of view, apart from the supply and cost of current, which need attention are the transformers, both as to capacity and workmanship, their connections and application of the energy to the metal.

That transformer capacity has been insufficient is, I think, now generally recognised, but from being under-powered one could go to the other extreme and even then not get the best all-round result. Whilst heats may be able to be turned out more quickly, yet as the current factor is so high in the cost it might not be so economical as a more medium power unit would give. Generally, the steel maker buys a furnace, designed by the makers thereof, as a standard furnace of so many cwts. capacity, but except for the data supplied by the builders, he has little other reliable information upon which to judge for himself. Reliable comparisons of results of output, class of steel melted, costs of various items, times of heats, costs per ton, units per ton, electrode consumption, and delays have been mostly conspicuous by their non-publication except as averages summarised by the Ministry. Those who care to inquire of users must be struck by the great inequality in the working output and costs of different work using approximately the same size and type of furnace, and if some statistics were available of a number of each make of furnace of similar capacities the results would, I think, be very surprising, and would confer a considerably benefit on both steel makers and furnace designers by emphasising weak spots for general rectification.

Labour takes second place in the scale of costs, about which one can say very little. Wages are the same for good or indifferent men, so be satisfied only in obtaining the best and most experienced men available. The cost of electrodes follows labour very closely. The two types are graphite and amorphous carbon. Each have their merits and demerits. Amorphous carbon is less costly, more cumbersome to handle, necessitating heavier lifting gear and holders, has a much lower conductivity and, therefore, must be larger than graphite in diameter, having thus a larger radiating surface with consequent loss of energy. The quality is often jumpy and not consistent; one lot may be quite good and the next much inferior.

Graphite, as before mentioned, has jumped up in price considerably and to such an extent that it may well now be questionable whether in the long run it is the more efficient on a cost basis. If graphite is used of only sufficient size to carry the current, then one gets a very small heating area for melting, and consequently, in small furnaces, increased liability to breakages due to the smaller diameter. To overcome this, in practice it is better to use such electrodes of greater thickness, say, 5 in. instead of 4 in. and so on, for the advantage gained by fewer breakages and by reduction in melting time soon covers the extra weight of electrode used.

Few comparisons are available, and those we have show such an amazing latitude that without considerable explanation these can form no reliable standard, although such standard is very necessary. Such records as are now available show that the consumption varies from 6½ lb. of graphite electrode per ton on a 5-ton furnace to 47 lb. on a ½-ton furnace, and as low as 13 lb. on others, ranging then as high as 17 lb., 25 lb. and 37 lb. per ton.

General Conclusions.

The following conclusions may be drawn :—

1. That electric furnaces served their purpose during the war by increasing the output of special steels for automobile and aircraft work, which was of vital importance, but are now being superseded by the Siemens, owing to competition, except for steels of superior quality and for which a better price can be obtained.

2. When steel of high-class quality is required, such as can only be made from carefully selected and high-priced materials, under favourable conditions the electric furnace could compete with the open hearth, especially so if the molten metal is taken from the Bessemer converter or Siemens and refined in the electric furnace.

3. Steel castings for the motor trade, and light castings generally, are a proposition in which electric steel is the most suitable material, and these offer the most favourable proposition for this new branch of the steel industry.

4. If the electric furnace ever becomes a serious competitor of the Siemens, &c., processes, this will no doubt be brought about by the joint efforts of the furnace designer, electrician, chemist and steel maker, all of whom must contribute their quota in the direction of further economy and efficiency.

In conclusion, I should like to thank my co-director, Mr. Widdowson, of the Apex Steel Company, for his generous criticisms and assistance and particularly for supplying the sketches of the different types of furnaces.

The Future of the Electrical Equipment of Small Reversing Mills.

By L. ROTHERA, B.Sc., A.M.I.C.E., Member I. and S. Inst.

MUCH attention has been paid in recent years to the driving of large reversing mills by means of reversing motors working in conjunction with flywheel equalisers on the Ilgner principle, and over 20 such equipments, with powers at the mill ranging from 6,000 H.P. to 20,000 H.P. have been supplied, or are under construction at the present time in this country. The mills so driven have rolls varying from 28 in. to 40 in. diameter, and the ingots or slabs with which they deal range from 16 cwt. to 7 tons, the products comprising tin bars, sections, slabs and plates. As in these mills steel is the material which has to be rolled, it follows that motors of large power are employed.

The impressive size of these large equipments has tended somewhat to obscure a similar but equally important movement which is taking place in the metal trades, where an identical form of drive has been employed for dealing with sheets and plates of brass, copper, nickel and lead. For such work reversing motors of much smaller power than those required for steel rolling are sufficient. These range from about 200 H.P. to 1,200 H.P., which, in conjunction with the slow speed of the mills frequently employed, has generally resulted in a gear reduction being inserted between the reversing motor and the mill, in contradistinction to the practice in large mill drives, where in almost every instance the motor is direct coupled to the pinion shaft.

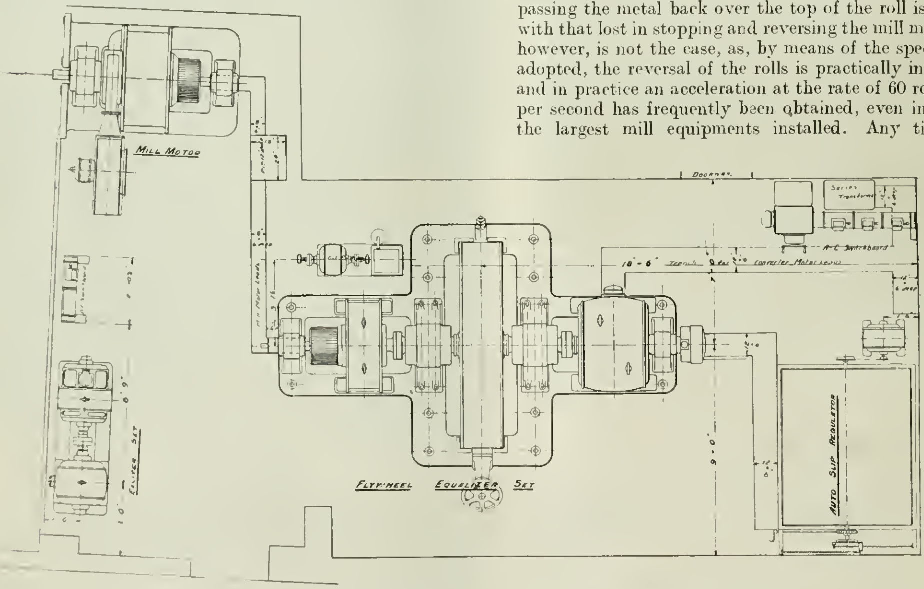


Fig. 1.—General Arrangement of Converter House and Rolling Mill Motor.

For breaking down and finishing brass and copper plates it has been usual to employ a "two-high" continuous-running mill, where the material, after passing through the rolls, is lifted and pulled back over the top roll, preparatory to the next pass taking place. The time taken in passing the metal back in this manner generally exceeds that occupied while the metal is actually in the rolls. Thus, the time necessary for the rolling process is more than doubled, and the output of the mill is but one-half that of which it is capable if it is worked reversing. Moreover, anything which extends the period of rolling entails a large heat loss due to radiation and conduction. This renders it difficult to finish the work at a desirable rolling temperature, and, incidentally, increases the power necessary to roll the plate. The physical effort required to lift the material at the back side of the rolls necessitates the employment of additional men in the case of slabs of considerable size.

By the employment of the reversing motor the time lost in passing the metal back over the top roll becomes available for rolling, with the result that the output is increased and a much higher average temperature of rolling is attained. The number of operators can also be reduced, as no lifting of the material is required. It may be argued that the time lost in passing the metal back over the top of the roll is comparable with that lost in stopping and reversing the mill motor. Such, however, is not the case, as, by means of the special methods adopted, the reversal of the rolls is practically instantaneous, and in practice an acceleration at the rate of 60 revs. per min. per second has frequently been obtained, even in the case of the largest mill equipments installed. Any time lost by entering the metal slowly into the rolls is counterbalanced by the power of speeding up the mill to any desired value during the pass. This speed in many instances is in excess of the normal speed of continuous-running mills, which speed is fixed to some extent by the necessity of limiting the shock on the rolls and housings when entering the slab or plate. A number of these small equipments have been supplied for mills with rolls varying in size from 18 in. to 28 in. diameter, the weight of the slabs rolled ranging from 150 lb. to 2,400 lb.

With small machines, such as are required for this class of work, a very compact arrangement of the plant is possible, and Fig. 1 shows the lay-out adopted in one instance to make use of the space available. In this installation it was found convenient that the flywheel set be placed adjacent to the mill motor; but there is no objection to the flywheel set being erected in any convenient sub-station away from the mill, the only effect of this being to lengthen the connecting leads between the flywheel set and the mill motor. It is quite permissible to drive a number of reversing motors from one flywheel set if so desired, each mill motor requiring its own generator coupled to the former.

The lay-out, Fig. 1, shows a reversing motor with a maximum of 630 h.p. at a speed variable between ±500 revs. per min. Power is supplied from a flywheel equaliser set, the driving motor of which is rated for a continuous output of 170 h.p. running at 750 revs. per min., and working in conjunction with a flywheel weighing 11 tons and 8½ ft. in diameter, the generator of the set being of suitable capacity for supplying the mill motor. The whole of the plant is contained in one building. The shaft of the mill motor passes through the wall, and is coupled to a double helical 10 : 1 totally enclosed reduction gear, the spur wheel of which is connected to the bottom pinion of the mill. The mill itself consists of one stand of rolls, 22 in. diameter by 5 ft. long.

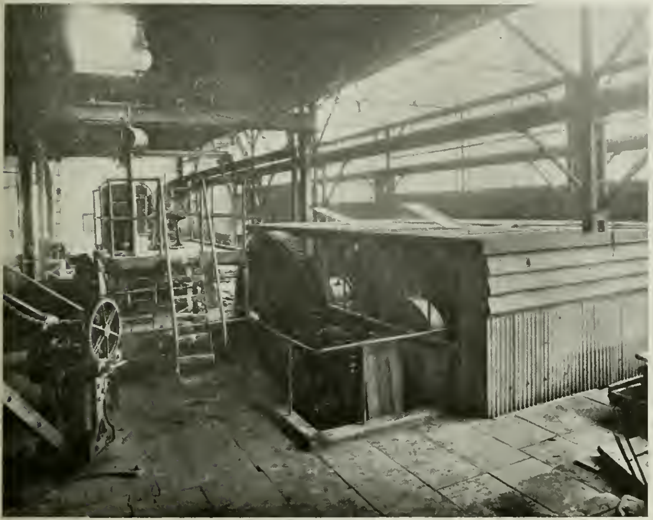


Fig. 2.—View of Motor House.

Fig. 2 gives a photographic view of another plant, in which the driving motor, flywheel set and switchgear are contained in the sunken house seen on the right of the photo.

Fig. 3 gives a view of the mill, which consists of one stand of rolls, 28 in. diameter by 7 ft. long, having a speed range of ±35 revs. per min. A 5 : 1 reduction gearing is inserted between the motor and the pinion shaft, as may be clearly seen in Fig. 2, the spur wheel being coupled by means of a leading spindle to the bottom mill pinion. The mill motor is designed to give a maximum power of 890 h.p. between speeds of ±175 revs. per min., and the flywheel set has a driving motor of 125 h.p. coupled to a steel flywheel weighing 7½ tons, and having a diameter of 8 ft. 2 in. The control platform, from which the operation of the mill is carried out, can be seen above the connecting spindle between the spur wheel and pinion. The space taken up by the complete drive, as shown in Fig. 1, is approximately 550 sq. ft., and in that of Fig. 2 about 650 sq. ft. As explained above, however, there is no need to make use of the actual mill floor space for the greater part of the equipment, as the reversing motor is the only portion of the plant which requires to be in close proximity to the mill.

The advantages of the electrical reversing drive have been discussed on frequent occasions, and there is no need to consider these in this article ; but, as an illustration of the perfect control of the mill motor, there may be instanced the rolling of a fire-box plate. The design of these plates renders it necessary to have one end considerably thinner than the remainder, and to do this the plate is entered into the rolls, and a draught taken up to a certain datum line. The motor is then stopped, reversed and the plate run out, leaving the thicker end untouched. The necessity of being able to stop and reverse the mill at exactly the right moment is obvious, and this class of work has been successfully carried out in practice.

The uses of the Ilgner drive are not confined solely to rolling-mill work. Apart from its wide application to "winders" and "hoists," this drive has been most successfully employed for the operation of extrusion presses. Here the flywheel equaliser takes the place of the cumbersome, inefficient and expensive hydraulic accumulator. The powers come within the limits of the small drives hitherto employed in the metal trades, and, as an example, there may be mentioned a plant where the motor driving the hydraulic pumps has a maximum power of 300 h.p. Stopping, starting and speed variation are controlled exactly as in the case of a mill motor. The flywheel set in this instance is driven by a 120 h.p. motor, having a 3½ ton flywheel, 5ft. 6in. in diameter.

It would appear that at present the capabilities and advantages of the small reversing mill plant have not been fully grasped by manufacturers ; but it is anticipated that, with an increasing necessity for large outputs and a reduction in operating costs, the future will see a wide extension of the electrical reversing drive of small mills.

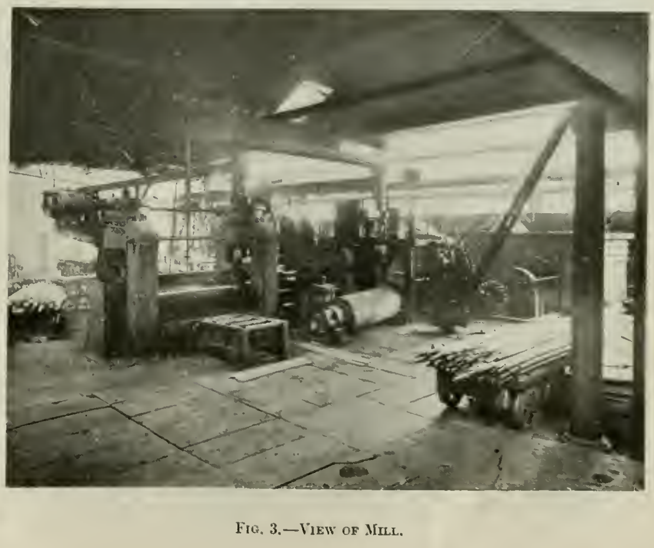


Fig. 3.—View of Mill.

Motor Equipment for Main Drive of Rolling Mills.

We give below particulars of electrically-driven rolling mills equipped by British firms in so far as such data have been supplied to us :—

Installed for	Description of mill.	Motor.		Supply.	Drive.	Installed by
		H.P.	Speed.			
Steel, Peech & Tozer	Continuous billet	1200	92	3 ph., 6300 v., 50 cyc.	Gear	B.T.H.
Whitecross Co.	Wire rod	4700	490	3 ph., 2000 v., 50 cyc.	Rope & gr.	B.T.H.
Steel, Peech & Tozer	Slab	3000	240	3 ph., 6300 v., 50 cyc.	Gear	B.T.H.
S. African Steel Union Corporation	3 high	1800	365	3 ph., 525 v., 50 cyc.	Rope	B.T.H.
Govt. Rolling Mills, Southampton	24 in. & 20 in. sheet	1600	266	3 ph., 3300 v., 50 cyc.	Rope & gr.	B.T.H.
Elliott Metal Co.	Sheet	1450	120	3 ph., 440 v., 25 cyc.	Rope & gr.	B.T.H.
F. Smith & Co.	Roughing & finishing rod	1400	365	3 ph., 2200 v., 50 cyc.	Rope drct.	B.T.H.
Andrews & Co.	9 in. rod (finishing)	1300	650	3 ph., 3300 v., 50 cyc.	Direct	B.T.H.
Melingriffith Co.	24 in. sheet (three mills)	1500	360	3 ph., 2200 v., 25 cyc.	Gear	B.T.H.
Babcock & Wilcox	Tube piercing	1400	290	3 ph., 400 v., 25 cyc.	Gear	B.T.H.
Birmingham Corrugated Iron Co.	28 in. sheet (two mills)	1400	730	3 ph., 440 v., 50 cyc.	Gear	B.T.H.
Upper Forest & Worcester S. & T. Co.	24 in. sheet (four mills)	1300	210	3 ph., 3300 v., 50 cyc.	Gear	B.T.H.
Upper Forest & Worcester S. & T. Co.	24 in. sheet (four mills)	1100	210	3 ph., 3300 v., 50 cyc.	Gear	B.T.H.
Upper Forest & Worcester S. & T. Co.	24 in. sheet (four mills)	1100	210	3 ph., 3300 v., 50 cyc.	Gear	B.T.H.
Govt. Rolling Mills, Southampton	20 in. & 18 in. sheet	1100	292	3 ph., 3300 v., 50 cyc.	Rope & gr.	B.T.H.
Weldless Steel Tube Co.	Tube piercing	1200	730	2 ph., 2700 v., 50 cyc.	Gear	B.T.H.
Govt. Rolling Mills, Southampton	20 in. & 18 in. Sheet	1000	292	3 ph., 3300 v., 50 cyc.	Rope & gr.	B.T.H.
F. Smith & Co.	Draw benches	1000	730	3 ph., 2200 v., 50 cyc.	Gear	B.T.H.
Andrews & Co.	14 in. roughing	900	730	3 ph., 3300 v., 50 cyc.	Gear	B.T.H.
Govt. Rolling Mills, Southampton	18 in. sheet	800	332	3 ph., 3300 v., 50 cyc.	Rope & gr.	B.T.H.
Govt. Rolling Mills, Southampton	16 in. & 15 in. sheet	800	332	3 ph., 3300 v., 50 cyc.	Rope & gr.	B.T.H.
Babcock & Wilcox	Tube rolling	800	104	3 ph., 400 v., 25 cyc.	Gear	B.T.H.
Stewart & Lloyds	20 in. sheet (3 stands)	900	360	3 ph., 400 v., 25 cyc.	Rope & gr.	B.T.H.
Munition Factory, Birmingham	30 in. & 24 in. sheet	1000	360	3 ph., 440 v., 25 cyc.	Gear	B.T.H.
T. Bolton & Sons	Slabbing and sheet	750	580	3 ph., 400 v., 50 cyc.	Gear	B.T.H.
Elliott Metal Co.	Sheet	690	360	3 ph., 440 v., 25 cyc.	Gear	B.T.H.
Govt. Rolling Mills, Southampton	15 in. & 12 in. sheet	600	322	3 ph., 3300 v., 50 cyc.	Rope & gr.	B.T.H.
Govt. Rolling Mills, Southampton	Sheet	600	322	3 ph., 3300 v., 50 cyc.	Rope & gr.	B.T.H.
Andrews & Co.	14 in. intermediate	600	210	3 ph., 3300 v., 50 cyc.	Direct	B.T.H.
Tubes Limited	Tube rolling	600	290	3 ph., 5000 v., 25 cyc.	Rope	B.T.H.
Tubes Limited	Hydraulic piercing	800	485	3 ph., 440 v., 25 cyc.	Gear	B.T.H.
Tubes Limited	Tube piercing	720	730	3 ph., 440 v., 25 cyc.	Gear	B.T.H.
Tubes Limited	Tube piercing	720	730	3 ph., 440 v., 25 cyc.	Gear	B.T.H.
Tubes Limited	Tube piercing	720	730	3 ph., 440 v., 25 cyc.	Gear	B.T.H.
Munition Factory, Birmingham	24 in. & 18 in. sheet	650	366	3 ph., 440 v., 25 cyc.	Gear	B.T.H.
Babcock & Wilcox	Tube piercing	600	730	3 ph., 400 v., 25 cyc.	Gear	B.T.H.
Munition Factory, Birmingham	Sheet	550	290	3 ph., 440 v., 25 cyc.	Gear	B.T.H.
Muntz Metal Co.	Tube piercing	500	480	2 ph., 440 v., 50 cyc.	Gear	B.T.H.
Muntz Metal Co.	Tube rolling	500	480	2 ph., 440 v., 50 cyc.	Gear	B.T.H.
Aluminium Corporation	Sheet	500	415	3 ph., 440 v., 50 cyc.	Rope	B.T.H.
Jones & Colver	Rod	500	485	2 ph., 200 v., 50 cyc.	Belt	B.T.H.
Perfecta Tube Co.	Pilger	400	360	3 ph., 440 v., 25 cyc.	Rope	B.T.H.
Babcock & Wilcox	Pilger	360	360	3 ph., 400 v., 25 cyc.	Rope	B.T.H.
Dorman, Long & Co.	Continuous rod	325	360	3 ph., 440 v., 40 cyc.	Gear	B.T.H.
Dorman, Long & Co.	Continuous rod	325	470	3 ph., 440 v., 40 cyc.	Gear	B.T.H.
Dorman, Long & Co.	Continuous rod	325	780	3 ph., 440 v., 40 cyc.	Gear	B.T.H.
Oldbury Rolling Mills	9 in. rghng. & 7 in. finshg.	300	360	3 ph., 400 v., 25 cyc.	Rpe. & dir.	B.T.H.
Munition Factory, Birmingham	Sheet	250	490	3 ph., 440 v., 25 cyc.	Gear	B.T.H.
Elliott Metal Co.	Sheet	200	490	3 ph., 440 v., 25 cyc.	Gear	B.T.H.
Cammell, Laird & Co.	Sheet	200	360	3 ph., 440 v., 25 cyc.	Gear	B.T.H.
Tupper & Co.	Rod	160	475	2 ph., 200 v., 50 cyc.	Belt	B.T.H.
Govt. Rolling Mills, Southampton	12 in. finishing	160	480	3 ph., 440 v., 50 cyc.	Gear	B.T.H.
Govt. Rolling Mills, Southampton	12 in. finishing	100	480	3 ph., 440 v., 50 cyc.	Gear	B.T.H.
Govt. Rolling Mills, Southampton	8 in. finishing	80	715	3 ph., 440 v., 50 cyc.	Gear	B.T.H.
Heeley Silver Mills	Cold rolls	60	725	2 ph., 200 v., 50 cyc.	Gear	B.T.H.
Dorman, Long & Co.	28 in. cogging	3600	90	3 ph., 400 v.	Direct	B.T.H.
Dorman, Long & Co.	Wire rod	2500	120/180	460 v. (d.c.)	Gear & blt.	B.T.H.
Partington Steel & Iron Co.	20 in. 3 high roughing	3000	55/90	500 v. (d.c.)	Direct	B.T.H.
Partington Steel & Iron Co.	18 in. 3 high intermediate	3000	90/180	500 v. (d.c.)	Direct	B.T.H.
Partington Steel & Iron Co.	18 in. 3 high finishing	3000	90/180	500 v. (d.c.)	Direct	B.T.H.
Blaenavon Co.	Tyre finishing	2000	175/350	460 v. (d.c.)	Gear	B.T.H.
Locke, Lancaster & Co.	Sheet	880	660	460 v. (d.c.)	Gear	B.T.H.
Glengarnock Iron & Steel Co.	12 in. guide	700	130/170	440 v. (d.c.)	Direct	B.T.H.
Metal Mfg. Co.	Tube piercing	400	500	250 v. (d.c.)	Gear	B.T.H.
London	Special	300	480	440 v. (d.c.)	Gear	B.T.H.
Gravesend Steel & Tinplate Co.	Cold rolls	200	200/300	220 v. (d.c.)	Gear	B.T.H.
London	Special	150	500	440 v. (d.c.)	Gear	B.T.H.
Neville Druce	Sheet	124	525/600	500 v. (d.c.)	Gear	B.T.H.
London	Special	100	600	440 v. (d.c.)	Gear	B.T.H.
Dorman, Long & Co.	42 in. reversing plate	20500	40/70	3 ph., 2750 v., 40 cyc.*	Direct	B.T.H.
Steel, Peech & Tozer	36 in. reversing cogging	15500	48/100	3 ph., 6300 v., 50 cyc.*	Direct	B.T.H.
Dorman, Long & Co.	29 in. reversing plate	12000	50/100	3 ph., 2750 v., 40 cyc.*	Direct	B.T.H.
Dorman, Long & Co.	28 in. reversing cogging	3600	70/90	3 ph., 2750 v., 40 cyc.*	Direct	B.T.H.
John Brown & Co.	24 in. reversing cogging	1800	117/170	3 ph., 6600 v., 50 cyc.*	Gear	B.T.H.
Patent Shaft & Axletree Co.	Special	500	90/180	3 ph., 5000 v., 50 cyc.	Direct	B.T.H.
Locke, Lancaster & Co.	21 in. sheet	300	200	460 v. (d.c.)	Gear	B.T.H.
Armstrong, Whitworth & Co.	Light sheet steel	650/2500	200	6,600 v., 50 cyc. and 500 v. (d.c.)*	Gear	Lancs.D.& M.Co.
Hanson, Dales & Co.	Lead	150	600	345 v., "Lancs." drv.	Dir. cpld.	Lancs.D.& M. Co.

* With flywheel motor generator sets.

Motor Equipment for Main Drive of Rolling Mills—*continued.*

Installed for	Description of mill.	Motor.		Supply.	Drive.	Installed by
		H.P.	Speed.			
Walker, Parker & Co.	Lead	150	600	420 v., "Lancs." drv.	Dir. cpld.	Lancs.D.& M. Co.
Walker, Parker & Co.	Lead	100	400	460 v., "Lancs." drv.	Gear	Lancs.D.& M. Co.
Armstrong, Whitworth & Co.	Tool steel (non-reversing)	120	400/475	500 v. (d.c.)	Gear	Lancs.D.& M. Co.
Blaenavon Co.	Steel tyres (non-reversing)	300	300	460 v. (d.c.)	Gear	Lancs.D.& M. Co.
Blaenavon Co.	Steel tyres (non-reversing)	300	300	460 v. (d.c.)	Gear	Lancs.D.& M. Co.
Darlington Rolling Mills Co.	Steel bars (non-reversing)	1000/1300	200	440 v. (d.c.)	Rope	Lancs.D.& M. Co.
Smith & McLean	Steel sheets (non-revers.)	400	120/200	500 v. (d.c.)	Gear	Lancs.D.& M. Co.
Taylor Bros.	Steel wheels (non-revers.)	530/800	300/600	250 v. (d.c.)	Gear	Lancs.D.& M. Co.
Bibby & Co.	Copper (non-reversing)	100	360/480	460 v. (d.c.)	Rope	Lancs.D.& M. Co.
British Insulated & Helsby Cables Co.	Copper (non-reversing)	400	350/400	240 v. (d.c.)	Rope	Lancs.D.& M. Co.
Broughton Copper Co.	Copper (non-reversing)	300	350/400	500 v. (d.c.)	Rope	Lancs.D.& M. Co.
G. Adams & Sons	Non-reversing	200	415	2700 v., 50 cyc., (a.c.)	Rope	Lancs.D.& M. Co.
Chesterfield Tube Co.	Tube (non-reversing)	150	240	440 v., 50 cyc. (a.c.)	Gear	Lancs.D.& M. Co.
Earle, Bonrne & Co.	Non-reversing	600	240	5000 v., 25 cyc. (a.c.)	Dir. cpld.	Lancs.D.& M. Co.
Earle, Bourne & Co.	Non-reversing	450	360	5000 v., 25 cyc. (a.c.)	Dir. cpld.	Lancs.D.& M. Co.
Earle, Bonrne & Co.	Non-reversing	200	360	5000 v., 25 cyc. (a.c.)	Dir. cpld.	Lancs.D.& M. Co.
Earle, Bourne & Co.	Non-reversing	225	360	2750 v., 50 cyc. (a.c.)	Dir. cpld.	Lancs.D.& M. Co.
Low Moor Iron Co.	Bar (non-reversing)	250	243	100 0v., 50 cyc. (a.c.)	Rope	Lancs.D.& M. Co.
Low Moor Iron Co.	Bar (non-reversing)	400	480/375	1000 v., 50 cyc. (a.c.)	Rope (cascade set)	Lancs.D.& M. Co.
Low Moor Iron Co.	Bar (non-reversing)	175	243	1000 v., 50 cyc. (a.c.)	Rope	Lancs.D.& M. Co.
J. Reynolds & Sons	Non-reversing	80	480	400 v., 25 cyc.	Gear	Lancs.D.& M.Co.
Skinningrove Iron Co.	Rvrsng., rghng. & finshng.	19,000	±140	±465 v. (d.c.)	Direct	Siemens.
Skinningrove Iron Co.	Reversing, cogging	12,000	±120	±550 v. (d.c.)	Direct	Siemens.
Cammell, Laird & Co.	Rvrsng., rghng & finshng.	19,000	±150	±465 v. (d.c.)	Direct	Siemens.
Wellman Seaver Rolling Mill Co.	Reversing, cogging	12,000	±120	±50 v. (d.c.)	Direct	Siemens.
Scottish Iron & Steel Co.	Reversing, cogging	6,380	±175	±630 v. (d.c.)	Direct	Siemens.
Monmouthshire Steel & Tinplate Co.	Reversing, finishing	5,300	±140	±600 v. (d.c.)	Direct	Siemens.
Monmouthshire Steel & Tinplate Co.	Reversing	1200	±100	500 v. (d.c.)	...	Siemens.
Elliott's Metal Co.	Reversing copper plate	890	±105	±400 v. (d.c.)	Gear	Siemens.
Birmingham Mint	Reversing copper plate	780	±500	±400 v. (d.c.)	Gear	Siemens.
Birmingham Battery & Metal Co.	Reversing copper plate	450	±210	±435 v. (d.c.)	Gear	Siemens.
Manganese, Bronze & Brass Co.	Extruding press	240	400	500 v. (d.c.)	Gear	Siemens.
Richard Johnson & Nephew	Wire	2750	500	3 ph., 6600 v., 50 cyc.	Gear	Siemens.
Richard Johnson & Nephew	Wire	750	750	3 ph., 6600 v., 50 cyc.	Gear	Siemens.
Richard Johnson & Nephew	Wire	750	750	3 ph., 6600 v., 50 cyc.	Gear	Siemens.
Richard Johnson & Nephew	Merchant	2000	80/150	460 v. (d.c.)	...	Siemens.
Kayser, Ellison & Co.	Wire	1200	245/365	3 ph., 500 v., 50 cyc.	Rope	Siemens.
Kayser, Ellison & Co.	Cogging	375	375	3 ph., 560 v., 50 cyc.	Belt	Siemens.
Eston Sheet & Galvanising Co.	Sheet	1060	200	3 ph., 2750 v., 40 cyc.	Rope	Siemens.
Cargo Fleet Iron Co.	Merchant	1000	150/75	3 ph. var. speed set, 2750 v., 40 cyc.	Direct	Siemens.
Elliott's Metal Co.	Copper	1000	250	3 ph., 440 v., 25 cyc.	Rope	Siemens
Birmingham Metal & Mnnitions Co.	Sheet	750	187	3 ph., 440 v., 25 cyc.	Rope	Siemens.
Monmouthshire Steel & Tinplate Co.	Cogging	750	75	3 ph., 2750 v., 25 cyc.	Direct	Siemens.
Baldwins Limited	Hot tinplate	600	150	3 ph., 2100 v., 50 cyc.	Rope	Siemens.
Baldwins Limited	Hot tinplate	600	150	3 ph., 2100 v., 50 cyc.	Rope	Siemens.
Baldwins Limited	Hot tinplate	600	150	3 ph., 2100 v., 50 cyc.	Rope	Siemens.
Baldwins Limited	Cold rolls	440	150	3 ph., 2160 v., 50 cyc.	Rope	Siemens.
Baldwins Limited	Cold rolls	300	250	3 ph., 2100 v., 50 cyc.	Rp. & gr.	Siemens
Darlington Rolling Mills Co.	Rail	600	270/450	460 v. (d.c.)	Rope	Siemens.
Darlington Rolling Mills Co.	Merchant	450	110/247	460 v. (d.c.)	Dir. cpld. & rope	Siemens.
Darlington Rolling Mills Co.	Forge train	250	300/450	460 v. (d.c.)	Rope	Siemens.
Darlington Rolling Mills Co.	Forge train	250	300/450	460 v. (d.c.)	Rope	Siemens.
Monks, Hall & Co.	Wire (finishing)	550	400/530	500 v. (d.c.)	Direct	Siemens.
Monks, Hall & Co.	Wire (roughing)	400	200/300	500 v. (d.c.)	Direct	Siemens.
Monks, Hall & Co.	Merchant	400	92/125	500 v. (d.c.)	Direct	Siemens.
Raine & Co.	Rail	660	60/120	500 v. (d.c.)	Direct	Siemens.
Raine & Co.	Merchant (roughing)	400	80/160	500 v. (d.c.)	Direct	Siemens.
Raine & Co.	Merchant (finishing)	400	60/250	500 v. (d.c.)	Direct	Siemens.
English Elec. Co.	Tyre	1350	500	3 ph., 6600 v., 50 cyc.	Gear	Siemens.
J. Brown & Co.	Tyre	600/1200	500	3 ph., 6000 v., 50 cyc.	Gear	Siemens.
J. Brown & Co.	Bar	200	450/200	230 v. (d.c.)	Rope	Siemens.
J. Brown & Co.	Bar	200	450/200	230 v. (d.c.)	Rope	Siemens.
Monk Bridge Iron Co.	Tyre	600	500	2 ph., 2000v., 50 cyc.	Direct	Siemens.
Monk Bridge Iron Co.	Tyre	300	500	2 ph., 2000 v., 50 cyc.	Direct	Siemens.
English McKenna Process Co.	Rail	500	280	3 ph., 400 v., 25 cyc.	Gear	Siemens.
English McKenna Process Co.	Rail	500	280	3 ph., 400 v., 25 cyc.	Gear	Siemens.
English McKenna Process Co.	Rail	500	280	3 ph., 400 v., 25 cyc.	Gear	Siemens.
English McKenna Process Co.	Rail	500	280	3 ph., 400 v., 25 cyc.	Gear	Siemens.
English McKenna Process Co.	Rail	500	280	5 ph., 400 v., 25 cyc.	Gear	Siemens.
English KcKenna Process Co.	Rail	500	280	3 ph., 400 v., 25 cyc.	Gear	Siemens.
English McKenna Process Co.	Merchant	350	250/125	3 ph. v. spd., 400 v. ...	Direct	Siemens.
John Williams	Merchant	500	300	3 ph., 400 v., 25 cyc.	Gear	Siemens.
Sheffield Forge & Rolling Mills Co.	Merchant	500	88	3 ph., 3300 v., 50 cyc.	Direct	Siemens.
Sheffield Forge & Rolling Mills Co.	Merchant	350	125	2 ph., 3300 v., 50 cyc.	Direct	Siemens.
Sheffield Forge & Rolling Mills Co.	Sheet	250	375	3 ph., 2000 v., 50 cyc.	Gear	Siemens.
Sheffield Forge & Rolling Mills Co.	Merchant	300	500	3 ph., 3300 v., 50 cyc.	Gear	Siemens.
Sheffield Forge & Rolling Mills Co.	Merchant	150	500	3 ph., 3300 v., 50 cyc.	Gear	Siemens.
Waterloo Tinplate Co.	Hot	500	214	500 v. (d.c.)	Gear	Siemens.
Waterloo Tinplate Co.	Cold	225	300	500 v. (d.c.)	Gear	Siemens.
D. Colville & Sons	Merchant	400	200/100	220 v. (d.c.)	Direct	Siemens.
D. Colville & Sons	Merchant (finishing)	400	150/300	220 v. (d.c.)	Direct	Siemens.
D. Colville & Sons	Merchant (roughing)	250	90/150	220 v. (d.c.)	Direct	Siemens.
Tubes Limited	Tube	375	375	3 ph., 5000 v., 25 cyc.	Rope	Siemens.

Motor Equipment for Main Drive of Rolling Mills—*continued.*

Installed for	Description of mill.	Motor.		Supply.	Drive.	Installed by
		H.P.	Speed.			
Tubes Limited	Tube	200	375	3 ph., 5000 v., 25 cyc.	Rope	Siemens.
Tubes Limited	Tube	200	375	3 ph., 5000 v., 25 cyc.	Rope	Siemens.
Tubes Limited	Tube	170	375	3 ph., 5000 v., 25 cyc.	Rope	Siemens.
Tubes Limited	Tube	170	375	3 ph., 5000 v., 25 cyc.	Rope	Siemens.
Tubes Limited	Tube	170	375	3 ph., 5000 v., 25 cyc.	Rope	Siemens.
Tubes Limited	Tube	150	480/360	460 v. (d.c.)	Belt	Siemens.
Tubes Limited	Tube	80	600/700	460 v. (d.c.)	Belt	Siemens.
Howell & Co.	Pilger tube	350	300/428	3 ph., 3000 v., 50 cyc.	Dir. cpld.	Siemens.
Howell & Co.	Tube	250	585	3 ph., 3000 v., 50 cyc.	...	Siemens.
Howell & Co.	Tube	110	600	3 ph., 3000 v., 50 cyc.	...	Siemens.
Howell & Co.	......	75	600	3 ph , 500 v., 50 cyc.	...	Siemens
Weldless Steel Tube Co.	Tube	340	750	2 ph., 2750 v., 50 cyc.	Gear	Siemens.
Weldless Steel Tube Co.	Tube	340	750	2 ph., 2750 v., 50 cyc.	Gear	Siemens.
Weldless Steel Tube Co.	Tube	150	750	2 ph., 2750 v., 50 cyc.	Gear	Siemens.
Weldless Steel Tube Co.	Tube	150	750	2 ph., 2750 v., 50 cyc.	Gear	Siemens.
Barrow Hæmatite Steel Co.	Merchant	360	85/200	440 v. (d.c.)	Direct	Siemens.
Barrow Hæmatite Steel Co.	Hoop	375	230/350	440 v. (d.c.)	Direct	Siemens.
Barrow Hæmatite Steel Co.	Planishing	340	230/350	440 v. (d.c.)	Direct	Siemens.
Brown, Bayley's Steel Works	Merchant	400	85/200	460 v. (d.c.)	Direct	Siemens.
Treforest Tinplate Co.	Sheet	400	40	3 ph. d.c. set, 440 v., 25 cyc.	Dir. cpld.	Siemens.
W. Bain & Co.	Merchant	350	300/100	3 ph. var. speed set, 440 v., 25 cyc.	Direct	Siemens.
Guest, Keen & Nettlefolds	......	275	375	3 ph., 440 v., 25 cyc.	...	Siemens.
Guest, Keen & Nettlefolds	......	200	750	3 ph., 440 v., 25 cyc.	...	Siemens.
Guest, Keen & Nettlefolds	......	175	375	3 ph., 440 v., 25 cyc.	...	Siemens.
Guest, Keen & Nettlefolds	......	100	375	3 ph., 440 v., 25 cyc.	...	Siemens.
Birmingham Battery & Metal Co.	Piercer	300	600	440 v. (d.c.)	Direct	Siemens.
Birmingham Battery & Metal Co.	......	120	550	440 v., (d.c.)	Dir. cpld.	Siemens.
C. Clifford & Sons	Sheet	275	300	3 ph., 5000 v., 25 cyc.	Gear	Siemens.
C. Clifford & Sons	Sheet	275	300	3 ph., 5000 v., 25 cyc.	Gear	Siemens.
C. Clifford & Sons	Sheet	105	250	3 ph., 440 v., 25 cyc.	Direct	Siemens.
Dugard Brothers	Sheet brass	275	375	3 ph., 5000 v., 25 cyc.	Gear	Siemens.
Dugard Brothers	Sheet brass	100	500	3 ph., 5000 v., 25 cyc.	...	Siemens.
Willans & Robinson	Tube	275	360	410 v. (d.c.)	Rope	Siemens.
A. Everitt & Sons	......	250	500	3 ph., 400 v., 25 cyc.	...	Siemens.
A. Everitt & Sons	......	250	375	3 ph., 400 v., 25 cyc.	...	Siemens.
A. Everitt & Sons	......	150	375	3 ph., 400 v., 25 cyc.	...	Siemens.
A. Everitt & Sons	......	150	375	3 ph., 400 v., 25 cyc.	...	Siemens.
A. Everitt & Sons	......	100	500	3 ph., 400 v. 25 cyc.	...	Siemens.
A. Everitt & Sons	......	100	500	3 ph. 400 v. 25 cyc.	...	Siemens.
A. Everitt & Sons	......	80	500	3 ph., 400 v., 25 cyc.	...	Siemens.
District Iron & Steel Co.	Hoop	250	365	3 ph., 5000 v., 25 cyc.	Rope	Siemens.
Barker & Allen	Sheet nickel	215	300	3 ph., 440 v., 25 cyc.	Rope	Siemens.
Barker & Allen	Sheet nickel	120	300	3 ph., 440 v., 25 cyc.	Rope	Siemens.
Barker & Allen	Sheet nickel	50	375	3 ph., 440 v., 25 cyc.	Rope	Siemens.
Barker & Allen	Sheet	50	750	3 ph., 440 v., 25 cyc.	Belt	Siemens.
Cammell, Laird & Co.	Merchant	210	750	3 ph., 3000 v., 50 cyc.	Belt	Siemens.
J. Hill & Sons	Hoop	250	250	2 ph., 2700 v., 50 cyc.	Direct	Siemens.
F. R. Simpson & Co.	Merchant, (roughing) 9 in., (finishing) 7 in.	250	500	3 ph., 400 v., 25 cyc.	Rope	Siemens.
Kynochs Limited	Sheet	200	600	3 ph., 500 v., 50 cyc.	Gear	Siemens.
Kynochs Limited	Sheet	200	600	3 ph., 520 v., 50 cyc.	...	Siemens.
Kynochs Limited	Sheet	200	600	3 ph., 520 v., 50 cyc.	...	Siemens.
Kynochs Limited	Sheet	165	600	3 ph., 500 v., 50 cyc.	Pinion	Siemens.
Kynochs Limited	Sheet	165	600	3 ph., 520 v., 50 cyc.	...	Siemens.
Kynochs Limited	Sheet	115	600	3 ph., 500 v., 50 cyc.	Gear	Siemens.
Kynochs Limited	Sheet	115	600	3 ph., 500 v., 50 cyc.	Belt	Siemens.
Kynochs Limited	Sheet	115	600	3 ph., 500 v., 50 cyc.	Belt	Siemens.
Kynochs Limited	Sheet	115	600	3 ph., 500 v , 50 cyc.	Pinion	Siemens.
Kynochs Limited	Sheet	100	750	3 ph., 500 v., 50 cyc.	Pinion	Siemens.
Kynochs Limited	Sheet	80	750	3 ph., 500 v., 50 cyc.	Belt	Siemens.
Kynochs Limited	Sheet	75	750	3 ph., 500 v., 50 cyc.	Pinion	Siemens.
Kynochs Limited	Sheet	75	750	3 ph., 500 v., 50 cyc.	Pinion	Siemens.
Kynochs Limited	......	65	750	3 ph., 500 v., 50 cyc.	...	Siemens.
Kynochs Limited	Sheet	65	750	3 ph., 520 v., 50 cyc.	...	Siemens.
Kynochs Limited	Sheet	65	750	3 ph., 520 v., 50 cyc.	...	Siemens.
Kynochs Limited	Sheet	65	750	3 ph., 520 v., 50 cyc.	...	Siemens.
Kynochs Limited	......	42	750	3 ph., 500 v., 50 cyc.	...	Siemens.
Kynochs Limited	......	42	750	3 ph., 500 v., 50 cyc.	...	Siemens.
Kynochs Limited	......	42	750	3 ph., 500 v., 50 cyc.	...	Siemens.
Kynochs Limited	......	42	750	3 ph., 500 v., 50 cyc.	...	Siemens.
Kynochs Limited	......	42	750	3 ph., 500 v., 50 cyc.	...	Siemens.
Kynochs Limited	Sheet	42	750	3 ph., 520 v., 50 cyc.	...	Siemens.
Kynochs Limited	Sheet	42	750	3 ph., 520 v., 50 cyc.	...	Siemens.
Tregoning & Co.	Cold rolls	200	200	3 ph., 500 v., 50 cyc.	Rope	Siemens.
Davy Bros., Ltd.	Plate	200	600	3 ph., 220 v.	Rope	Siemens.
Davy Bros., Ltd.	Merchant	120	500	2 ph., 2000 v.	Rope	Siemens.
Davy Bros., Ltd.	......	120	500	2 ph., 4 wr., 2000 v., 50 cyc.	...	Siemens.
H. Wiggin & Co.	Sheet nickel	200	300	3 ph., 440 v., 25 cyc.	Gear	Siemens.
H. Wiggin & Co.	Sheet nickel	150	375	3 ph., 440 v., 25 cyc.	Rp. & gr.	Siemens.
Astor Chain & Hook Co.	......	200	375	3 ph., 5000 v., 25 cyc.	Belt	Siemens.
Steel Nut & J. Hampton	Drawbench	200	510	3 ph	Rope	Siemens.
W. Bayliss, Ltd.	......	200	375	3 ph [illegible]0 v., 25 cyc.	Rope	Siemens.

Motor Equipment for Main Drive of Rolling Mills—*continued.*

Installed for	Description of mill.	Motor.		Supply.	Drive.	Installed by
		H.P.	Speed.			
W. Bayliss, Ltd.	......	172	500	3 ph., 5000 v., 25 cyc.	...	Siemens.
W. Bayliss, Ltd.	Tube	120	500	3 ph., 5000 v.	Gear	Siemens.
Crosthwaites Eng. & Furnace Co.	Reeling	150/400	500	3 ph., 400 v., 25 cyc.	Gear	Siemens.
Crosthwaites Eng. & Furnace Co.	Reeling	150/300	600	440 v. (d.c.)	Gear	Siemens.
Crosthwaites Eng. & Furnace Co.	Reeling	150/300	600	440 v., (d.c.)	Gear	Siemens.
Crosthwaites Eng. & Furnace Co.	Reeling	150/400	500	3 ph., 400 v., 25 cyc.	Gear	Siemens.
Crosthwaites Eng. & Furnace Co.	Reeling	150/400	500	3 ph., 400 v., 25 cyc.	Gear	Siemens.
G. Jones, Ltd.	Sheet	350	375	3 ph., 5000 v., 25 cyc.	Rope	Siemens.
G. Jones, Ltd.	Tube	120	550	3 ph., 5000 v., 25 cyc.	Gear	Siemens.
G. Jones, Ltd.	......	100	500	500 v. (d.c.)	...	Siemens.
R. Hill & Co.	Wire	175	385	3 ph., 2750 v., 40 cyc.	Gear	Siemens.
R. Hill & Co.	Wire	175	385	3 ph., 2750 v., 40 cyc.	Gear	Siemens.
R. Hill & Co.	Wire	132	392	3 ph., 440 v., 40 cyc.	Gear	Siemens.
Winfields Rolling Mills	Brass sheet	175	375	3 ph., 5000 v., 25 cyc.	Rope	Siemens.
Winfields Rolling Mills	Brass sheet	108	375	3 ph., 5000 v., 25 cyc.	...	Siemens.
Wilkes, Son & Mapplebeck	Copper plate	150	485	3 ph., 5000 v., 25 cyc.	Gear	Siemens.
Wilkes, Son & Mapplebeck	Copper plate	120	485	3 ph., 5000 v., 25 cyc.	Gear	Siemens.
Wilkes, Son & Mapplebeck	Copper plate	75	485	3 ph., 5000 v., 25 cyc.	Gear	Siemens.
A. F. Parkes	Sheet steel	150	375	3 ph., 5000 v., 25 cyc.	...	Siemens.
A. F. Parkes	......	142	375	3 ph., 5000 v., 25 cyc.	...	Siemens.
Heaton Dugard	Sheet	140	375	3 ph., 5000 v., 25 cyc.	...	Siemens.
Heaton Dugard	Sheet	100	500	3 ph., 440 v., 25 cyc.	Gear	Siemens.
Heaton Dugard	Sheet	100	500	3 ph., 440 v., 25 cyc.	Gear	Siemens.
Heaton Dugard	Sheet	80	500	3 ph., 440 v., 25 cyc.	Gear	Siemens.
J. Hands & Sons	Sheet	150	375	3 ph.	Belt	Siemens.
Wm. West	German silver	150	500	3 ph., 5000 v., 25 cyc.	Gear	Siemens.
Elliott's Metal Co.	......	150	375	3 ph., 400 v., 25 cyc.	...	Siemens.
J. Sumners & Sons	......	140	500	3 ph., 440 v., 50 cyc.	...	Siemens.
Redbrook Tinplate Co.	Cold rolls	125	240	3 ph., 2200 v.	Rope	Siemens.
Redbrook Tinplate Co.	Hot tinplate	100	240	3 ph., 2200 v.	Rope	Siemens.
J. Wood & Sons	Merchant	125	490	2 ph., 2000 v., 50 cyc.	Rope	Siemens.
T. Smith & Son	......	105	150	3 ph., 440 v., 25 cyc.	...	Siemens.
H. Roberts	......	100	750	2 ph., 200 v., 50 cyc.	...	Siemens.
Perry & Co.	......	100	300	3 ph., 440 v., 25 cyc.	Gear	Siemens.
Carr, Wild & Co.	......	100	750	2 ph., 200 v., 50 cyc.	Direct	Siemens.
I. Nash & Sons	......	95	375	2 ph., 2700 v., 50 cyc.	Belt	Siemens.
Kemp & Sons	Sheet	80	500	3 ph., 440 v., 25 cyc.	Gear	Siemens.
Kemp & Sons	Sheet	80	500	3 ph., 440 v., 25 cyc.	...	Siemens.
Kemp & Sons	Sheet	45	500	3 ph., 440 v., 25 cyc.	...	Siemens.
Rotherham Forge & Rolling Mills	Reeling	54	725	460 v. (d.c.)	Belt	Siemens.
E. Lloyd & Co.	Sheet	50	500	......	...	Siemens.
E. Lloyd & Co.	Sheet	50	500	......	...	Siemens.
Appleby Iron Co.	40 in. rev. slabbing	6000/15200	48/100	1350 v. (d.c.)	Dir. cpld.*	Westinghouse.
Appleby Iron Co.	10 ft. rev. plate	6000/15200	48/100	1350 v. (d.c.)	Dir. cpld.*	Westinghouse.
Appleby Iron Co.	7 ft. rev. plate	5000/13300	60/120	1350 v. (d.c.)	Dir. cpld.*	Westinghouse.
Patent Shaft & Axletree Co., Ltd.	32 in. rev. billet & bar	4000/11400	60/120	720 v. (d.c.)	Dir. cpld.*	Westinghouse.
Bolckow, Vaughan & Co., Ltd.	40 in. rev. cogging	3500/13700	50/100	600 v. (d.c.)	Dir. cpld.*	Westinghouse.
A. Hickman & Co.	26 in. bar	3000/9700	60/140	Direct current	Dir. cpld.*	Westinghouse.
Palmer's Shipbdg. & Iron Co., Ltd.	36 in. rev. finishing	3000/9500	45/120	900 v. (d.c.)	Dir. cpld.*	Westinghouse.
Patent Shaft & Axletree Co., Ltd.	36 in. rev. cogging	3000/8570	50/80	720 v. d.c.)	Direct*	Westinghouse.
Palmer's Shipbdg. & Iron Co., Ltd.	38 in. rev. cogging	2500/8500	40/75	800 v. (d.c.)	Direct*	Westinghouse.
Foster, Blackett & Wilson	Rev. lead rolling	90/180	435	460 v. (d.c.)	Geared*	Westinghouse.
Holman, Mitchell & Co., Ltd.	Rev. lead	90/180	120	550 v. (d.c.)	Geared*	Westinghouse.
The Ebbw Vale S., I. & C. Co.	Sheet	2000/5000	184	3 ph., 50 per., 2200 v.	Geared	Westinghouse.
Pearson & Knowles	Wire	1500	211	3 ph., 50 per., 2200 v.	Dir. cpld.†	Westinghouse.
F. Braby & Co., Ltd.	30 in. sheet	1300/3250	28/36	550 v. (d.c.)	Dir. cpld.	Westinghouse.
John Lysaght	Sheet	1300/3250	28/34	500 v. (d.c.)	Dir. cpld.*	Westinghouse.
Bolckow, Vaughan & Co., Ltd.	18 in. finishing	1200/2500	290	3 ph., 60 per., 2400 v.	Geared	Westinghouse.
Cargo Fleet Iron Co.	11 in.	100/2000	130/300	550 v. (d.c.)	Dir. cpld.	Westinghouse.
District I. & S. Co.	Con. 3 high, for finishing steel strips	1000/3000	245	3 ph., 50 per., 5000/5500 v.	Geared	Westinghouse.
District I. & S. Co.	12 in. continuous	1000/2300	180	3ph., 25pr., 5000/5500v.	Geared	Westinghouse.
Dorman, Long & Co.	3 high & 2 high finishing	800/2000	200/225	400 v. (d.c.)	Dir. cpld.	Westinghouse.
Cammell Laird	Tyre roughing	800	405	360 v. (d.c.)	Geared	Westinghouse.
		500	400	240 v. (d.c.)	Geared	Westinghouse.
Cammell Laird	Tyre finishing	800	500	500 v. (d.c.)		
Cammell Laird	Tyre finishing	750	480	3 ph., 50 per., 3000 v.	Geared	Westinghouse.
Sml. Fox & Co., Ltd.	14 in. dble. 2 high sheet	750/1690	125/200	500 v. (d.c.)	Dir. cpld.	Westinghouse.
Wm. Beardmore	Tyre finishing	700	490	3 ph., 25 per., 6500 v.	Geared	Westinghouse.
District I. & S. Co.	10 in.	600/2000	240	3 ph., 25 per., 5000 v.	Dir. cpld.	Westinghouse.
Effingham Steel Works	Strip	600	290	3 ph., 50 per., 3300 v.	Rope	Westinghouse.
Wm. Beardmore	Tyre roughing	600	405	345 v. (d.c.)	Geared	Westinghouse.
		400	585	230 v. (d.c.)	Geared	Westinghouse.
Holmes Steel Foundry Co.	Continuous	550/1200	363	3 ph., 50 per., 3000 v.	Rope	Westinghouse.
Smith & McLean	2 high sheet	500/1300	27·5/34·5	500 v. (d.c.)	Dir. cpld.	Westinghouse.
John Spencer & Sons	Patent 22 in. turnover	500/864	260/315	480 v. (d.c.)	Geared	Westinghouse.
Pather Iron & Steel Co.	3 high 12 in. merchant	500/1500	365	3 ph., 25 per., 400 v.	Ropes	Westinghouse.
Etna Iron & Steel Co.	3 high 12 in. merchant	500/1500	365	3 ph., 25 per., 400 v.	Ropes	Westinghouse.
The Glencairn Iron & Steel Co.	Merchant	500/1500	365	3 ph., 25 per., 440 v.	Rope	Westinghouse.
Bolckow, Vaughan & Co., Ltd.	16 in. roughing & finishing	500/1000	360	3 ph., 60 per., 2400 v.	Geared	Westinghouse.
Parkgate Iron & Steel Co., Ltd.	10 in. finishing	500	150/250	240 v. (d.c.)	Geared	Westinghouse.
		500/1000	150			
Tubes Limited	Piercer	500	730	3 ph., 25 per., 440 v.	Geared	Westinghouse.
Motherwell	10 in. merchant	500/1100	120/240	3 ph., 25 per., 2200 v.	Dir. cpld.	Westinghouse.
English McKenna Process Co.	6 rail re-rolling old rails, 1 merchant	500 350	290 250/125	3 ph., 50 per., 440 v.	Dbl. helic. gears	Westinghouse.

* With M.G. set.

† To countershaft.

Motor Equipment for Main Drive of Rolling Mills—*continued.*

Installed for	Description of mill.	Motor.		Supply.	Drive.	Installed by
		H.P.	Speed.			
The Mint, Birmingham	Merchant	400/1500	365	3 ph., 25 per., 440 v.	Geared	Westinghouse.
Birmingham Metal & Munitions	Cold copper, brass, nickel breaking down & rolling	400/800	365	3 ph., 25 per., 500 v.	Rope	Westinghouse.
Harts-Hill Iron Co.	10 in. 3 high finishing	350/700	220/400	650 v. (d.c.)	Geared	Westinghouse.
Redheugh Sheet Iron & Steel Co.	2 high sheet	350/1000	360	3 ph., 40 per., 400 v.	Ropes	Westinghouse.
Shelton I., S. & C. Co.	10 in. bar	350/700	450/720	500 v. (d.c.)	Ropes	Westinghouse.
Shelton I., S. & C. Co.	12 in. bar	350700	450/660	500 v. (d.c.)	Ropes	Westinghouse.
Fielding & Platt, Ltd.	Pilger	350	365	3 ph., 50 per., 2000 v.	Dir. cpld.	Westinghouse.
John Summers & Co.	3 high & 2 high strip	325/800	570	3 ph., 40 per., 400 v.	Ropes	Westinghouse.
Dorman, Long & Co.	3 high roughing	325/700	585	3 ph., 40 per., 2750 v.	Dbl. hel. gr.	Westinghouse.
District I. & S. Co.	Strip	300/700	360	3 ph., 25 per., 5000 v.	Geared	Westinghouse.
David Bennie & Sons	3 high roughing	300/600	250/330	500 v. (d.c.)	Dir. cpld.	Westinghouse.
Elliott's Metal Co., Ltd.	Cold brass rolling	300/600	365	3 ph., 25 per., 440 v.	Geared	Westinghouse.
Holmes Steel & Foundry Co., Ltd.	Steel strip rolling	300/600	240	3 ph., 50 per., 3000 v.	Dir. cpld.	Westinghouse.
Pitney Steel Rolling Mills, Ltd.	Cold brass	300/600	360	3 ph., 25 per., 5000 v.	Rope	Westinghouse.
Tividale Rolling Mills Co.	Cold roll	300/600	365	2 ph., 50 per., 200 v.	Geared	Westinghouse.
Tubes Limited	Piercer	300	290	3 ph., 25 per., 44 v.	Rope	Westinghouse.
Heeley Silver Mills, Ltd.	Cupro nickel cold rolling	300	365	3 ph., 50 per., 3300 v.	Geared	Westinghouse.
Perfecta Tubes, Ltd	Piercer	300	365	3 ph., 25 per., 440 v.	Geared	Westinghouse.
The Mint, Birmingham	Hot and rod	275/900	365	3 ph., 25 per., 440 v.	Dbl. hel.gr.	Westinghouse.
District Iron & Steel Co.	12 in. merchant & spoke	265/900	360	3 ph., 25 per., 440 v.	Geared	Westinghouse.
Etna Iron & Steel Co.	3 high 9 in. merchant	250/600	480	3 ph., 25 per., 440 v.	Ropes	Westinghouse.
G. Johnston & Co.	Sheet (brass)	250/700	240	3 ph., 25 per., 440 v.	Geared	Westinghouse.
British Insulated & Helsby Cable Co.	2 high sheet	250/375	350/380	240 v. (d.c.)	Belted	Westinghouse.
Victoria Iron Rolling Co.	......	250/290	210/700	460 v. (d.c.)	Dbl. hel.gr.	Westinghouse.
Evered & Co.	Strip	250/600	375	3 ph., 25 per., 400 v.	Dbl. hel.gr.	Westinghouse.
Parkgate Iron & Steel Co.	18 in. cogging	250/550	244	3 ph., 50 per., 3000 v.	Ropes	Westinghouse.
Muntz Metal	Tube piercing	250/300	485	3 ph., 25 per., 400 v.	Geared	Westinghouse.
The Mint, Birmingham	Brkng. dwn. & finshg. rolls	225/600	365	3 ph., 25 per., 440 v.	Dbl. hel.gr.	Westinghouse.
Holmes Steel & Foundry Co.	12 in. continuous roll	220/500	365	3 ph., 50 per., 3000 v.	Rope	Westinghouse.
Wm. Hunt & Son	Strip	200/450	365	3 ph., 25 per., 400 v.	Rope	Westinghouse.
Tubes Limited	Tube	200/450	365	3 ph., 25 per., 440 v.	Geared	Westinghouse.
J. Williams & Co.	2 high sheet	200/600	365	3 ph., 25 per., 400 v.	Ropes	Westinghouse.
W. Hunt & Sons (The Braides)	Special	200/600	365	3 ph., 25 per., 400 v.	Ropes	Westinghouse.
W. H. Moore & Son	Sheet (brass)	200/600	240	3 ph., 25 per., 440 v.	Geared	Westinghouse.
Jonas & Colver	Bar	200	500	2 ph., 50 per., 200 v.	Belted	Westinghouse.
J. Brown & Co.	12 in. merchant	200	200/450	230 v. (d.c.)	Dbl. hel.gr.	Westinghouse.
J. Brown & Co.	12 in. merchant	200	200/450	230 v. (d.c.)	Dbl. hel.gr.	Westinghouse.
Tubes Limited	Tube	200	365	3 ph., 25 per., 440 v.	Rope	Westinghouse.
Perfecta Tubes, Ltd	Breaking down	200	365	3 ph., 25 per., 440 v.	Geared	Westinghouse.
Birmingham Metal & Munitions	2 high sheet (brass & cop.)	two 160/500	365	3 ph., 25 per., 400 v.	Dbl. hel.gr.	Westinghouse.
W. Jessop & Sons	Merchant	150/300	216	500 v. (d.c.)	Dir. cpld.	Westinghouse.
David Bennie & Sons	2 high finishing	150/300	200/265	500 v. (d.c.)	Dir. cpld.	Westinghouse.
Oldbury Rolling Mills	3 high merchant	150/400	480	3 ph., 25 per., 400 v.	Dbl.hel.gr.	Westinghouse.
Harrison & Co.	Cold brass	150/300	480	3 ph., 25 per., 440 v.	Geared	Westinghouse.
Sir W. G. Armstrong, Whitworth	Brass sheet rolling	150	390	3 ph., 40 per., 440 v.	Geared	Westinghouse.
Perfecta Tubes, Ltd	Breaking down	150	365	3 ph., 25 per., 440 v.	Geared	Westinghouse.
W. H. Robertson, Ltd.	Groove	150	640	110 v. (d.c.)	Geared	Westinghouse.
Britannia Tube Co.	Brass rolling	150	240	3 ph., 25 per., 440 v.	Rope	Westinghouse.
Barker Bros., Ltd., Birmingham	Cold roll for German silver	130/400	480	3 ph., 25 per., 440 v.	Belt drvn.	Westinghouse.
Bassett, Bagnall & Co.	Strip	125/190	575	500 v. (d.c.)	Dbl. hel. gr.	Westinghouse.
Hall Street Metal Rolling Co., Ltd	Cold brass	125/250	480	3 ph., 25 per., 440 v.	Rope	Westinghouse.
Harrison & Co.	Cold brass	100/225	480	3 ph., 25 per., 440 v.	Geared	Westinghouse.
C. A. Robinson & Co.	Strip	100/250	480	2 ph., 50 per., 200 v.	Dbl. hel.gr.	Westinghouse.
The Empire Aluminium Co.	Aluminium sheet	100/200	400	500 v. (d.c.)	Dir. cpld.	Westinghouse.
Rotherham Forge & Rolling Mill Co.	8 in. rod	100	725	3 ph., 50 per., 3000 v.	Geared	Westinghouse.
Foster, Blackett & Wilson	2 high lead sheet	90	570	3 ph., 40 per., 400 v.	...	Westinghouse.
R. B. Byass & Co.	Copper (2 sets)	90	500	500 v. (d.c.)	Geared	Westinghouse.
Mardy Tinplate Co.	Three sheet	80/200	300	400 v. (d.c.)	Geared	Westinghouse.

Note.—The British Westinghouse Company (abbreviated above to Westinghouse) is now known as the Metropolitan-Vickers Electrica Company. Similar work is also carried out by the Electric Construction Company, the English Electric Company, the General Electric Company, and Vickers Limited, but the required data were not available in time for this issue.

The Gattie Transport Scheme.

Further evidence in support of Mr. A. W. Gattie's transport scheme has been heard by the Board of Trade Committee.

Mr. Roy Horniman, director of the New Transport Company, stated that there were more than 3,000 acres of land occupied in London by goods yards, representing a value of 45 to 50 million pounds, while the value of such yards for the whole country was over 300 million pounds. The abolition of shunting would allow an economy of 680,000 of the railway-owned wagons in use to-day, and the remainder would be enough and to spare to deal with the country's goods traffic. The abolition of shunting would do away with well over 70 per cent. of the locomotive work in London. The railways would save £52,136,000 per annum. Cheap cartage and transport would also be a great benefit to agriculture. He had no doubt that when Mr. Gattie's scheme was working, private cartage would in time disappear. Our private freight rates were the highest in the world, as they must be under the present extraordinary terminal arrangements. A rough and ready estimate of the outlay necessary before the benefit of the Gattie economics could be realised, was between 300 and 400 million pounds. He agreed that 5,000,000 workers would be displaced by the clearing-house scheme, but 400,000 would be absorbed in the building of the clearing houses, and the establishment of the clearing-house system would give such an impetus to trade that there would be an enormous " boom " in labour. Districts which had died industrially would be restored.

Mr. H. W. Flatau, timber broker, said that the Surrey Docks were hopelessly behind any other port in Europe. For all practical purposes the Surrey Docks were without railway facilities, and cargoes had to be conveyed to the vans practically as they were a hundred years ago, on men's backs, and transported in that primitive manner to the various railway stations. The Gattie scheme of mechanical transport would be a great asset at the Surrey Docks, and it would obviate much delay by stopping congestion of the quays.

Mr. G. W. Shirgo, representing a parcel express agency, said that vanmen often waited four or five hours at a station before getting unloaded. Recently a man went twice to the same station with goods and, owing to the congestion, had to return with the goods each time; and that was his day's work. He gave instances of serious delay caused by the present system.

Mr. Arthur E. Collins, City Engineer of Norwich, though the Gattie scheme would effect a considerable saving in the wear and tear of roads, and reduce expenditure. Terminal charges were very high in this country. The application of the Gattie system would mean that railways would be able to deal with goods so rapidly and cheaply that road traffic would be almost shut out, as it could not compete with the railway.

Electric Furnaces for Heat Treatment of Steel.

THE expression "Heat Treatment" is one which has been generally adopted because of its more general and embracing connotation than the particular and exclusive expression "hardening." The latter operation is obviously only one function that may be carried out by an electric furnace designed for the purpose, and to limit ourselves to this title excludes other operations and investigations for which such a furnace may be applicable. This preamble is necessary, because strictly speaking, there are only two general types of electric furnaces in use, namely, furnaces for melting and furnaces for heat treatment. All the electro-metallurgical processes embracing the conversion of electric into heat energy are confined to these two general types.

However, whilst electric melting furnaces can trace their inception and commercial application well back into the last century, furnaces for the heat treatment of steel are of comparatively recent development, well within the present century. The really vital developments may indeed be attributed to the tremendous stimulus for research, precision and rapidity of manufacture provided by the great war.

The inception of electric furnaces for heat treatment arose, without doubt, from the excellent results obtained by electric melting. Manufacturers and chemists, seeing how electricity served them in this respect, became more alive to the fact that the subsequent operations with fuel-fired furnaces did not give the desired accuracy and were not subject to adequate control, in spite of the low cost of fuel. It began to be recognised that exactness of temperature control and consequent uniformity of the steel could only be obtained by electric treatment. This being once appreciated, provided the necessary inducement to investigation and research, leading up to the present developments which, to use a very hackneyed phrase, are still in their infancy.

HISTORICAL.

Some of the earlier attempts at electric heat treatment may be passed over briefly, bearing in mind that history has been made so quickly with the processes under consideration.

One method for hardening the points of tools was to connect one pole of a dynamo to the tool and the other to a cast-iron tank, containing a bath of potassium carbonate solution. The tool was then partially immersed in the bath, thus completing the circuit and setting up heat in the immersed part. When the latter was considered to be sufficiently heated, the current was switched off and the solution chilled and hardened the point of the tool.

Another method was to place the tool on a bed of refractory material and to start an arc at the point with a carbon electrode, gradually increasing this arc as required.

A third method of heat treatment, namely, tempering milling cutters, &c., was to mount the tool on a mandrel which formed part of the circuit of a single-turn low-resistance secondary of a low-voltage transformer. The current was maintained until the colour of the tool attained the desired shade.

It is obvious that methods such as these are extremely crude and unreliable, and it is not surprising, therefore, that they have given place to others of a more accurate and controllable kind.

TYPES OF FURNACES.

Electric furnaces for heat treatment may be roughly divided into two main types :—

1. Electrode furnaces, which, like the melting furnaces, make use of the arc, but apply it in a different manner.

2. Resistance furnaces, which derive their heat from resistance windings of wire, or from carbon resistances.

These types may be further sub-divided into two classes :—

(*a*) Dry furnaces.

(*b*) Salt bath furnaces.

ELECTRODE FURNACES.

Probably the earliest of this type of a commercial nature was the furnace designed by Moissan, for his experiments in connection with the production of diamonds. It is of the dry class, the two carbon electrodes forming the arc between them in a cavity of refractory material, which radiates the heat on to the substance under treatment below. A modification of this furnace is made by Messrs. Marryat & Place, of 28, Hatton Garden, London, E.C., for laboratory use, in several sizes up to 1,000 amperes with direct current or alternating current at 50 to 100 volts.

A hardening furnace of the salt bath type was introduced by the A.E.G. many years ago, and is still to be found in use. Essentially, this comprised a fireclay crucible containing the salt bath and two electrodes of Swedish ingot iron. The crucible is surrounded by an asbestos lining, a fireclay jacket and a layer of insulation, the whole being contained in a cast-iron case. The heating of the salts is effected by an auxiliary electrode and a piece of arc lamp carbon, and when the salts are fused it is claimed that there is uniformity of temperature throughout the whole bath, except in an upper layer about ½ in. thick where it is 11°-19°C. lower owing to radiation. The furnace is used with alternating current single-phase 25-60 cycles. Various kinds of salts are used to produce temperatures varying from 205° to 1590°C., so that the furnace can be used for tempering steel, annealing non-ferrous metals, hardening carbon steel and hardening high-speed steel. The starting voltage is 70 volts, but 5 to 30 volts serve to maintain the temperature, the control being by transformer.

The disadvantages of a salt bath electrode furnace of this type are :—

Inefficiency due to heat losses from electrodes and radiation from the top.

Permeation by salts of fireclay to the iron case, producing further heat losses.

Deterioration of electrodes and fireclay.

During the last few years the study and production of high-speed steel have advanced with rapid strides, but its electric heat treatment on a commercial scale, with accuracy and proper control has still to be attained. In this connection an electrical furnace marking an entirely new departure is being developed, which, it is claimed, will be suitable for both hardening and melting, without the disadvantages of the A E.G. type.

RESISTANCE FURNACES.

As already stated, these derive heat from :—

(*a*) Resistance windings, consisting of bare high-resistance wire. They are generally known as "wound" furnaces, and may be either of the dry or salt bath classes.

(*b*) Carbon resistances, longitudinally arranged, or pressed carbon rings. These are generally known as "resistor" furnaces and are of the dry class.

Wound furnaces of either class are necessarily, from the nature of their construction, relatively small, because when a certain limit of size is exceeded the cost of the winding would become prohibitive. The wound dry class, therefore, embraces tube, rectangular, D-shaped and tubular muffles (vertical) and oven furnaces (horizontal). The chief makers of these are A. Gallenkamp & Company, Ltd., of 19-21, Sun street, Finsbury Square, E.C.; The Bastian Electric Co., Ltd., 185, Wardour-street, W.; and Automatic & Electric Furnaces, Ltd., of 281-283, Grays Inn-road, W.C.1.

Gallenkamp's patent furnaces are essentially for laboratory purposes. The heating chamber is of fused silica or of alundum wound with a high resistance alloy wire for temperatures up to 1,000°C. The winding is protected with a special cement which keeps the coils stationary. The lagging is in the form of slabs consisting chiefly of silica, and the space between the winding and the lagging is packed with a special insulating material, held together by four steel tie-rods, and the whole is inserted in a sheet-iron case on four angle-iron legs. These furnaces can be used either on direct-current or alternating-current circuits, and may be wound for any voltage up to 250 volts. They comprise tube furnaces (single, double and quadruple tubes) in many standard sizes; explosion tube furnaces for heating substances in glass tubes up to 400°C.; rectangular muffles and crucible furnaces. One of the chief advantages of this make is that the heating element can easily be replaced. The Bastian Electric Co., Ltd., manufacture dry wound muffle, crucible, and tube furnaces on the same principle but only in one size, although others are in course of preparation.

The wound furnaces (dry class), manufactured by Automatic & Electric Furnaces, Ltd., also comprise similar types in many sizes. The design is, however, different. A silica pot is wound with special resistance wire and surrounded by a metal case with suitable legs or stand, the space between being tightly packed with a special lagging. The temperature limit (normal) is also 1,000°C., and the furnaces are wound for any direct-current or alternating-current voltage between 100 and 500 volts.

With all these makes the power consumptions are about the same for similar sizes, but the last mentioned firm's sizes run larger and extend to oven furnaces for annealing glass, baking, drying, &c., up to about 600°C. Other uses to which dry wound furnaces can be put include laboratory experiments with steel, analysis of ash in organic substances, reductions, incinerations, &c., and in the larger sizes, annealing and hardening tools and small steel articles on a commercial scale, firing artificial teeth, &c. A further development of muffles under the Bastian and Wild-Barfield patents will be referred to later on.

Wound furnaces of the salt bath class are at present exclusively manufactured by Automatic & Electric Furnaces, Ltd., under the Wild-Barfield patents. This invention has been described previously in detail in these pages[*], but a brief account may be given here. In the ordinary heat treatment furnace, the steel is heated to an empirical temperature (controlled by a pyrometer) communicated by the steel maker. The temperature may be right or wrong, or may not be correct for each lot of steel supplied; the pyrometer may be faulty or may be wrongly read by the manipulator, or he may remove the steel from the furnace just too soon or just too late. In any case there is plenty of room for human error. The Wild-Barfield patents cover (besides the leaving of a cool edge at the upper part of the crucible) an automatic device for determining the point of decalescence of the steel without possibility of human error. This is based on the well-known fact that when carbon steel reached the point of decalescence it suddenly loses any magnetism it may contain.

The Wild-Barfield patent furnace comprises a silica crucible wound as to about two-thirds of its height (or less) with a special resistance wire (this object being to prevent the salts creeping over the edge), surrounded by a fire-clay cylinder, the space between being packed with a special lagging. The outer cylinder is wound with a so-called pyroscopic detector coil, which is connected to a ballistic mirror galvanometer. The crucible contains a special salt, and a quenching bath is provided, built on the same principle, but without the pyroscopic coil and containing another special salt. Now, when the current passes through the inner winding, the heat generated fuses the salt in the crucible up to about 850°C. (which is purposely somewhat higher than the critical point in order that the steel may heat up quickly). When the steel article is suspended in the salt bath it not only heats up but becomes magnetised by reason of the winding round the crucible. This causes a flow of magnetism through the outer (or pyroscopic) coil and induces a current in it, which causes a permanent deflection of the galvanometer spot. At the point of decalescence the disappearance of the magnetism in the scale induces a current in the opposite direction. The galvanometer spot travels back and the operator then removes the steel articles and quenches them.

It is claimed that by this process the critical point is accurately determinable and the best desired degree of hardness and grain is obtained, whilst there is absolute uniformity of heating, and distortion is reduced to a minimum. It therefore marks a great advance in electric heat treatment which need no longer be based on empirical standards. The furnaces are made in sizes from 2 in. to 12 in. in diameter, and so quick is the operation that the largest size will handle about 65 lb. of work per hour, or say, 1 ton per week. A recent modification embodies a pouring type of furnace, the molten salts being poured out into a container when the furnace is shut down.

The patent pyroscopic detector principle is now being applied also to electric muffles when required, and to coke and gas fired muffles for large work. In the latter case, the coil which is adapted to the muffle has two windings, one for connecting to the electric supply for providing the necessary magnetising current (about 200 watts), and the other being the pyroscopic winding. By this means, the low cost of coke firing is combined with the accuracy of the Wild-Barfield furnace, in that the work can be removed from the furnace at the point of decalescence without the use of a pyrometer.

Resistor Furnaces.

The Bastian Electric Company, Ltd., also make use of the peculiarity of steel, that its magnetism vanishes at the point of decalescence, in an invention (patent applied for) which they apply to their furnaces already referred to. In this arrangement a delicate magnetic compass is adjustably mounted on the exterior of the furnace casing. The heat chamber is encircled with a wire winding which serves as a magnetising coil, and in the case of electrically heated furnaces the magnetising coil can also serve as the heating coil.

The polarity of the magnetising coil and the position of the furnace in relation to the earth's magnetic field are so correlated that when the furnace is charged with steel the compass is deflected from its normal position by about 180 deg. Directly the steel reaches the change point or temperature of decalescence, the compass needle swings steadily back to its former normal position under the influence of the earth's magnetic field, which latter is much stronger than the stray field from the magnetising coil. The movement of the compass needle can be adapted so as to cause an electric bell to ring, or to automatically discharge the furnace.

This type of dry resistance furnace was evolved in the United States, and further developed during the war. When the Americans received orders from the Allies and were confronted with the rigid specifications which we all know, they recognised that there was no time to commence research work, which had already been undertaken here, and so they took a short cut to obtain the accuracy and uniformity desired, by developing the electric muffle principle on a large commercial scale.

The furnaces consist essentially of fire-brick walls and heat-insulating material enclosed in steel frame work, with troughs of refractory material running lengthwise along both sides of the interior and filled with the resistor material, consisting of broken carbon or graphite, with copper electrodes at the ends. The heat from these troughs is radiated to the furnace roof and reflected down on the charge, which is fed on to suitable mechanical sliding devices by a pusher mechanism. Automatic control of the temperature (empirical) is obtained by contact making pyrometers located at the discharge end of the furnace. These actuate a pyrometer instrument which, through relays, operates a valve-pulpit device, which in turn raises the charge door of the furnace, swings a manipulator under the discharge door, causes the pusher to insert a fresh charge, discharges the treated charge on to the manipulator platform, and this, when centred there, is removed by the manipulator from the furnace and plunged into the quencher, the pusher being withdrawn and the door closed. A time-element device now comes into play which holds the charge in the quenching bath for a definite time, then raises it on to the platform of a second furnace ("drawing" furnace), where it remains until the pyrometer of the second furnace puts into play a similar operation. Thus the heat treatment—hardening, quenching, annealing or whatever the case may be, is as automatic as possible based on an empirical temperature.

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[*] *See* The Electrician, Vol. lxxix., p. 629, 1917.

The resistor material is, of course, subject to wastage, which causes fluctuations. These occur only during the heating up of the furnace previous to inserting a charge, and are at once indicated at the switchboard and easily corrected by adding more material and manipulating one or more oil-break switches of the regulating transformer. When the desired temperature has been attained the resistance remains practically constant.

The following are some data of two furnaces used for treating crankshafts for ground and aeroplane engines :—

Hearth	20 ft. by 7 ft.
Capacity	72 tons per 24 hours
Temperature	870°C.
Consumption 1st......	600 kw., two-phase, 60 cycles, 320 and 120 volts.
,, 2nd ...	300 kw. single-phase, heating troughs run in parallel

Maximum temperature variation not more than 6°C.

It is claimed that one unit operated recently for over eight months and treated more than 14,000 tons of steel, and that there were no rejections due to heat treatment. Other sizes and types have been in use, but space prevents a description of these. It may, however, be mentioned that the system has been applied to the treatment of shell billets before forging, to steel strip in large lengths, and that an electric soaking pit for hot ingots has been under consideration, which it is claimed will compete with gas, ensure freedom from scale and uniformity of heat and material.

Much more might be written about electric heat treatment of steel, and reference made to numerous designs differing only slightly from the muffle furnaces already described, but the subject may be summarised by stating that whilst electric heating alone cannot compete with the cost of gas or coke firing, the advantages of control, accuracy, uniformity, absence of distortion and oxidation and smallness of rejections, are so enormous that there is no question that the future is with the electric furnace.

The Municipal Tramways Association.

At the Annual Conference of this Association last week the following discussion took place upon Mr. Councillor Kelly's Paper " Where Do We Stand ? " (which was abstracted in our last issue) :—

Coun. J. W. **Squires**, J.P. (chairman of London County Council Highways Committee) said be had heard the remark that Glasgow was the Mecca of tramways, but the traffic question in London presented features which had no parallel in other traffic centres owing to the magnitude of the area and the exceptional requirements, and there were forces of partisanship and controversy brought into play which were not known elsewhere. London was not master in its own house like great municipal republics such as Manchester, Liverpool, and Glasgow. He deprecated sweeping generalisations in favour of either tramways or motor-buses, but the brightly-painted motor-bus compared very favourably with the often dingy tramway car. They ought to beware of embarking on a capital expenditure on permanent works which would tie them for all time to a particular form of traction on certain routes. He thought the advantage of underground systems for certain classes of thoroughfares admitted of argument. In London the hands of the London County Council had been forced because 28 local authorities had it in their power to veto the use of overhead traction, and they had not always used that power with mercy, discretion, or judgment. Some local authorities had pandered to the public outcry against increased fares. The only sound and possible line to take was that the tramways must pay their way, but the public should be convinced of the reasonableness and necessity of the arrangements which were made. Above all, it must be remembered in framing their tramway policy that the spectre of national bankruptcy was in every mind.

Coun. **Jackson** (Liverpool) said other countries were showing much more progress than was being shown at home, and both mechanically and electrically there was much to be learned in the United Kingdom. He supported Coun. Kelly's suggestion that municipalities should give their managers an opportunity of visiting other countries, and he would urge that the general manager, the deputy manager, and the electrical engineer should be allowed to visit the whole world if necessary, and the vision, the outlook, and the practical knowledge they would gain would be of great value, and would lead to the introduction of new ideas of transport. Coun. Jackson also advocated a more thorough system of collecting fares, as he believed considerable sums were lost through the want of such methods, and he urged that substantial salaries should be paid to secure the best men to place at the head of municipal tramways.

Coun. **Turner** (Chairman of Belfast Tramways Committee) declared the salaries paid to tramway managers were in many cases inadequate for the services rendered. On the other hand, though employees should be treated generously, a stand must be made somewhere. The time had come to pull up, to take stock, and to look to the future.

Ald. **Fenton** (Deputy-Chairman of Sheffield Tramways Committee) did not admit that the alternative to buying rails abroad was to allow the track to go to ruin. He was not sure the Glasgow Corporation did a good thing when they went to America for rails in view of the debt this country already owed to America. He thought all tramway undertakings should purchase rails from British manufacturers, even though they paid a little more per ton. He advocated the conferring of greater powers on large corporations, so that they could carry out local schemes without the cost and inconvenience of going to Parliament.

Coun. **Irving**, M.P. (Vice-Chairman of Birmingham Tramways Committee), said profit-making in the monetary sense, and as it entered into private concerns, should not enter into tramway or any other municipal undertakings; the comfort, convenience, and pleasure of the citizens should be the paramount consideration. They needed a considerable margin to meet possible loss, but when it was not so required, that money should be used to free the tramway undertakings of liability, and not for the reduction of rates.

Coun. **Collins** (Nottingham) maintained that a tramway undertaking had a right to make a profit. He thought they had come to the parting of the ways with regard to the demands of labour.

The **Author**, replying to the discussion, said Glasgow Corporation's policy had always been to support home industry, though the cost of purchasing the home material should be greater, all other things being equal, but they had no option but to accept the American offer for rails. The material was urgently required, and the English makers could not give delivery for some months. They simply loved the halfpenny fare in Glasgow, and would not let it go, and the consequence was that they were now very near bedrock. His expectation was their general manager would have to report that in the first three months of the present year they were not paying working expenses.

The following discussion took place upon Mr. A. R. **Fearnley**'s Paper on " Motor Omnibus Services," which was also abstracted in our last issue :—

Ald. E. **Russell Taylor**, J.P. (Chairman of Liverpool Tramways Committee), said there were vast possibilities in the motor-bus. To-day the motor-bus was a very keen rival to the tramway, because of the ever-increasing cost of the permanent way or track, and the extraordinary cost of underground ways and overhead equipment. Another factor for the consideration of engineers was the great development of the internal combustion engine, which by its application to traction rendered it a formidable competitor to the tramway system. The initial capital expenditure of the tramway system was infinitely greater than that of motor-buses, while the cost of maintenance per mile was similar, so far as their experience in Liverpool showed; but the life of the tramcar was somewhat longer than that of the omnibus. In regard to earning capacity the motor-buses were greatly handicapped. A recent Act of Parliament, obviously framed at the instance of road authorities to protect the roads against motors, had a clause restricting the size of the motor-bus, so that this vehicle could not have the same seating accommodation and earning power as the tramcar; but with the advent of the Ministry of Transport it was to be hoped this anomaly would disappear and the motor be given a fair chance. The motor-bus, owing to its great mobility was capable of making a greater number of journeys than the tramcars within a given time, and its course could always be diverted to avoid obstruction. Both forms of transport could be usefully employed in dealing with the congestion of passenger traffic in large centres, but he believed at no distant date municipalities would have more motor-buses than tramcars. The financial difficulties of municipal transport should be met, not by the tax-payer, but by the fare-payer.

Mr. **Harry Webber** (Manager, Keighley Tramways) said he could not conceive how any tramway manager, in dealing with the subject of motor-buses, could fail to consider the other alternative to the tramcar—namely, the trackless trolley, which was half-way between the tramcar and the motor.

Mr. J. B. **Hamilton** (Manager, Leeds Corporation Tramways) pointed out that Ald. Russell, when he said the capital expenditure involved in the tramway was greater than that of the motor-bus, failed to take into consideration that roads over which municipal omnibuses ran had to be maintained by municipalities. So far as his experience went, it had been found that the cost of operating the motor-bus was double that of operating the tramcar. Carrying people in motor 'buses from and to industrial districts was like taking soup with a tea-spoon. If tramcars were made more convenient for exit and entrance, and were able to ply more quickly, and if the noise of gears and wheels could be decreased, they had in tramways one of the best methods of moving large bodies of people. Both forms of transport were capable of development.

Mr. James Dalrymple (Manager, Glasgow Tramways) said Mr. Fearnley indicated that there was a point at which he thought it was desirable to discard motor-buses in favour of tramways, and he would like to know at what point the change should be made, and the lines laid down. Many of them were contemplating extensions from their present termini to populations two or three miles farther out, and they would like to know if it was worth their while purchasing omnibuses for that service, or whether they should proceed at once to lay tramway lines.

Ald. Sir John W. Courtis (Cardiff) pointed out that roads would have to be very different in construction to the present roads if there was to be increased motor-bus services, with greater seating capacity. Cardiff had under consideration the question of initiating a municipal motor service, but he was a believer in the tramways.

Mr. R. H. Wilkinson (Manager, Bradford Tramways) thought the motor-bus was only at the fringe of its career, and could be improved to such an extent that it would become a very serious competitor with the tramways.

Mr. J. M. M'Elroy (Manager, Manchester Tramways) said the transport problem in the great cities wore a different complexion to the problem in the suburbs. In regard to the usefulness of trackless trollies and motor-buses, one had to take local circumstances into account; but, in his opinion, for carrying great tides of traffic into and out of large centres of population, the tramway car held the field for the moment.

Coun. J. W. Squires, J.P. (London County Council), was of opinion that there was ample room for both tramways and motor-buses. In London there were roads upon which motor-buses would save tremendous expense, and, generally speaking, the initiation of motor-bus services was a valuable means of finding out whether in the near future it would pay to put down tramway lines.

Coun. Turner (Belfast) agreed that the motor-bus served its best purpose by being a pioneer of tramway extension.

The Author replying to the discussion, said he could not dogmatise as to the point at which it was advisable to substitute the tramway for the omnibus service, for the reason that the traffic in a particular district might be week-end or summer traffic, and each case must be decided by the attending circumstances.

The Conference then terminated.

At the subsequent business meeting, Ald. Sir John W. Courtis (Cardiff) was unanimously elected president for the ensuing year, and Mr. G. W. Holford (Salford), vice-president.

The annual report of the Executive Council (abstracted below) was adopted.

Report of the Executive Council.

The following is an abstract of the Council's report, which was submitted to the Annual General Meeting after the Conference :—

The total membership is 201. There are 97 local authorities in Great Britain owning and working tramways, and 85 of these are members of the Association.

Upon the resignation of Mr. Clough from the office of Honorary Secretary, owing to his having obtained an appointment outside the Municipal service, Mr. Holford (Salford) consented to occupy the position until the appointment of a general secretary. Applications for the position were invited in May last, and Mr. J. Beckett, F.S.A.A., Borough Treasurer of Accrington, was appointed out of 740 applicants, at a salary of £850 per annum. He will also discharge the duties of Secretary of the Municipal Employers on the new Joint Industrial Council. At a special meeting of the Association in May last it was decided to discontinue the meetings of the Municipal Tramways Conference which had been dealing with matters of wages, &c., and in future the subject should be dealt with by the Association.

A new scale of annual subscriptions is set out in the report, varying from 10 guineas when the revenue of an undertaking is under £20,000 to 100 guineas when it is over £1,000,000.

The Joint Committee, the appointment of which was referred to in last year's report, have continued their deliberations on the standardisation of overhead line material, and will submit their recommendations to the Association in due course, and the Executive Council hope to report fully on the question of wear and tear allowances for income tax.

At the suggestion of the Tramways and Light Railways Association, the Council elected a sub-committee, consisting of Mr. Fell, Mr. Mozley, Mr. Silvers and Mr. Holford (hon. secretary), to confer with them on the subject of the standardisation of gear wheels, pinions and axles, and the work was still proceeding. Mr. Baker and Mr. Fell were appointed to confer with representatives of the Board of Trade and the Home Office on the subject of future regulations as to tramcar lighting. Up to the present no new regulations have been issued. Mr. Mozley has succeeded Mr. Fearnley as the representative of the Association on the Electric Vehicle Committee, and Messrs. Craven, Fell and Silvers were appointed to represent the Association on the Committee on Standardization of Wheels, Axles, &c., and Messrs. Fell, Hamilton and McElroy represent the Association on the British Engineering Standards Committee *re* Rails.

During the year the Council received a communication from the Secretary of the British Engineering Standards Association, saying that the sub-committee dealing with the standardisation of Wheel Centres had decided to recommend the adoption of the following sizes for wheel centres, viz. : (1) A standard driving wheel centre of 27 in., with alternative dimensions of 32 in. or 33 in. over the tread. (2) A standard pony wheel of 17 in., with a dimension of 22 in. over the tread.

A recommendation was forwarded to the Board of Trade, stating that, in the opinion of the Council, folding steps to tram cars are neither requisite nor desirable, and suggesting that the Board should withdraw the clauses in their regulations requiring these to be provided.

A list is given of the 44 members of the new Joint Industrial Council for the Tramway Industry, of whom 14 represent the Municipal Tramways Association, 8 the Tramways and Light Railways Association, and 22 the Employees.

The Transport Bill, 1919, is next dealt with, and extracts from the Bill and from the proceedings in Parliament are given.

In regard to the Statutory Undertakings (Temporary Increase of Charges) Act, 1918, the Council are of opinion that the recognition of ample annual provision for depreciation for wasting assets is of cardinal importance, and they will be glad to be informed from time to time of members' experience in relation to it.

Other matters dealt with are : (1) The exclusion of car sheds from the relief from taxation allowed on account of depreciation of buildings, which exclusion the Council consider unjustified ; (2) the Electricity (Supply) Bill, 1919, and (3) the Report of the Select Committee of the House of Commons on Local Legislation dealing with the anomaly of making municipal authorities pay for upkeep of roads and not private enterprises.

The ordinary income of the Association for the year was £386, and the expenditure £370.

On the evening of the opening day of the conference, the delegates and visitors were entertained by the Lord Provost, magistrates and Town Council of Dundee at a dinner in the Albert Hall, and the Association's annual luncheon took place on the second day, also in the Albert Hall. The delegates and their friends were given opportunities to visit local works, and to take part in river and other excursions.

Siemens Pocket Lamps and Dry Batteries.

Messrs. Siemens Brothers & Company, Ltd., Palace-place Mansions, Kensington-court, W.8, and Woolwich, S.E., have recently issued their catalogue No. 538, of pocket lamps and torches, dry battery refills, Wotan flashlight lamps, &c. Particulars and prices are given, and illustrations of many standard types are included. The manufacture of dry batteries has now been continued uninterruptedly for over 25 years at the company's Woolwich works, and it is claimed that the researches carried out and manufacturing experience gained by them during this period enable them to produce dry batteries for pocket lamps and torches possessing all the high qualities which have gained for their dry cells generally a very high reputation. The extensions made in the primary battery department at the Woolwich factory in order to meet the demands of the Government for dry cells for war purposes now enable them to execute promptly orders for these small batteries in large quantities. The company are also in a position to supply cases for the batteries ; these cases are neat in appearance and substantial in construction, and the complete article (case, battery and lamp) is claimed to be thoroughly dependable. Fig. 1 shows a baby torch pattern (two-cell) dry battery and Fig. 2 a small three-cell pocket battery.

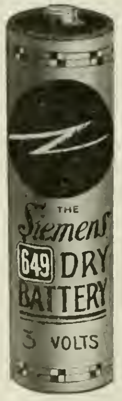


Fig. 1.

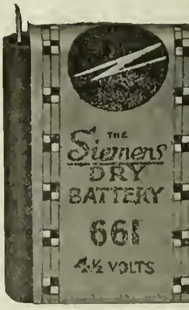


Fig. 2.

Electricity Supply Commercial Association.

During the week ended Sept. 13 a number of mass meetings were held in the Provinces under the auspices of this Association, and "something attempted, something done" appears to have been the keynote of the proceedings at the various gatherings. The meetings were organised by the National Council in order to give existing members a full report of the Association's activities and to extend an invitation to all eligible members of electricity undertakings to join the Association.

The opening meeting took place at Manchester on Sept. 8, Mr. Kingston (Chairman West Yorks Division) presiding over a large attendance. He was supported by the President of the E.P.E.A., representatives of the West Yorks and Lancs Divisions, and the General Secretary of the Electricity Supply Commercial Association (Mr. G. R. Smith).

In his address Mr. Smith supplied details of the many phases of the Association's work and usefulness. Considering that the Association, as it is now known, was only formed in February last by the amalgamation of the Chief Commercial Officers' Association and the Clerical Assistants' Association, he said the progress made had been truly remarkable. To enrol nearly 2,000 members in that short period was a great accomplishment in itself. Mr. Smith went on to trace its progress through the process of forming a new set of rules; of registering the Association as a Trade Union; the organisation of the divisions and local government; its efforts during the dark days of the war in dealing with the questions of inadequate war bonuses and salaries (giving many cases in which individual members benefited materially through these efforts); its work in connection with the protection of its members under the clauses of the Electricity (Supply) Bill, and the question of representation on Industrial Councils; its successful struggle to obtain recognition as the only authority set up to represent exclusively the interests of its members and all members of the commercial and clerical staffs of electricity supply and tramway undertakings; its work in connection with the new Federation of Technical, Scientific and Professional Associations; to an outline of the Association's general policy and outlook. Mr. Smith's address was received with enthusiasm by the audience. Quite apart from the questions of protection, status, salary, &c., the National Council is convinced that the Association is a power for good and is doing a great deal of good in binding together the members in good fellowship and in promoting educational questions in order to improve the personnel of members whose status they are endeavouring to raise.

The President of the E.P.E.A. also addressed the meeting showing the various ways in which the E.P.E.A. and the Commercial Association are working together in common purpose, and touched briefly on the questions of federation and direct affiliation. Representatives from West Yorks and Lancashire Divisions also gave brief addresses, after which a unanimous pledge of support to the Association was carried.

At the West Yorks meeting held at Leeds on Sept. 9th, the Lancashire meeting at Liverpool on Sept. 11th, and at the West Midlands Division at Birmingham on Sept. 13th, a similar programme was adopted before large attendances. We are informed that everywhere the meetings were very successful and were marked with keen enthusiasm. At Leeds a representative of the North Eastern Division assured the members of the keen interest of nearly 200 members of his Division.

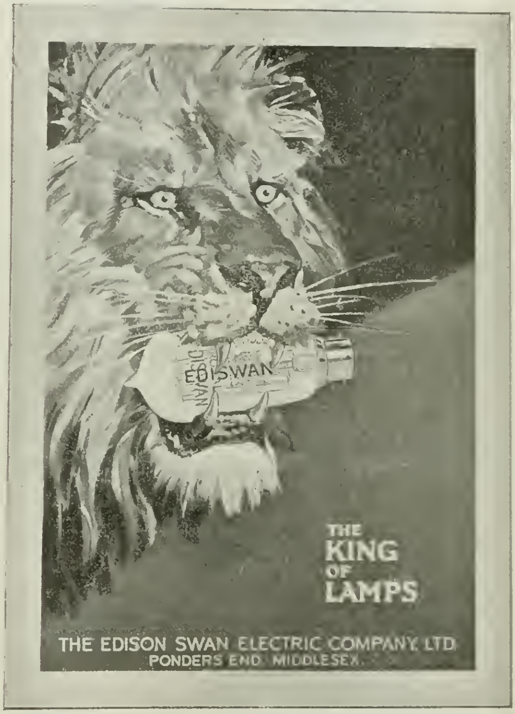
The last of the series of meetings was held at Birmingham, where a splendid concert, organised by the West Midland Council, was enjoyed. The President of the Association was also present and delivered an address exhorting the members to study hard to secure greater efficiency, to be calm in judgment, dignified in reverses, to work for improving the status of the Association, and to increase its power by making its objects more widely known and its membership greatly increased.

In addition, the hon. general secretary also addressed the meeting and said those gatherings were held for a twofold purpose. Existing members had many points of interest explained to them and those proposing to join obtained a clear understanding of the work and purpose of the Association. Meetings of that nature often had far-reaching results, but direct proof was at hand to show that well over 100 new members had been obtained. The Association believed that it could take a great part in educating not only its members, but the general public on the needs of developing the electrical industry, and schemes to that end were under consideration. They were living in difficult times where rigid economy had to be displayed, but he believed that the present great age of reconstruction was also going to be a great age for the growth of the electricity industry. If members realised that and worked for it, and above all studied hard to improve their efficiency and status, they would, he said, be playing no small part in the development of their great industry. "It doesn't matter whether you are a member or not, you are bound to profit by the work of this Association. If enthusiasm is any gauge, the E.S.C.A. is going to play a great part in your future whether you want it or not, and the member of any electricity undertaking, now beyond the pale, 'ploughing the lonely furrow' will find himself in the near future in greater difficulties than he now anticipates. If you have any regard in the least for your future welfare you will join your colleagues to-night and help to make the Association worthy of its purpose."

A further mass meeting will be held in London on Oct. 13th at Caxton Hall, Westminster. Admission will be by ticket, open to members and all eligible for membership on application to Mr. J. C. Adams, hon. secretary of the Greater London Division, 87, Connaught-road, Teddington.

Edison-Swan Lamp Show Card.

With the opening of the winter lighting season will come a budget of leaflets, show cards and posters from the lamp makers. The first to arrive is the show card of the Edison-Swan Electric Company, Ltd. We understand that this is also to be the company's poster. It is one of the most effective lamp advertisements that we have so far seen, and Mr. Ingamells, the publicity manager, is to be congratulated upon it. There have been many attempts to work in animals in connection with the sale of electric lamps, but this is the first time that a lion has been effectively introduced. The adjoining reproduction speaks for itself, and the choice of the trade slogan "The King of Lamps" is very happy. We understand that the distribution of these cards to the trade has already commenced, and if any of our readers are not early recipients they should apply to the company at Ponder's End, Middlesex.



Shop Window Lighting.

Few people would dispute that there is a close relation between the lighting of a shop window and the resulting business. It is true that a crowd may gather round a badly-lighted window, but this is because their attention has been attracted by some object of interest. A well-lighted window on the other hand, will, by its pleasing nature, draw the attention of passers by, affording an opportunity for the objects in the window to come under their notice. The essential thing in good window lighting is to illuminate the goods, not to exhibit lamps and fittings. The object should also be attained as economically as possible, *i.e.*, as much light as possible must be directed on the goods—not on the ceiling, pavement, or passers by.

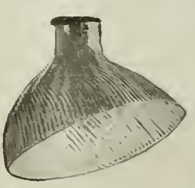


Fig. 1.—"X-Ray" Mirror Reflector for Window Lighting.

The British Thomson-Houston Company, Ltd., make a feature of their system of lighting with Mazda gas-filled half-watt lamps in "X-Ray" reflectors. Fig. 1 shows a typical reflector of this type, and Fig. 2 the method of arranging the lighting units along the top edge of the window behind the facia; or, if this is not available, a shallow curtain may be employed. Attention is paid to the proper spacing of reflectors so as to produce a uniform illumination on the contents of the window.

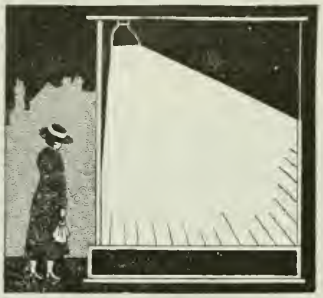


Fig. 2.—Diagram showing Lighting Effect obtained with "X-Ray" Reflectors.

The light is concentrated on the display; none is wasted on the pavement or ceiling, and the lamps are invisible to people looking in the window.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1919 Specifications.

130,620 Sartori. Alternating-current motors. (12/4/17.)
130,625 MacCullum. Incandescent electric lamps. (22/8/18.)
130,641 Austing. Combination of telegraph and telephone apparatus. (27/2/18.)
130,642 Plaisant. Dynamo-electric machines. (22/6/17. Divided application on 18,387/16.)
130,643 Plaisant. Dynamo-electric machines. (22/6/17. Divided application on 18,387/16.)
130,656 Vickers, Etchells & Stedman. Switches for controlling electric motors. (2/3/18.)
130,663 Mauclaire, Garbarini & Gautier. Arc lamps. (13/10/17.)
130,667 Edridge & Boite. Variable condensers for wireless telegraphy and telephony. (8/3/18.)
130,679 Morse. Inductively untappable telegraph. (12/3/18. Cognate application, 5,798/18.)
114,161 Siemens-Schuckertwerke. Electric switches. (20/1/17.)
130,687 Gow. Mounting electrodes of electric furnaces. (14/3/18.)
130,700 Plaisant. Dynamo-electric machines. (18/3/18. Addition to 18,387/16.)
130,703 B.T.-H. Co. & Ash. Electric arc furnaces. (19/3/18.)
130,710 Hall & Duxbury. Electric heating quilts, blankets or the like. (8/5/18.)
118,096 Splitdorf Electrical Co. Magnetos. (1/12/16.)
130,740 Trier & Martin, Trier, & Smith & Sons. Constant-current dynamos. (2/8/18. Addition to 5,652/10.)
130,741 Feli. Electric traction systems employing a centre gripping rail. (2/8/18.)
130,749 Midgley & Vandervell & Co. Ignition systems for internal combustion engines. (3/8/18.)
130,752 Hutchinson. Electric accumulators or storage batteries. (6/8/18.)
130,762 B.T.-H. Co. (G.E. Co.) Recording apparatus for electric-current impulses. (7/8/18.)
130,782 Alloy Welding Processes, Ltd., & Jones. Manufacture of electrodes for welding and depositing metals by the electric arc. (10/8/18.)
118,629 Guess. Process of electrolytically separating nickel from copper. (14/8/17.)
130,816 Bibby. Electric arc furnaces. (2/9/18.)
130,835 Kent, Ltd., & Avery. Field magnets and dynamos and motors and their method of construction. (24/9/18.)
120,720 Aktieselskabet Elektrisk Bureau. Telephone apparatus for use on one common line. (15/11/17.)
130,850 B.T.-H. Co. (G.E. Co.) Systems of electric motor. (16/10/18.)
130,888 Edridge & Boite. Worm-gear adjustments applicable to variable condensers for wireless telegraphy and telephony. (14/1/19. Addition to 4,057/18.)
130,901 Marsican. Means for securing electric conducting wires to their insulators. (5/2/19.)
130,909 Fogarty & Lehmann. Electrical resistances. (19/2/19.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

August 18, 1919.

20,237 Newey. Switches.
20,252 Scott-Taggart. Thermionic amplifiers.
20,260 Thompson. (Hames.) Automatic push telephone apparatus.
20,261 Thompson. (Cie Gen. de Telegraphie et Telephonie.) Automatic push intercommunication telephone apparatus.
20,269 Scott-Taggart. Vacuum tube devices for wireless telegraphy.
20,279 Lo-Thermo Patents, Ltd., & Burleigh. Dynamos.
20,284 B.T.-H. Co. Controlling apparatus for electrically operated hoisting mechanism, &c.
20,283 Robinson. Wireless reception apparatus.
20,325 Pouchain. Switches.

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20,368 Brown. Combined electric bell and battery.
20,371 De Mole. Shade carriers for electric lamps.
20,380 Tattersall. Popping corn by electric heat.
20,387 Western Electric Co. & Deakin. Telephone exchange systems.
20,398 Round. Wireless telegraph transmitters.
20,399 Round. Wireless direction finders.
20,400 Thompson. Electric lamp.
20,412 Ruthardt & Co. Electromagnetic circuit interrupters. (19/8/19. Germany.)

Commercial Topics.

Anglo-German Trade Control.

It is announced that the German Government has agreed to a scheme for a clearing house to be established in Berlin under the control of a British official, who will have entire control of the licence department. Any goods leaving Germany or coming into Germany from Britain without a licence from this department will be confiscated. The object of the scheme is to secure effective control of all exports from Germany to the British Empire and of imports from Britain into Germany. Mr. Knott, President of the British Chamber of Commerce in Germany, propose to lay details of the scheme before the Board of Trade.

Although we are not enamoured of Government control of trade we think that effective steps should be taken to prevent the dumping of German goods upon the market, and we hope that the scheme will provide effectively against this.

* * * *

A Venuezuelar Exhibition.

The National Exhibition, which will be held in Caracas, in December next, should afford British manufacturers and exporters an opportunity of displaying their goods, and of extending the trade with Vennezuela. The opening of the exhibition is fixed for the 19th December, and, provided full particulars of goods to be exhibited are supplied by the 31st prox., arrangements can probably be made for receipt of these exhibits up to 20th November. British firms desirous of participating are invited to consign exhibits to Victor Maldonado, Caracas, who is willing to undertake all responsibility free of charge. Consignments for Caracas should be shipped to the port of La Guaira.

* * *

Board of Trade Organisation.

The President of the Board of Trade has established an internal Administrative Council, consisting of the Parliamentary and Permanent Secretaries and the heads of the chief Administrative Departments, which will meet regularly and frequently to deal with current business involving questions of policy. Sir H. Llewellyn Smith, G.C.B., Permanent Secretary of the Board, has been appointed Economic Adviser with reference to the larger national and imperial economic questions, especially for the present those arising out of the Peace Settlement and the transition to normal conditions. He will retain close connection with the Board of Trade in the capacity of Vice-President of the Administrative Council, over which he will preside in the absence of the President of the Board of Trade. In order to fill the vacancies caused by the appointment of Sir H. Llewellyn Smith and the transfer of Sir William F. Marwood, K.C.B., to the Ministry of Transport, the President of the Board of Trade has appointed Mr. S. J. Chapman, C.B., C.B.E. (Senior Assistant Secretary, General Economic Department) and Mr. H. A. Payne, C.B. (Comptroller of the Companies), to be Joint Permanent Secretaries.

We are informed that the Administrative Council is quite distinct from, and in no way supersedes the Board of Trade Advisory Council.

* * * *

How to capture the Spanish Market.

In a statement by H.M. Consul at Malaga, British merchants are urged in view of the keen competition which they now have to face in Spain to do all they can to attract the attention of Spanish houses. The prospective buyer should be relieved of as much trouble as possible in obtaining the goods, and one method of doing this is to quote c.i.f. prices. An instance is cited of a large British firm who imported and kept at Barcelona large stocks of goods, and supplied buyers from those stocks, sea freight, insurance and duty already paid. This system might with advantage be copied by other firms dealing in goods of a nature suitable to be stored in comparatively large quantities. In Malaga, and presumably elsewhere, importing houses were able, before the war, to obtain from some Hamburg houses not only c.i.f. prices, but prices "delivered in warehouse," Custom duties and all other charges paid. A British firm desirous of quoting inclusive terms of this nature should engage the services of a reputable Customs agent to work out what addition must be made to their prices for this purpose.

It must be remembered that Spain is rich in minerals and in water-power, and that the Spanish Government is now turning its attention to the development of all national resources, particularly water-power. In the early part of the year a Commission was appointed to study the question of establishing a national system of electricity supply and distribution, and in a recent report it is recommended that a standard voltage and frequency be adopted. In a great many cases the present system of generation is three-phase, 50 cycles. For the main hydro-electric transmission lines, it is recommended that the voltage be not less than 120,000. Either concrete or steel posts will be employed, with suspension type insulators, and a series of transmission lines will pass through or near the important consuming centres. Power will be generated at the larger waterfalls and also at mines, where coal of too low grade to be exploited commercially could be used to produce energy cheaply by being burned at the mine shafts. The steam stations would be used mainly during the dry season.

It will thus be seen that the Spanish market in electrical machinery and supplies promises to be of great importance and British manufacturers would do well to watch developments. In regard to electric lighting, it is stated that the Spaniards are fond of plenty of lighting points and of elaborate fixtures. In Catalonia generally there is a promising field for the sale of electrical supplies and fittings for lighting, power and domestic purposes.

Electricity Supply.

An arrangement has been made between the Bury Electricity Committee and the Lancashire Electric Power Company for the connection of the two systems at Radcliffe.

Matlock Urban Council has been informed by the Board of Trade that it is not their practice to grant statutory powers for the supply of electricity to individuals.

The Coventry Guardians has instructed their architect to prepare a report on the cost of adopting electric lighting throughout the whole of the Institution.

A new gas engine set was recently started at the Leek Electricity Works by the chairman of the Lighting Committee (Mr. W. A. Furmstone). The engine was supplied by the National Gas Engine Company.

The Woking Electricity Company is contemplating extending its mains into the Chobbam area, and a committee of the Parish Council is to meet the company's engineer (Mr. F. Woods) in order to consider the question of street lighting, &c.

Plymouth Council has applied for sanction to borrow £69,750 for the provision of additional plant for the electricity works. The demand for electric current for lighting is so great that no further applications can be met without extensions of the generating plant and mains.

Oldham Electricity Committee has received sanction to the borrowing of sums of £35,000 and £15,000 for expenditure on mains, transformers and switchgear for the Electricity department. Regret has been expressed by the Committee, in view of the many applications for current, at the holding up of the larger scheme.

A local inquiry was held at Wolverhampton on Tuesday to inquire into the application of the Corporation for sanction to borrow (among other sums) £6,747 for the purchase of premises in Red Lion-street, for the electricity undertaking. The output has increased in recent years from 14,000,000 to 40,000,000 units, and the undertaking is said to be the second largest output per head of the population in the country.

Lowestoft Corporation has applied to the Board of Trade for sanction to increase the maximum prices for electric current by 50 per cent. In order to meet the increased price of coal and other expenditure as from the September quarter, the prices for current will be: Lighting, 10d. per unit; heating and cooking, 2½d.; traction, 2d. meter rent, 2s. minimum. All new consumers connected to the mains will be charged a minimum of 13s. 4d. per quarter, owing to the increased cost of services.

The City of London Corporation has intimated to the Board of Trade that it is opposed to the application of the Charing-cross, West-end and City Electricity Supply Company to increase maximum price of electric current to 8d. per unit for lighting in the City, having regard to the increase granted last year. The Corporation is not, however opposed to the increase in the price of gas to 4s. 8d. per 1,000, but it is suggested that certain conditions might be inserted in any order which the Board may make.

The accounts of Sheffield electric supply department for the year ended March 25, 1919, show revenue £671,267 (compared with £639,667 in previous year), and working expenses £443,401 (£372,490). Interest required £71,319 (£63,780) and repayment of loans £89,375 (£70,329), leaving a credit balance of £67,171 (£133,066). Working expenses were 0·65d. (0·51d.) per unit sold, and total cost, including capital charges, 0·89d. (0·7d.). Average price obtained was 0·19d. (0·88d.). Units generated were 192,019,666 (99,522,937) and sold 161,899,041 (172,451,007). Total maximum demand was 59,546 k.v.a. (57,338 k.v.a.).

Walsall Council has authorised an expenditure of £5,921 on extensions of mains and services. There is a greatly increased demand for electricity, especially for alternating current for industrial purposes. The Electricity Committee has been empowered to apply for sanction to borrow £44,000 for further extensions of the electricity undertaking. £21,000 is required for laying mains to Cannock, to supply several big consumers, and money will be required for a duplicate feeder to Bloxwich. The Council has also asked for sanction to a further loan of £11,000 in respect of the Birchills power house.

In a report of the Newcastle-on-Tyne Parliamentary Committee, the deputation appointed to watch the progress of the Electricity (Supply) Bill, it is stated that the Bill as amended affords adequate opportunities for the formulation of local schemes for the setting up of joint electricity authorities, and only in the event of a scheme not being locally submitted within the time allowed, or no scheme which the Commissioners can approve being so submitted, are the Commissioners to have authority to impose a scheme for a joint electricity authority upon the district, while a district board (as distinguished from a joint electricity authority) is not to be established unless it appears to the Commissioners that a satisfactory scheme for a joint authority cannot be formulated.

The accounts of the Glasgow electricity department for the year ended May 31, 1919, show revenue £865,039 (compared with £789,001 in previous year), working and general expenses £567,258 (£542,716), and gross profit £297,780 (£246,285). The amount of depreciation written off works and plant was £60,464 (£60,134), interest required £116,809 (£101,649) and repayment of loans £1,642 (£1,586), and the surplus, £32,761 (£7,145), has been placed to reserve. Generation, distribution and management cost 0·8407d. (0·748d.) per unit sold, total statutory expenditure was 1·2759d. (1·114d.), and total cost, including special charges and depreciation, 1·3781d. (1·2091d.), while receipts were 1·4324d. (1·2201d.). Units generated were 169,873,301 (182,481,170) and sold 144,930,164 (155,194,785). Total maximum supply demanded was 141,967 kw. (132,316 kw.). Motors equal to 113,721 h.p. 105,739 h.p.) are connected to the mains.

Electric Traction.

Neath Corporation has decided to purchase two electric vehicles for refuse collection.

Colne Corporation is considering a proposal to extend the municipal tramways system to Earby.

When Ashton-under-Lyne Corporation obtain possession of the local tramways a portion of the track will be doubled.

Harwich Corporation has applied to the Ministry of Health for sanction to borrow £3,000 for the purchase of two electric vehicles.

Sunderland Tramways Committee, which recently ordered six new tramcars, has now decided to purchase six additional cars.

South Shields Council are seeking powers to run motor omnibuses to Boldon Colliery from near a new line of tramway to be laid to Cleadon.

Greenock Corporation have decided to postpone the question of the purchase of the local tramways until the Committee has reported fully upon the whole question.

Owing to the increase in traffic on the Brighton Corporation tramways, it has become necessary to order additional tramcars. The engineer and manager (Mr. W. Marsh) reports that the traffic has doubled, and that on certain occasions during the summer many more than the vehicles available were needed to cope with the demand.

Aberdeen Electricity Committee proposes to renew the agreement for the supply of electrical energy to the Aberdeen Suburban Tramways Company for a further period of three years. The price of electricity will be 2d. per unit, to be increased or decreased by 0·01d. for every complete 6d. by which the average price of coal is higher or lower than the basis price of 29s. per ton.

Kettering Urban Council has had a 3½-ton G.V. electric vehicle for over two years in successful operation, and for the year ended March, 8,102 tons of coal and clinker were carted at a total cost (including depreciation, current, battery upkeep, wages and repairs, &c.) of £785, or 1s. 11d. per ton. The mileage covered by the vehicle, which is fitted with an Ironclad Exide battery, is 4,392.

Reports have appeared in the Press to the effect that the directors of the G.E. Railway Company have agreed upon an extensive scheme of electrification; but we learn that nothing definite has yet been decided though the question is under consideration. There is a very heavy passenger traffic on the company's suburban lines, and we have no doubt that a change to electric traction would be a great benefit to the company and to the travelling public.

Newcastle-on-Tyne Corporation are recommended by the Parliamentary Committee to promote a Bill to authorise the construction of tramways over the High Level Bridge. In the session of 1913-14 the Council undertook to apply in the 1914-15 Session for powers to carry tramways over the bridge which would serve to connect the systems in operation in Newcastle-upon-Tyne and Gateshead. Owing to the war, however, it was not possible to carry out the undertaking.

The Middlesbrough Corporation and Eston Urban Council, which are taking over the local trackless trolley undertaking in a month's time, have constituted the Teeside Railless Traction Board, and will shortly commence a service of cars betwen Middlesbrough, Grangetown, South Bank and Eston. Statutory powers were obtained in 1912 and the new Board acquired the right of purchase this year. Seven cars are ready for running, but a service cannot be commenced until the Board of Trade inspection takes place.

At the adjourned inquest on Saturday on the two men who died as a result of the L.C.C. Tramcar Accident, which occurred in the Pancras-road on the 14th ult., the jury returned a verdict of "Accidental Death." They also found that the driver of the car was in no way responsible for the accident and complimented him on remaining at his post till the car was overturned. They were further of opinion that the speed of all tramcars travelling down to the curve at the corner of Great College-street should be reduced considerably from the speed at which they are at present usually driven.

The accounts of Aberdeen Corporation tramways department for the year ended May 31, 1919, show revenue £140,901 (compared with £116,397 in the previous year), working expenses £108,451 (£76,997) and gross profit £32,450 (£39,400). Interest required £2,207 (£2,735), sinking fund contribution £6,142 (£5,932), and special expenditure £3,385 (£4,690). £13,877 (£13,829) has been placed to depreciation and renewals fund, and £4,557 (£8,141) to reserve, leaving £2,000 (£2,000) to contribute to common good and £278 (£2,070) for city improvements. Traffic receipts per car-mile were 15·11d. (12·7d.) and working expenses 11·75d. (8·50d.). Passengers carried were 41,946,442 (increase 9,206,914) and car-miles run 2,215,796 (increase 43,003).

The Ministry of Transport commenced its formal existence on Monday morning. All powers and duties of any Government department in relation to (a) railways, (b) light railways, (c) tramways, (d) canals, waterways and inland navigations, (e) roads, bridges, and ferries, and vehicles and traffic thereon, and (f) harbours, docks and piers, have been transferred, by Order in Council, to the Minister of Transport (Sir Eric Geddes). The offices are at 5 and 6, Whitehall-gardens, S.W., and the Ministry is divided into four main departments under departmental heads, with Sir Eric as chief and Sir Hardman Lever as representative of the Treasury. Sir Philip Nash is in charge of the railway department, Sir J. G. Beharrell of the finance and statistical department, General Sir H. Maybury of the road department, and the development section is in the hands of Sir Charles Martin de Bartholme. Sir Francis Dunnell is secretary and solicitor to the Ministry.

The Tramway Arbitration.

On Tuesday an interim Court of Arbitration sat in private at Westminster to consider the demand of the National Transport Workers' Federation for an advance of 12s. a week for tramway workers. On subsequent days the arbitrators sat at Bristol, Glasgow and Manchester to hear the parties and to take evidence.

Representatives of the Municipal Tramways and the Tramways and Light Railways Associations, of the London County Council and of the Transport Workers' Federation were present. Evidence was given showing the financial position of various undertakings, as the employers contend that no further increases of wages can be granted without either raising fares or increasing local rates to meet deficiencies. It was arranged to take the cases of the London County Council, of a number of companies and of 20 municipalities.

Sir Lynden Macassey, K.C., for the Municipal Tramways Association (with Mr. J. M. McElroy and Mr. J. Beckett, secretary), informed the Court that each authority would insist upon being heard, and that it was clear that the time allotted to the various centres was inadequate. The total amount of wages involved in the arbitration was three millions per annum, in addition to the bonuses already granted, and the number of employees is about 85,000.

For the London County Council the evidence showed that fares had been increased to the point of equilibrium and could not economically be raised higher. All sections of the community had sent in protests against the raising of the fares, and 120 petitions had been received. The L.C.C. tramway undertaking would, at the present pace, have to come on the rates; the system was being carried on out of capital.

The cases of West Ham, Luton, Colchester, Dover, Ipswich and a number of private companies were gone into. At Ipswich and Colchester the undertakings are already on the rates, and in regard to West Ham, Ald. Crow stated that the rates were now bearing 10d. in the £ for tramway losses, and the total rate for the current year would amount to 15s. 7d. in the £. In the other cases it was shown that the municipal tramways were being run at a loss.

By consent the Court removed from the terms of reference the merging of war bonus into permanent wages, and the reduction of the qualifying period for the maximum wage.

On Wednesday the arbitrators sat at Bristol where evidence was given on behalf of eight Corporations and a number of companies. The Court will also sit at Manchester and Glasgow.

Imperial and Foreign Notes.

Victorian Electricity Commissioners recommend the Government to take over as a monopoly the brown coal scheme at Morwell, in order to be in a position to supply Melbourne with electricity, and experts have been engaged to report on the brown coal and the Kiewa schemes.

The Traffic Congestion Board, appointed by the Victorian Government to deal with the congestion of traffic in Melbourne, has made recommendations that direct lines of tramway be constructed between certain outer districts, so as to relieve congestion in the centre of the city, and also that a scheme of "staggering" the travelling hours of passengers should be studied.

A scheme for the Electrification of Some of the Western Australia Railways has been submitted to the Cabinet, and the Minister for Railways (Mr. Scaddan) recently visited Melbourne in order to collect information as to the working of the electric trains in and around that city. The present scheme relates to the Perth suburban lines, with a possible extension 80 miles in length to Northam, and it is proposed to take the necessary power from the Government's power station at Perth.

The question of the acquisition of the undertaking of the Chili Telephone Company by the Chilian Government is under negotiation. We understand that if the proposed transfer is agreed upon, payment will be spread over a considerable number of years.

We are glad to learn from a Reuter telegram that a representative of a British firm, who are interested in the scheme for the utilisation of the Iguazu waterfall, Argentina, has submitted details of their scheme to the Minister for Foreign Affairs. A Bill for acquiring land in the vicinity of the fall has been laid before the Chamber. Argentina and Brazil will co-operate in the scheme for using the water-power of the Falls for the generation of electrical energy. It is estimated that 166,000 H.P. can be made available in Buenos Aires, after deducting 20 per cent. for transmission losses, and that energy could be supplied in that city at half the present cost of the current now in use. The construction work will take about 2½ years.

In connection with the proposal to adopt Electric Traction on the Italian Railways it is stated that the necessary electrical energy will be supplied by the existing electric supply company to sub-stations placed along the lines—except in special cases, where the Transport Office considers it better to get the energy transformed by the State Railways themselves. In the case of new hydro-electric plants or when the supplies are made under special conditions, there will be allowed to the supplying concerns a subsidy not more than 40 lire for every kilowatt-year used by the railways, and such subsidy is to be continued for a period of 20 years. When the electric energy is generated by means of plants utilizing the national fuel (lignites), special subsidies are granted.

The Italian Minister of Public Works has decided (according to the Central News) that henceforth no permission will be given for the construction of new steam traction railways, and only electric railways are to be built in Italy.

Educational.

A course of lectures on electric furnaces is being given at the Birmingham Municipal Technical School on Wednesday evenings, commencing Sept. 24.

The next session of the University of Edinburgh commences on Oct. 8. There are complete courses in civil, mechanical and electrical engineering, qualifying for the degree B.Sc. in engineering, and extending over three years. Particulars can be obtained from the matriculation office of the University.

At the Northampton Polytechnic Institute there are day and evening courses in all branches of mechanical and electrical engineering. The evening courses commenced on Monday last, and the full-time sessional day courses in engineering and in technical optics will commence on Monday next. The courses prepare for the engineering degrees of the University of London. The laboratories are well equipped with modern apparatus, which, on the mechanical side, provides for specialisation in automobile and aeronautical engineering, and on the electrical side for specialisation in alternate and continuous-current work, in radio-telegraphy and telephony, and in electrical testing.

The Manchester College of Technology provides complete courses of instruction in mechanical engineering (Prof. G. G. Stoney, F.R.S.), electrical engineering (Prof. Miles Walker, D.Sc.), sanitary and municipal engineering, the chemical industries (Prof. F. L. Pyman, D.Sc.), textile industries (Prof. A. J. Turner, M.A., B.Sc.), photographic technology, architecture, mining, &c. Provision is also made for advanced study and research, and the college possesses extensive laboratories and workshops, which are equipped with modern apparatus. The new session will commence on Oct. 8. The degree courses lead to the B.Sc. and M.Sc. technical degrees.

In the faculty of engineering of King's College, London, special advanced lectures will be given during the 1919-20 session. Lieut.-Col. W. A. G. O'Meara will deliver a course of 10 lectures on "The Preparation of Engineering Schemes and Contracts" on Thursdays, commencing Oct. 9. This course is intended to assist those preparing for the A.M.I.C.E. examination in drawings, specifications and quantities. Mr. J. S. Highfield will give a course of four lectures on "Electrical Engineering with Reference to its Commercial Aspects"; and Mr. J. E. Sears three lectures on "The Principles of Metrology and their Application to Engineering Standardisation." Further particulars of these courses, as well as of the general courses of instruction given at the college, can be obtained from the Secretary of the College, Strand, W.C.2.

Business Items.

Messrs. Glenfield & Kennedy, Ltd., of Kilmarnock, have decided to establish an electrical department of its engineering works.

The Acme Lighting & Engineering Company, of Fortess-road, Kentish Town, has removed to Waverley-road, St. Albans, Herts.

The proprietor of patent No. 17,345 of 1913, relating to electric cut-outs, wishes to sell same or to grant working licences. Applications to Messrs. Boult, Wade & Tennant, 111 and 112, Hatton Garden, E.C.1.

The British Ever Ready Company, Ltd., of Hercules-place, Holloway, N.7, has issued a leaflet containing extracts from letters of customers which testify to the good quality and long life of its batteries.

On Oct. 8 and following days, by direction of the Disposal Board, there will be a Sale by Auction of a large quantity of plant and machinery, including electrical plant, electric motors, machine tools, stores, &c., at the National Shell Forgings Factory, Liverpool. Further particulars and catalogues may be obtained from the auctioneers, Messrs. Geo. N. Dixon & Company, 41, Castle-street, Liverpool.

The C.E.A. (Commercial Electrical Accessories, Ltd.), successors to Tredegars Limited, wholesale and export electrical supplies department, Diana-place, Euston-road, N.W. 1, have issued their catalogue of electrical accessories, and also an interesting leaflet on their drybatteries and locking rings for lamps, which will be sent post free on application.

Batteries, Ltd., of Redditch, which was recently registered as a private company with a capital of £100,000, has obtained the patents and patent rights for the United Kingdom and the Colonies, of a nickel-iron alkaline electric accumulator; based on the patented inventions of Dr. Junger, of Sweden, these accumulators, we understand, were made abroad before the war, and will now be manufactured in this country.

In the revised edition of the catalogue of the Silent Electric Company, 192, Goswell-road, E.C.1., there is a general description of electric clock systems, and this is followed by a special description of the company's "Silectock" system. Various types of master clocks and receiving clocks, workmen's time recorders, synchronised master clocks, &c., which are manufactured by the company, are described and illustrated. A long list of users of silent electric clocks, which are all British in design and manufacture, is included.

A revised edition of their catalogue of d.c. motors and dynamos has just been published by Messrs. J. H. Holmes & Company, of Portland-road, Newcastle-on-Tyne. Starting with a specification and description of "Castle" W. type of motors and dynamos, the catalogue, which contains over 60 pages, gives general information as to the standard pressures, speeds, &c., for which the firm's machines are designed, and then detailed particulars, with tables of outputs and speeds, prices, &c., of the various types of motors and dynamos. There are some good illustrations of typical machines and generating sets. The firm also manufacture two and three-phase induction motors, single, two and three-phase alternators, small rotary converters, &c.

Miscellaneous.

At a recent meeting at the Ministry of Labour the question of creating a Whitley Council for the clerical, administrative and technical staffs of municipalities was considered, and a basis of representation was decided upon.

The Automatic & Electric Furnaces, Ltd., notify that in view of the great interest aroused in their new magnetic sclerometer among the universities and technical schools, and in consequence of the numerous applications for the loan of an instrument, they have decided to lend an apparatus, complete with samples of different steels having varying heat treatments. The apparatus will be on loan for short periods for purposes of demonstration, and will be supplied to recognised educational authorities upon receipt of an application from Principals or Senior demonstrators.

The Minister of Munitions has appointed a Committee, under the chairmanship of the Financial Secretary to the Ministry, for expediting the liquidation of contracts in all departments of the Ministry, and also to ensure greater co-ordination between the Liquidating and Accounting Departments and their associated services. The Chairman of the Committee is Mr. James F. Hope, M.P., and the other members are Messrs. M. Webster Jenkinson, O.B.E., L. J. Coates and A. E. Watson, O.B.E. The Committee have full authority to deal with the liquidation of contracts.

A snooker handicap has been arranged amongst the members of the Birmingham & District Electric Club and a sub-committee formed to arrange the handicap figures and other details. A nominal entrance fee of one shilling will be charged to cover printing and postage expenses. Entries must be made by Sept. 29. The games will be played at the Grand Hotel and further details as to when the various rounds will be played will be issued later. Mr. S. R. Hare, Mr. J. Hill (Past Pres.) and Mr. J. M. Couch have offered prizes—first, second, and for the best break. A silver spoon has also been promised for the highest score made in any one game excluding handicap points.

An unfortunate strike of ironfounders, core makers and iron, steel and metal dressers, has broken out and directly affects about 50,000 men and may, if the strike continues, result in a paralysis of the whole of the engineering and allied trades. The strike is the outcome of the refusal of the Interim Court of Arbitration in June to grant the claim of the engineering workers for an increase of 15s. per week (and 7s. 6d. for boys). Altogether 51 unions were concerned, but 48 of them accepted the award, though they have notified that when the Interim Court of Arbitration meets again in October they will renew their demand for the increase in wages. In the meantime the ironfounders, core makers and iron and steel and metal dressers broke away from their associates and have struck in order to enforce their claim.

Tenders Invited and Accepted.

Warrington Electricity and Tramways Committee require tenders by noon Oct. 7 for high-and low-tension, lead-covered cable. Specification, &c., from the Borough Electrical and Tramways Engineer.

St. Helens Electricity Committee require tenders by Oct. 4 for the supply and installation of a 5,000 kw. steam turbine, condensing plant and auxiliaries. Specifications from the Borough Electrical Engineer.

Tenders are required by Jan. 20 for the supply, &c., to the Australian Commonwealth Postmaster-General's Department, State of Victoria, of Automatic Telephone Switchboards at Collingwood, as per schedule 1,583. Tender forms, &c., from the High Commissioner, Room 406, Australia House, Strand, London, W.C.

Dundee Corporation invite tenders for (section A) Switchgear for one 5,000 kw. Turbo-generator, and six Feeders ; and (section B) alteration, and additions to present Switchgear for two 5,000 kw. Turbo-generators, one feeder, and one 500 kw. Transformer. Specifications, &c., from Mr. H. Richardson, M.Inst.E.E., general manager and engineer, Electricity Dept., Dundee. Tenders to the Town Clerk by 10 a.m. Oct. 8.

Bolton Corporation have placed an order with the English Electric Company for the supply of eight tramcar equipments, and four spare motors.

The Belfast Harbour Board has accepted the tender of Messrs. Alexander Chaplin & Company, Ltd., for the supply and erection of three electric cranes.

Appointments Vacant and Filled.

A junior shift engineer is required for a main generating station. Salary £3 7s. 6d. per week.

A junior demonstrator, with practical engineering training, is required for the drawing office and physical laboratory of Faraday House, Southampton Row, W.C. 1. Applications to the Principal.

The Delegacy of the City and Guilds Engineering College require a workshop instructor in electrical engineering. Salary £160, plus bonus of £100. Applications to Prof. T. Mather, F.R.S., Exhibition-road, London, S.W.7, by Sept. 30.

Dr. A. W. Stewart has been appointed to the chair of chemistry at the Queen's University, Belfast.

Mr. Duncan M'Lennan, of London, has been appointed engineer and manager of the Alloa Corporation electricity works.

Dr. George W. Todd, B.A., D.Sc., has been appointed to the newly created professorship of Experimental Physics at Armstrong College, Newcastle.

Companies' Reports, &c.

Sir Clement B. Simpson has joined the board of directors of Mather & Platt, Ltd.

A quarterly dividend of 2 per cent. has been declared on the capital stock of the General Electric Company (U.S.A.).

The Shawinigan Water & Power Co. has declared a dividend of 1¾ per cent. on the common stock for the quarter ended Sept. 30.

A dividend of 1½ per cent., less tax, has been declared on the common stock of the Mackay Companies for the current quarter, payable on Oct. 1.

Bromley (Kent) Electric Light & Power Company has decided not to pay an interim dividend this year. Last year a dividend of 2 per cent. was paid.

The Shipston Electrical Company, Ltd., and the Wolfram Agency, Ltd., will be struck off the Register of Joint Stock Companies unless cause to the contrary is shown before Dec. 19.

Particulars of the registration of the R. M. Radio, Ltd., were given in our last issue and we are informed that the following are the first directors :—Mr. H. R. Rivers-Moore (chairman), Mr. A. G. Ionides, Mr. W. H. Merriman, Major A. E. Snape and Capt. H. de A. Donisthorpe.

The directors of the Direct Spanish Telegraph Company, Ltd., have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent. per annum, tax free, on the ordinary shares, both for the half-year ended June 30 last, and payable on October 1 next.

At the general meeting of the shareholders of the Marconi Wireless Telegraph Company of Canada, held in Montreal on the 17th instant, it was agreed to reduce the capital of the Company from $5,000,000 to $3,750,000 by reducing the par value of the issued shares from $5 to $2.50, and authorising the issue of 500,000 additional shares of $2.50 each.

The report of the Compañia de Tramways Electricas del Sud (Buenos Aires) for the year ended June 30, 1919, states that the company's service was stopped between Jan. 9 and May 10 last by the strike of its men. Every effort having been made by the Board to obtain a settlement of the strike consistent with the economic and financial capacity of the company, it is difficult to explain the unusual duration of the movement. The profit and loss account shows a debit balance of $45,319 m/n.

The report of the Nairobi Electric Power & Lighting Company, Ltd., for 1918 states that the net profit amounted to £7,710. Dividends have been paid amounting to 10 per cent. for the year (less tax), the same as last year, £1,813 being carried forward. The number of units generated by water power was 779,082, against 1,458,091 ; by steam power, 369,991, against 179,899 ; total, 1,149,073, against 1,637,990 ; motors connected, B.H.P., 677 (693) ; lights connected, 40-watts equivalents, 14,675 (13,833). A first interim dividend on account of the current year at the rate of 4 per cent. per annum has been declared by the Company.

The Halifax & Bermudas Cable Company report that the net result of the working for the year ended June 30 is a balance of £26,628, compared with £9,697 for the year 1917-18. An interim dividend of 3 per cent. tax free has already been paid, and it is now proposed to make a further equal payment tax free, which will leave £23,628 to be carried forward. The balance to credit of revenue account, which was last year £19,257, has been debited with £1,500 applied to dividend and with £11,322 expended in repairs, and credited with £23,628 surplus revenue of the past year, and it now stands at £30,063, subject to excess profits duty. The company's cable was repaired on Nov. 3, 1918, and worked efficiently until June 21, 1919, when it was again interrupted, and repaired on July 22, 1919. The directors have elected Mr. R. J. Hughes to fill the vacancy on the board created by the death of Mr. Fred Ward.

At the annual meeting of the Dumbarton Burgh & County Tramway Company last week the chairman, Mr. Geo. Balfour, M.P., stated that the past year's traffic receipts amounted to £41,821, compared with £38,150 for the previous year. They had increased expenditure in all departments, the expenses amounting to £28,784, an increase of £7,511. The increased cost exceeded the increased revenue by £3,840. The company's cars ran 507,127 miles, compared with 585,591, and carried 4,873,888 passengers, against 5,060,233. Since the close of the year the traffic receipts had been satisfactory, and subject to any abnormal change in conditions, the directors should be able to present a satisfactory account next year. It was impossible for the company to bear any increased expenditure without an increase being made to the present maximum fares allowed by statute.

The report of the Direct West India Cable Company for the year ended June 30 last states that the net result of the year's working is a balance of £14,074, compared with £15,225 for the previous year. An interim dividend of 3 per cent. tax free has already been paid, and it is now proposed to make a further equal payment tax free, which will leave £11,374 to be carried forward. The balance to credit of revenue account, which was last year £84,146, has been debited with £1,350 applied to dividend and with £25 expended in repairs, and credited with £11,374 surplus revenue of the past year, and it now stands at £94,145, subject to excess profits duty. The company's cables have worked efficiently during the year, but the insulation of the Bermuda-Turks Island section remains low. The directors have elected Mr. R. J. Hughes to fill the vacancy created by the death of Mr. Fred Ward.

It is announced that the change of name of the British Westinghouse Electric & Mfg. Company to that of Metropolitan-Vickers Electrical

Company, Ltd., follows as a result of amalgamation with the extensive Vickers interests and the Metropolitan Carriage, Wagon & Finance Company. From its inception in 1899 until 1917 the British Westinghouse Company was controlled by American shareholders, but in the latter year the American holding was taken over by the Metropolitan Carriage Company, and later amalgamation with the Vickers interests became effected. The company therefore becomes entirely British. The change of name will not affect the general policy except that a broader field for advancement will be opened up. The Metropolitan-Vickers Electrical Company will carry on just the same, but ultimately will proceed to greater development. As a result of the amalgamation much additional strength will be gained; greater possibilities of competition in the markets of the world for the foreign trade which is so essential to the needs of the country will be effected; and a greater standardisation of engineering products and consequently a larger and cheaper output will become possible.

A meeting of the shareholders of the Constantinople Telephone Company will be held in Constantinople on Nov. 4 to receive a report on the condition and prospects of the company. The last report submitted presented the accounts up to Dec. 31, 1913, and no accounts have been published since, owing to the officials of the company being compelled to leave Turkey early in 1915, before the accounts for 1914 could be completed. Shareholders will be asked to appoint two directors in place of the late Sir George Franklin and the late Mr. David Smith. They will also be asked to ratify the acts of the directors since the last annual meeting. The system was taken over by the Turkish Government in 1915, but after the Armistice the general manager and expert staff of the company regained possession on Dec. 2, 1918. The company proposes that the receipts and expenditure during the working of the system by the Turkish Government (from March 15, 1915, to April 1, 1919) should be for the account of that Government, with the obligation on its part to pay to the company an indemnity which will put it in a position to pay interest to the bondholders and shareholders in respect of the said period. The funds available in London since the period of the last report have been utilised for the supply of materials for repairs, renewals and additions to the system and other urgent expenditure. The general manager is of opinion that the revenue now being received in Constantinople will be more than sufficient to meet the local expenditure.

The Marquess of Winchester, who presided over the annual meeting of the Victoria Falls & Transvaal Power Company, Ltd., on Friday last, congratulated the shareholders on the continued success of the undertaking. Notwithstanding the increase in cost of all materials, wages and freights, the African revenue showed improvement, and in spite of the increase in taxation, involving a larger provision for depreciation and British taxation, the year's trading enabled the company to maintain the same dividends and addition to reserve fund as for the previous year, with a carry forward of practically the same amount. In the course of an analysis of the capital and revenue accounts, &c., he said that the company's loan to the Rand Mines Power Supply Company and the 500,000 shares in that company stood at £2,981,530. The revenue from power and lighting amounted to £860,172, an increase of £31,919 over previous year, and after meeting expenses, debenture charges, &c., the balance was £321,819. Of that sum, a further amount of £50,000 had been placed to reserve, leaving £271,819. The preference shareholders had received three dividends, two each of 3 and one of 4 per cent., and the ordinary shareholders received a dividend of 5 per cent. less tax. These dividends absorbed net £178,125, leaving a balance of £93,693, which has been carried forward.

The chairman, referring to the relief to be obtained from British income tax in respect of colonial taxation, regretted that they had not yet been able to come to a satisfactory settlement with the Inland Revenue authorities. The claim for the fiscal years 1916-17 and 1917-18 had been before the authorities for over a year. They would next year deal with the question of the renewal of the earlier group of contracts which were negotiated for 12 years, with the option of renewal on the same terms for five years. They approached that matter with the great advantage that, during the years which had elapsed since the commencement of supply, the regularity and convenience of the electrical drive had been thoroughly tested and not found wanting. A further reason in favour of power supply from central stations was that in the future the cost of raising capital was not likely to fall much for many years, and the cost of new plant was not likely to gravitate towards cheapness, seeing the high rate of labour in all classes. Their consumers had an interest in their prosperity through a participation in their revenue after all outgoings and certain charges on capital hitherto not covered had been allowed for, and that would in future operate as a reduction in the price of power. Since then the low grade mines had continued to work during the prolonged period of war, and the gold mining industry having now a free market, and taking into account the world's need for gold and the importance of the mining industry to South Africa, it was to be hoped that some means would be found to avoid the closing of those properties. The satisfactory maintenance of supply under the trying conditions produced by the war reflected the greatest credit on their operating and maintenance staff, and the difficulty of providing spare parts and replacements had been most successfully overcome by the staff at the company's workshops, who had succeeded in producing special and complicated parts of machinery never previously manufactured in South Africa. The Rand Mines Power Supply Company had secured a Bill to legalise its use of water from the Vaal River for the present power station. The chairman concluded by paying a high tribute to the service rendered by Major Bagot, Mr. B. Price and the members of the staff.

New Companies.

COMMERCIAL WELDING & ENGINEERING COMPANY, LTD. (158,474). Private company. Reg. Sept. 3, capital £5,000 in £1 shares. Objects: To carry on the business indicated by the title, and that of manufacturers of motor cars, marine and electrical engineers, &c. First directors are: J. Thomas, W. Thomas and J. E. Thomas. Reg. office, 7, Dumfries-place, Cardiff.

ELECTRIC WEAVING APPLIANCES, LTD.—Private company. Reg. in Dublin Aug. 27, capital £5,000 in £1 shares. To purchase or acquire any patent licences, &c., and to carry on business as dealers in spinning and weaving machines. Secretary: G. B. Brown.

GRIMSBY ELECTRIC WELDING COMPANY, LTD. (158,854).—Private company. Reg. Sept. 17, capital £5,000 in £1 shares. Objects: To carry on the business of electric welders, engineers, aircraft and motor manufacturers, &c. First directors are: H. Blanchard (managing director), C. A. Osborne and W. H. Coggon. Reg. office, Humber Bank, Fish Docks, Grimsby.

METROPOLITAN-VICKERS ELECTRICAL EXPORT COMPANY, LTD.—(158,935)—Private company. Reg. Sept. 19, capital £100,000 in £1 shares, to carry on the business of dealers in and exporters of electrical plant and machinery, &c. Power is taken to construct, lay down and maintain telegraphs, telephones, marine cables, &c. First directors are: Sir Edmund W. Smith, John E. Hutton, Harold Lloyd and Robert S. Hilton. Reg. office: 2, Norfolk-street, Strand, W.C.2.

WARD & GOLDSTONE, LTD. (158,956)—Reg. Sept. 19, capital £200,000 in £1 shares (100,000 preference), to take over the business of engineers carried on by J. H. Ward, M. H. Goldstone, A. A. Goldstone and L. B. Goldstone at Salford as Ward & Goldstone. First directors are: J. H. Ward, M. H. Goldstone, A. A. Goldstone and L. B. Goldstone. Secretary: A. Lowe. Reg. office: Sampson Works, St. Simon-street, Salford.

Prices of Metals, Chemicals, &c.

Tuesday, Sept. 23.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£110 0 0	—	—
Electrolytic bars ...	,,	£121 0 0	—	—
H.C. wire bars	,,	£121 0 0	—	—
Sheet	,,	£146 0 0	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	per lb.	1s. $8\frac{3}{16}$d.	$\frac{1}{4}$d.	—
Brass 60/40—				
Rod, basis	,,	0s. 11d.	$\frac{1}{8}$d.	—
Sheet, basis	,,	1s. $2\frac{3}{8}$d.	—	—
Wire, basis	,,	1s. $2\frac{1}{4}$d.	—	—
Pig Iron—				
Cleveland No. 1 ...	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	33 10 0	—	—
Lead Pig—				
English	,,	26 15 0	5s. 0d.	—
Foreign or colonial	,,	25 12 6	7s. 6d.	—
Tin—Ingot	,,	275 0 0	£11 0 0	—
Wire, basis	per lb.	0 3 $6\frac{1}{2}$	—	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £21.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £42.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. $6\frac{1}{2}$d.

Shellac.—480s. October delivery 465s.

Rubber.—Para fine, 2s. $6\frac{1}{4}$d.; plantation 1st. latex 2s. 3d. lb.

Thirty-Seven Years Ago.

[From The Electrician, Sept. 23, 1882.]

Lighting the Thames Embankment.—The number of electric lights on the Thames Embankment is shortly to be considerably increased, the Metropolitan Board of Works having extended their contract with the Jablochkoff Electric Light Company. for that purpose.

Edison v. Swan.—At the meeting of the Swan United Electric Light Company held this week, the chairman stated with reference to the threatened litigation between Edison's Company and theirs, that there could be no doubt as to the separate character of the inventions, and that he thought it not unlikely that the companies would join forces rather than fight each other.

University College, Bristol.—New buildings are being added to this college, and will be completed shortly, thus affording extra facilities for students. Arrangements have been made by which those who may desire to do so can receive thorough training as electrical engineers, and instruction in general science generally. Prof. Silvanus Thompson, so well known in the electrical world, is the lecturer in this branch of science.

THE ELECTRICIAN:

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Notes.

National Suicide.

LITTLE did we think when we penned a note last week on the seriousness of the ironfounders' strike that by the time the note appeared in print we should be faced by the most momentous strike this country has ever known. The first public suggestion of a railway strike was made on Tuesday of last week by Mr. THOMAS, the secretary of the men's union. The same day the secretary of the Associated Society of Locomotive Engineers and Firemen, according to his statement, appeared to know nothing of the impending catastrophe. Yet the decisions to strike were reached on the Tuesday and Wednesday, and instructions to strike were issued without waiting to negotiate. The reason for this extraordinary action, according to Mr. THOMAS, was that if a strike should be inevitable it might be difficult to let the members know what were their instructions. Thus everyone on the Tuesday, except the railwaymen, were ignorant of what was to take place, and yet the strike was an actual fact at midnight on Friday. Never was there greater haste over issues which were not immediate and on a decision of the greatest gravity. As Mr. LLOYD GEORGE truly says, every employer and every worker is entitled to at least a week's notice to terminate a contract of service on either side. But the Union had no scruples about a "lightning" strike of the greatest magnitude and which may cause untold damage and suffering. What would be thought of employers if they were to adopt corresponding tactics? Moreover, the wage rates under discussion could not become operative before January 1st, and the terms offered must be regarded as reasonable. Why, then, this precipitancy of action? There is only one conclusion that can be reached, namely, that the trade union did not intend serious negotiation. The immediate object was to obtain the capitulation of the Government and the final objective to govern the country not by the House of Commons but by the trade unions. Mr. CRAMP, president of the N.U.R., openly hinted at this possibility last June. It is thus not merely an industrial matter. The object is to govern by force. It is all very well for Mr. THOMAS to state that last Friday was the saddest day in his life, and for Mr. FOOT, the secretary of the London Branch of the Union, to make a reference to the recognition of the humanitarian aspect of the case in abandoning the horses of the railway companies. Most men will regard such sentiments as made by a man with his tongue in his cheek and as mere claptrap. Mr. THOMAS, if he were a believer in moderate principles, would have dissociated himself from his council and refused to be a party to a strike which has been called with the utmost callousness and disregard of the country's welfare.

The Issues.

IT is well that the wages issue should be clearly understood. The Government offer is that the new rates shall be on the average 100 per cent. above the pre-war rates with a minimum of £2, and that the difference between this wage and present wages shall continue until the cost of living has fallen to 110 per cent. over the pre-war figure. To-day it is 115 per cent. When the cost of living falls to 110 per cent. or less, the war wage will be subject to adjustment. On the other hand, the Union demands that every man shall receive his pre-war wage plus his war wage and shall have a minimum of £3 per week. According to the evidence in the negotiations that have been published, the Union's demand may apparently be put in the form that the new permanent standard rate of each grade should be the maximum pre-war rate *of any worker* in that grade plus the 33s. war wage. It is evident that the object is to retain the war wages irrespective of the cost of living. Not only is this an unjustifiable object, but it must be remembered that whatever is secured by one industry to-day will necessarily be demanded by every other industry to-morrow, probably by means of the strike. It is therefore impossible to give way in a matter of this kind if the country is to maintain its industrial existence. The railways are already being worked at a loss, and the more this loss is increased the greater will be the burden on the industries and on the community as a whole. What we do not doubt will be felt by all responsible people in the industrial world is that the present object of many agitators is merely to find a good cause for a strike. In the present instance the drivers and firemen have been given particularly good terms, as it was felt that such preferential terms should be given and were definitely put forward by the unions, for these men had not received fair treatment during the war. If such preferential terms had not been given there would have been a strike for the purpose of securing them. Now that the preferential terms have been given there is a strike because the Government does not agree to give similar preferential terms to all other grades. Thus. whatever is done there is good cause for a strike. The settlement of a crisis to-day merely means that another crisis will be found to-morrow. The position, in fact, becomes intolerable. The present trouble emphasises the great danger of allowing enormous power to pass into the hands of a council of some dozen men who are prepared to use their power without realising their national responsibility. We doubt if the present strike would have taken place if the opinion of the men had been taken by ballot. The union council, however, would not run a risk of this kind, nor permit any steps that might rob the strike of its "lightning" character. It is time the community decided that the country must not be governed by force in this way. In order to eliminate this danger, legislation should be introduced forthwith to render strikes of those engaged in public utilities illegal, to permit the funds of unions engaged in such strikes to be sequestrated and to bring to account those who promote such action. Disputes with those employed in public utilities should be submitted to arbitration. We have always been in favour of adequate wages and proper conditions for labour, but the community as a whole cannot afford to be trampled upon by small minorities or to permit strikes that are against the State. If the position were put fairly before the railwaymen we believe the great majority of them would endorse these principles. The present contest must result in great harm to the legitimate progress of trade unionism. Meanwhile, the only thing to be done is to fight the danger to a finish and to support the Government in every possible way.

The Fruits of Interfering With Industry.

When the Sankey Award gave the miners another 2s. a day the position was viewed with great alarm by many of those engaged in those industries which are largely dependent upon coal. This award was followed by the advance of 6s. per ton in the price of coal since July 15. The first disastrous effect of this policy is seen in the shale oil industry in Scotland. The principal employers in that industry find that the Sankey Award has entailed an additional working charge of over £250,000 per annum, and the advance of 6s. per ton has made a further additional working charge of £215,000 per annum, so that the industry is now being worked at a loss of £190,000 per annum, disregarding depreciation and any return on capital. The demand that the working day should be reduced from 8 hours to 7 hours would mean a further large loss. Obviously it is impossible to carry on an industry under these conditions. The employers have, therefore, intimated that if the terms of the miners are insisted upon the industry of shale mining must be shut down. As the miners were not prepared to give way, instructions have been given to shut down practically all the shale mines in Midlothian and West Lothian. It was also stated recently that some of the minor Welsh collieries have been shut down as they can no longer be worked on a remunerative basis. Perhaps in due time the folly of interfering unduly with industry, and stipulating wage rates which cannot be paid, will be realised. We fear, however, this will not be the case until a great deal of harm has been done to various industries in this country.

The Electrical Equipment of Ships.

It has long been recognised that the wiring of ships entails very special problems of its own, and it was for this reason that in May 1916 a Committee of the Institution of Electrical Engineers was set up with the title of Ship Electrical Equipment Committee to consider the drawing up of a comprehensive set of rules. This work has now been accomplished and some account of these rules will be found in another column. Here it will be sufficient to say that the procedure followed by the Committee was to discuss all questions of principle and then to remit the actual drafting of the rules to a small editing sub-committee. In this way consistency has been attained. Concurrently with the work of the Committee a number of sub-committees of the British Engineering Standards Association have been at work standardising apparatus that would comply with the regulations drawn up by the Institution committee. A small standing sub-committee has been appointed to whom all communications may still be remitted, so that the rules will be kept fully up to date. We believe that they have been already submitted to a good deal of discussion, and consequently they ought to meet the necessary requirements. We have only one general criticism to make. It will be found that all sizes of wire are given in the form of sectional area in square inches. No doubt this is a good method for exactness and there may be objections to continuing the use of the standard wire gauge; nevertheless we think it will be agreed that the S.W.G. number conveys much more to the average man than the sectional area. Everyone knows what is meant by a No. 16 or a No. 22. We therefore feel that these numbers should have been retained and, if necessary, put alongside the sectional areas; otherwise we fear that the rules will lose some of their effectiveness.

Association of Mining Electrical Engineers.—The meetings of the London Branch of this Association have been resumed after a lapse of several years owing to war contingencies. The next meeting will be held at Kingsway Chambers (top floor), 46, Kingsway, at 6.30 p.m., October 22nd. The general meeting will be held at Edinburgh on October 10th and 11th, when the Lord Provost has invited all members of the Association to a civic reception on the Saturday afternoon. The Secretary of the London Branch is Mr. Fred. J. Turquand, 73, Albion House, New Oxford-street, W.C.1.

Diesel Engine Users' Association.—At the next meeting of this Association the subject of the life of "Connecting Rod Bolts" and their periodical renewal, as well as the general question of heat treatment, is to be further discussed. Information is also to be given as to the proposed Research Association under the Government scheme for carrying out research work on liquid fuels for use in Diesel and semi-Diesel engines. The dinner of the Association will be held on the 23rd inst., and will be attended by several eminent engineers who have taken a prominent part in the developments in Diesel engine practice and fuel oil technology.

Liquids for Optical Levels.—The choice of liquid in so-called "spirit-levels" may seem a small matter, but it is interesting to note that there is a material difference in the qualifications of liquids commonly used for this purpose. In a Paper before the Optical Society some time ago Mr. J. W. French referred to this matter. Benzol, he remarked, is worse than alcohol as regards expansion, but is twice as good, as regards viscosity, *i.e.*, from the point of view of a bubble. It is worse than ether as regards viscosity, but better as regards expansion; worse than carbon disulphide as regards viscosity and about the same as regards expansion. A certain amount of viscosity in the liquid may, however, be desirable. On the whole it would appear that the choice of benzol is a good one. The spirit used in the level on a captured Zeiss instrument appeared to be 90 per cent. benzol.

Subway Lighting.—An article in the "Electrical World," by Messrs. Ward Harrison and E. A. Anderson, deals with a somewhat difficult problem, the lighting of a subway station and the passages connected with it. As the roof is in general quite low it is not easy to keep the lights out of the field of view and yet afford the necessary even lighting and strong illumination of vertical surfaces. Fortunately, in this case the problem was rendered easier by the design of the lighting arrangements at an early stage in the proceedings and the adaptation of construction thereto. A feature was the use of panels of diffusing glass, flush with the surface, having behind them a pair of gas-filled 75-watt lamps. These lamps are on two separate independent circuits. Special lighting devices were employed in other sections of the subways, and in general an attempt appears to have been made to deal with the problem on sound lines.

Electric Bakery Ovens.—"Le Génie Civil" recently described a series of electric baking ovens in use in Switzerland where the shortage of fuel and comparative abundance of water-power is favourable to the development of electric heating and cooking. The ovens are embedded in brickwork, and present about 6-12 sq. m. of heating surface, and in the larger types it is possible to bake about 18 kg. of bread per square metre. of oven surface. An ordinary loaf requires about 1-1½ hr. of baking, according to size. The baking temperature is 250°C.-300°C. and about 6 kw. per square metre of oven are called for. The consumption of power per weight of bread produced naturally varies according to the process and the number of loaves similarly treated, but in general appears to be of the order of 0·4-0·8 kw. per kilogram (say, roughly, 0·2-0·4 kw. per lb.).

Prospective Electrification of the Chicago Railway System.—Among big electrical schemes which are likely to receive attention shortly in the United States is the electrification of the Chicago railway system, which appears now to be favourably regarded by the authorities, an agreement having been reached between the Illinois Central Railroad, the Chicago South Park Commissioners and the City of Chicago, after eight years of negotiation. The "Electrical World," in discussing the matter, states that about 118 million dollars will be involved in the projected scheme of improvement, and reclamation of the lake front, of which the electrical installation will absorb about 23 million dollars. About 8 million dollars of this will be required for the electrification of the suburban passenger service. The work is to commence within 60 days after the ordinance becomes effective, and the electrification will probably be commenced two years later.

Transmission of Coloured Light Through Fog.—In a recent issue of the "Transactions" of the American Illuminating Engineering Society, Mr. C. L. Utterback gives an account of some experiments on the transmission of coloured light through a form of fog produced by the condensation of water vapour in a long tube into which dusty air is admitted. A parallel beam of light passing through this tube illuminates a white surface at its extremity, and the brightness of this enables the relative absorption to be calculated. The author presents a curve showing that the transmission diminishes both in the red and violet, and is a maximum for wave-lengths between the limits 5,300–5,900 $\mu\mu$. Another curve for water vapour, obtained by a different observer, is also appended for comparison. Its nature is generally similar, but the point of maximum transmission is somewhat further advanced towards the green. However, other observations do not entirely support this result for water vapour. It appears that the absorption of light depends on the nature of the fog, which may not be correctly imitated artificially. Common experience of the appearance of the sun and moon at rising and setting suggests, however, that in general the red and yellow element is accentuated at the expense of the blue end of the spectrum in the transmitted light.

Windmill Power in Denmark.—In Denmark, during the coal famine caused by the war, quite an impetus was given to the generation of electric power from dynamos geared to windmills, and the "Journal of the Royal Society of Arts" states that about 250 such installations have been recently made on farms and small estates with fair success. During about one-third of the year, however, there is practically no wind, so that the source of power could not be depended upon and had to be used as a supplement to steam or gas-driven plants. Nevertheless considerable saving in fuel was effected. It is stated that the cost per kilowatt from peat gas-fired plants was about the same as for a windmill installation. Among the chief factors in such installation are the design of the sails to enable automatic adjustment, thus saving in the cost of attendance, also the use of mechanical devices to ensure a turning movement of the sails so that during very high winds they assume a position almost parallel to the wind direction, thus protecting the mill from overstrain. The following data are of interest :—

Velocity of wind (feet per sec.).	Power obtained kw.	No. of hours of useful wind.	Total kw.-hrs. produced per annum.
16·4	3·1	1,796	5,600
19·6	6·0	1,080	6,500
23·0	10·9	900	9,800
26·2 & over	13·0	1,945	25,100
		Total 5,721	47,000

Tests on Wire Rope.—A Technologic Paper issued by the Bureau of Standards (Washington) (No. 121), summarises some tests by Messrs. J. H. Griffith and J. C. Bragg on the strength and other properties of wire rope. Tests were made on 275 wire ropes submitted by manufacturers to comply with the specification of the Isthmian Canal Commission, the diameters of the ropes varying from 1½ in. to 3¼ in.; over half were hoisting ropes of six and eight strands of 19 wires each, the remainder using respectively six strands of seven wires and six strands of 42 wires each. Formulæ relating to structural data on such ropes are presented. When observed maximum loads were plotted as functions of diameter, the lower boundary of the field comprising these observations could be expressed within fairly close limits by the formulæ, $\text{Load} = C\,75{,}000\,D^2$, where D is the diameter of the cable and C a constant varying from about 0·35-1·0, according to the nature of the rope. In general tests showed good agreement with values fixed by this relation. Elongations were nearly proportional to stress, the calculated moduli varying from $3 \times 10_6$ to $9 \times 10_6$ lb. per square inch of cable cross section. The limit of 12,000,000 lb. per square inch used in the calculation of bending stresses appears ample. The tensile strengths of wires in a strand were quite uniform. The fibre used in ropes was apparently manila, jute or istle. The preservatives were wood or vegetable tar combined with petroleum products. Cables bent over sheaves should be lubricated frequently to prevent corrosion and denting.

Personal.

Mr. Bennett Melville Jones, of Emmanuel College, Cambridge, has been elected to the Francis Mond Professorship of Aeronautical Engineering at Cambridge University.

Mr. Hubert W. Shillback, who has left the Aberpergwm Collieries Company to take up the appointment of chief electrical engineer to Messrs. North's Navigation Collieries, of Maesteg, has been presented by his late colleagues with an inscribed gold chronograph watch and a silver-mounted walking stick by the Powell House staff.

Leeds University has conferred the honorary degree of D.Sc. upon Prof. W. H. Bragg, F.R.S.

Dr. R. Whiddington, of Cambridge, has been appointed Cavendish Professor of Physics at Leeds University, and Dr. W. P. Milne, D.Sc., M.A., Professor of Mathematics.

Arrangements for the Week.

FRIDAY, Oct. 3rd.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Paper on "The Deduction of Formulæ from Plotted Figures," by Mr. A. J. Paxman.

SATURDAY, Oct. 4th.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

7 p.m. At Cannon-street Hotel, London, E.C. Paper on "Elimination of First Stretch in Steel for Reinforcing Concrete," by Mr. A. W. Shelf.

FRIDAY, Oct. 10th.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At the Shipping, Engineering and Machinery Exhibition. Olympia, London, W. Lecture on "Some Hydraulic Exhibits," by Dr. H. S. Hele-Shaw

The Three-Electrode Thermionic Valve as an Alternating Current Generator.*

By Prof. C. L. FORTESCUE.

(*Continued from page* 295).

To represent an alternating current something must be done to the model to keep the piston oscillating at the rate at which it naturally tends to move when left alone. One conceivable method of doing this is shown in Fig. 3. A vane *G* is introduced which operates a double ported valve *V*. Normally the vane is maintained in a central position by the light springs attached to the arm *Q*. But the stream of water past the vane will deflect it upwards and downwards and in so doing will open and close the valve. When the vane is deflected upwards the nozzle N_2 is connected to a high-pressure supply, so that a jet of water enters the system so giving an impetus to the upward stream of water. When the water is flowing downwards the vane will be deflected downwards and a jet of high-pressure water enters through the nozzle N_1, again tending to maintain the stream. In order to prevent an accumulation of water in the system the nozzles must be alternately connected to the exhaust as indicated in the figure.

With such a piece of apparatus it is quite conceivable that the nozzles and the ports of the valve could be so arranged that the oscillating too and fro of the piston was just maintained by the impulses of the water from the high-pressure system.

This method of converting the mechanical damped oscillations of the piston into continually maintained oscillations is very closely analogous to the action of the three-electrode valve in the electrical case. It acts as a combination of the vane and the water valve, and its function is to allow suitably timed impulses of current from a high-pressure battery to pass through a part of the inductance and so convert the damped electrical oscillations into the continuously maintained oscillation known as an alternating current.

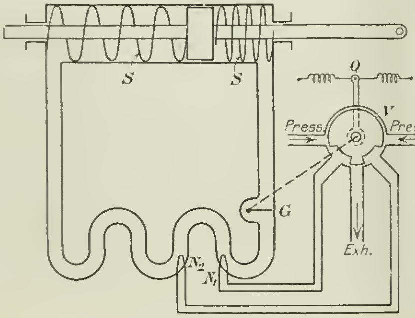

Fig. 3.

The principles of the action of the three-electrode valve itself have already been described on many occasions. For the purpose of generating alternating currents a highly exhausted valve is generally used. Fig. 4 shows the construction of such a valve. In the centre is a tungsten filament similar to the filament of an ordinary incandescent lamp. This filament is raised to a temperature generally somewhat higher than that used in the incandescent lamp and under those conditions there is emitted from its surface a copious supply of free electrons.

Surrounding the filament is a cylindrical electrode, which is maintained strongly positive to the filament by some external battery, dynamo or other source. The electrons from the filament are attracted by this positive electrode, fly across to it from the filament and so constitute a current of electricity across the vacuous space inside the tube.

The third electrode of the valve consists of a more or less open screen placed between the filament and the positive electrode, in such a position that the stream of electrons from the one to the other has to pass between the openings in the screen. This third electrode is usually known as the "Grid," and its function is to control the stream of electrons from the filament to the positive electrode. If the grid is connected up to a battery so that it is negative to the filament, it repels the electrons into the filament, and it is only when the positive electrode is very strongly positive indeed, that any electrons are attracted through the openings of the grid screen. On the other hand, if the grid is maintained slightly positive with respect to the filament, it assists in attracting the electrons away, and a large stream from filament to positive electrode will be maintained. If the grid is made very strongly positive to the filament, it acts itself as the positive electrode and attracts a large proportion of the electrons with the result that the stream across to the positive electrode proper is reduced.

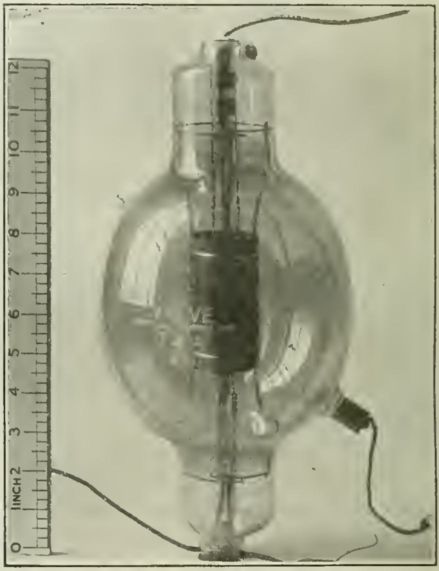

Fig. 4.—Wave Transmitting T4 A.

Characteristic curves showing the control exercised by the grid electrode are given in Fig. 5. In this figure the voltage of the grid with respect to the filament is plotted horizontally and the current at the positive electrode is plotted vertically for three different values of the steady positive voltage applied to that electrode.

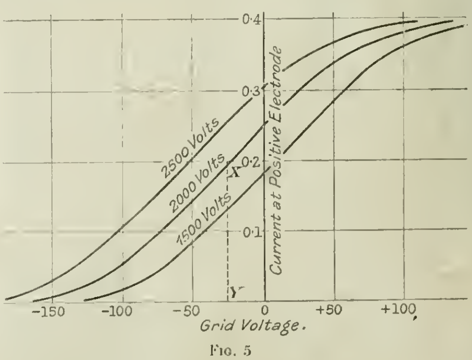

Fig. 5

From these curves it is observed that with the grid 100 volts or more negative to the filament, it is only with high voltage on the positive electrode that the current at this electrode is appreciable. As the grid becomes in turn less negative and then moderately positive, the current at the positive electrode gradually increases to a more or less clearly defined maximum value. This maximum value corresponds to the total rate at which the free electrons are emitted from the filament, and the hotter the filament is, the greater will be this rate of emission and the greater will be the maximum value of the current. After this maximum has been reached any further increase of the positive voltage of the grid will lead to a decrease of the current at the positive electrode because of the diversion of an appreciable proportion of the electron stream to the grid itself.

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*Paper read before the British Association at Bournemouth.

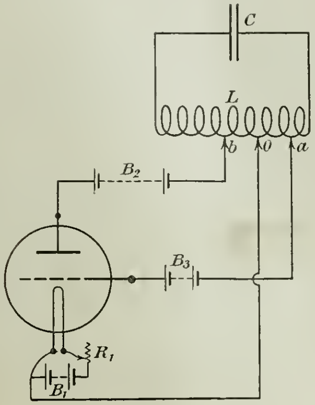

Fig. 6.

The voltage of the grid thus controls the electron stream somewhat in the same way that the opening and closing of a stopcock controls the stream of water in a water main. The analogy is not quite exact but is sufficiently good for the purposes of illustration.

There are many ways of connecting up a three-electrode valve of this kind to an inductance-capacity circuit so as to maintain the oscillations. One of the simplest is that shown in Fig. 6. Here C is the condenser and L is the inductance. The filament of the valve is heated by a battery B_1, the heating current being controlled by the resistance R_1. The filament is directly connected to a point O on the inductance. The positive electrode is connected to a point b on the inductance through a battery or other source B_2. The grid is connected to a point a on the inductance, on the opposite side of the point O to that of the point b, with a battery B_3 in series.

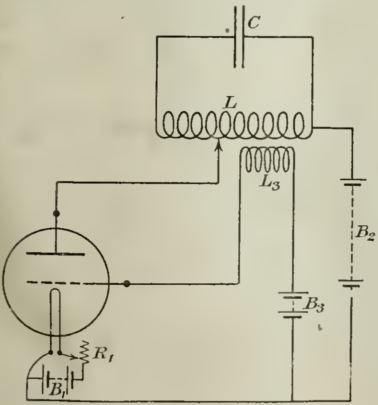

Fig. 7

The filament current and the voltages of the batteries B_2 and B_3 are adjusted so that the steady conditions correspond to a point X on the curves of Fig. 5. A steady current of value of XY will then be flowing through the part Ob of the inductance. If now the inductance-capacity circuit be caused to oscillate by any means, the induced E.M.F. in the part aO of the inductance will act upon the grid and will cause a rise and fall of the voltage with respect to the grid. This rise and fall is accompanied by a rise and fall of the electron stream reaching the positive electrode, and so by a rise and fall of the current through the part Ob of the inductance L. This rise and fall of the current through Ob acts upon the electrical circuit just as the alternating rush of high-pressure water from the nozzles of Fig. 3. If the points a and b on the inductance are suitably chosen any small oscillation in the circuit LC will be assisted and built up into an oscillation of magnitude depending upon the power output of the valve and the energy loss in the circuits.

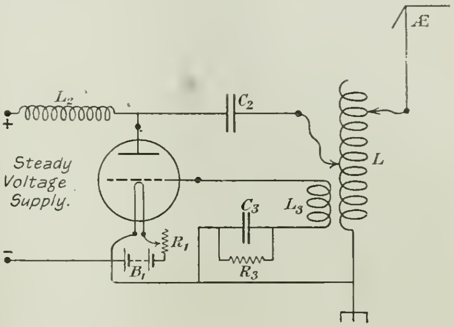

Fig. 8.

Assuming that there is no time-lag in the adjustment of the electronic stream to the changes of grid voltage—as should be the case theoretically for all frequencies up to 10 million or more per second—then this arrangement of a valve with a capacity-inductance circuit becomes an alternator of frequency depending upon the natural frequency with which the current in the c circuit will oscillate. By adjusting the capacity and the inductance to suitable values this frequency can have any desired value from at least 10 million cycles per second, downwards to frequencies of 250 cycles per second, or even less if somewhat bulky apparatus is not objected to. If either the inductance or the condenser or both are made quickly variable by turning a handle, the adjustment of the frequency to any required value within the range of the particular set of instruments in use, can be carried out with a minimum of

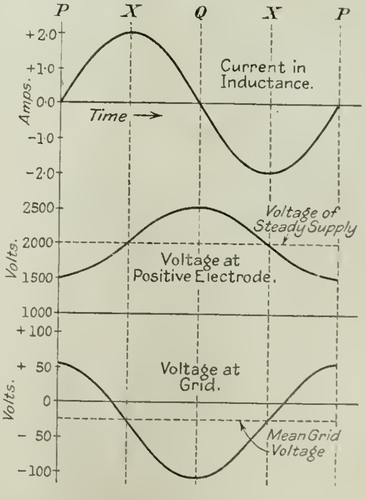

Fig. 9.

trouble. This property is invaluable for wave changing in wireless telegraphy, or where the generator is used for laboratory testing purposes

The circuit arrangement of Fig. 6 is but one of many possible ones. For instance, Fig. 7 shows a very commonly used circuit. Here the grid is influenced by the induced E.M.F. in the coil L_3 instead of by the induced E.M.F. in a part of the main coil L, as in Fig. 6 Fig. 8 shows a very convenient circuit arrangement for a valve transmitter for wireless telegraphy. This arrangement is in principle the same as Fig. 7. The addition of the condensers C_2 and C_3; and of the inductance L_2 are for reasons of practical convenience rather than difference of principle. For example, the aerial system is insulated from the high voltage source by the condenser C_2. This condenser allows the high-frequency currents necessary for the maintenance of the aerial current to pass through it freely, but does not allow any steady current to pass. Thus a failure of the insulation of the aerial does not lead to a short circuit of the high-voltage supply. And again, if the parts of the aerial circuit are inadvertently touched by anyone standing near no serious harm is done, whereas a shock from the high-voltage supply would almost certainly be fatal.

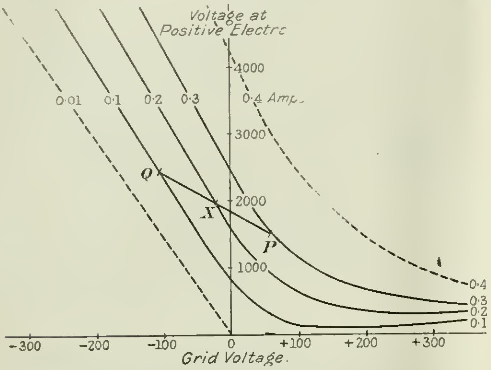

Fig. 10.

3. Theory of the Combination of Valve and Capacity-Inductance Circuit

In designing the valve and circuit two things have to be kept in mind. In the first place the conditions must always be such that any incipient oscillation in the capacity-inductance circuit will cause sufficient power to be supplied from the valve for the oscillation to be built up from the indefinitely small initial values to relatively large amplitude. In the second place, the circuit arrangements should be such that the maximum power is taken from the tube, so setting up oscillations of the greatest possible amplitude; in which connection it may be remarked that with bad proportioning of the circuit and the valve, the current generated may reach a stable maximum value long before the possible maximum power output from the tube is attained. Bad design of this kind is obviously wasteful, as it leads to the use of unnecessarily large and expensive valves.

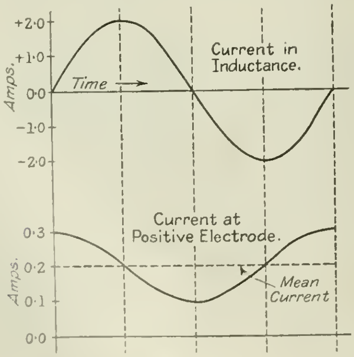

Fig. 11.

Referring to the simple circuit arrangement of Fig. 6, it will be seen that in the course of one cycle of the oscillating current in the capacity-inductance circuit, the effective voltages both between the grid and the filament and between the positive electrode and the filament, are varying. In Fig. 9 the variation of these two voltages is plotted for one cycle in the correct relative phases to the current in the inductance; the positive direction of the current in the inductance being from the point a to the point O, and on to the point b (Fig. 6). With regard to the tube the positive directions for the voltages at both the positive electrode and the grid is when the filament is negative. In order to determine the nature of the current in the part Ob of the inductance L it is necessary to refer to the characteristics of the valves. These may be plotted as in Fig. 5, but are preferably drawn out as in Fig. 10, a method adopted in H.M.S. "Vernon" in 1915. In this figure the voltage at the grid is plotted horizontally, the voltage at the positive electrode vertically and the current at the positive electrode is drawn in as a series of contours of constant current.

The first point of the cycle of Fig. 9 is a point where the voltage at the grid is a maximum and that at the positive electrode a minimum. This will correspond to a point P in Fig. 10. After one quarter of a cycle has been passed through the voltage at both the grid and the positive electrode will be at the normal values as maintained by the batteries. This state corresponds to the point X of Fig. 10 (which also corresponds to the point X of Fig. 5). After one-half cycle has been passed through the point Q of Fig 10 will have been reached. After three-quarters of a cycle a return is made to the point X; and back again to the point P on completion of the whole cycle. Since the alternating components of the voltages in Fig. 9 differ in phase by 180 deg., the points P, X and Q of Fig. 10 will lie on a straight line, which has been called the "oscillation line." The way in which this line cuts the contours in Fig. 10 shows the variation of the current in the part Ob of the inductance L. This variation has been plotted in Fig. 11 in its correct phase relation to the current in the inductance. It will be seen from an inspection of the second curves of Figs. 9 and 11 that the alternating component of the current flowing in at O and out at b (Fig. 6) is opposite in phase to the alternating component of the voltage between these two points. The conditions chosen for the diagrams represent therefore a supply of alternating power to the inductance. Had the oscillation line been drawn as in Fig. 12, the phase of the current would have been reversed, and power would have been abstracted from the circuit. One condition necessary for the building up of a small incipient oscillation is, therefore, that the oscillation line should lie as in Fig. 10 and not as in Fig. 12. Another condition is that the alternating power supplied to the circuit should exceed the sum of the power expended in the circuit and the power abstracted from the circuit (by any means whatever). The power expended in the circuit is due to the main oscillating current in the inductance and the condenser, and to the exciting valve current in the part Ob of the inductance. With the simple circuit arrangement the power abstracted is only that required to vary the voltage of the grid, observing that the grid current is usually in phase with the alternating voltage across the part aO of the inductance.

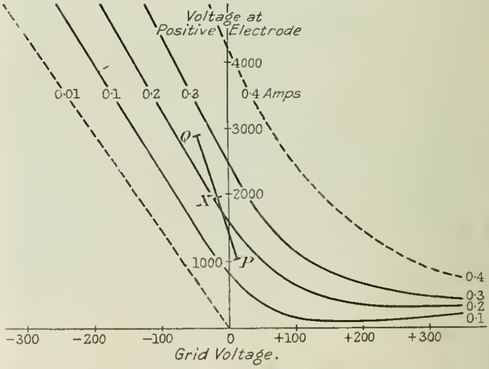

Fig. 12.

(*To be concluded.*)

Large Power Transformers.*

By A. G. ELLIS and J. L. THOMPSON.

(Concluded from p. 298.)

Summary.—The authors first refer to the progress towards increased size of modern stations generating units and transformers, and the tendency to higher pressures. Limiting sizes of transformers as effected by handling and cooling are discussed, and prices per kilovolt-ampere in relation to output, voltage and cooling are presented. The condition affecting choice of types and relative advantages of shell and core transformers are next dealt with. Subsequently safety factors, transformers for interlinking and the operation and care of transformers (switching in and out, drying out, &c.) receive attention. The final section of the Paper discusses the influence of war conditions.

11. Operation and Care of Transformer Installations.

(*a*) *Switching In and Out.*—The switching in and out of transformers, while an easy operation, may present difficulties unless the transformer is correctly designed. There are two main difficulties possible during switching—viz., (1) Heavy current rush and (2) sudden high-voltage rise.

1. The heavy rush of current, which is a magnetising current, does not cause any severe abnormal mechanical strain on the windings, but may cause inconvenience by operating the overload relays. The switch should be closed slowly. As the distance between the contacts becomes smaller the voltage causes the current to jump across the gap. This jump will take place at or near the point of maximum voltage, which is the point of the wave desired for minimum current rush.

2. Voltage rises are frequently experienced when switching a transformer in and out, and the rise is higher the lower the flux density in the transformer core. If the switch is closed at the maximum point of the voltage wave no rise of voltage will be experienced unless the core has residual magnetism. In modern transformers the possible voltage rise will not exceed 1·6 to 1·8 times normal voltage, unless the flux density is low, when it may attain to 3 to 5 times normal voltage. This latter condition is rarely met with except in high frequency transformers. Frequent or unnecessary switching should be avoided and transformer switches should be closed slowly. It is then quite possible to switch large and high-voltage transformers directly on to the line without danger.

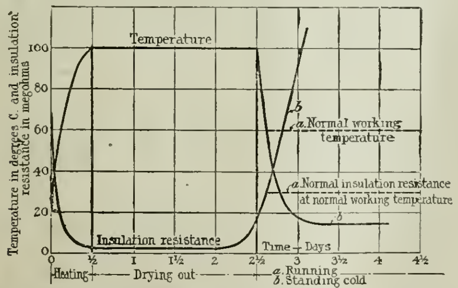

Fig. 9.—Curves Showing Variation of Insulation Resistance with Temperature and Time for Oil-immersed Transformers Before, During and After Drying Out.

Note.—The actual values of time and insulation resistance are only average representative figures.

(*b*) *Drying Out.*—All transformers of moderate and high voltage should be dried out before being put into service. The insulation resistance should be measured during the drying-out period, and the values should follow the characteristics similar to the curve shown in Fig. 9, if the process is proceeding satisfactorily.

"Megger" readings of the insulation resistance values, while useful, are not safe figures on which to base an assumption that the transformer is dry. Unless the actual detailed history of the transformer is known, it should be dried out whatever the measured insulation resistance.

(*c*) *Inspection.*—Periodic inspection of all transformers of other than small capacity should be regularly made every 6 to 12 months, according to size, voltage and severity of service. Auxiliaries such as coolers, pumps, &c., should also be subjected to this inspection. The principal points to be watched for in such inspection are shrinkage of windings, slackening of core-clamping bolts, moisture and sludge in oil, deterioration of insulation due to heating, freedom of oil or air ducts from dirt or dust. In medium and large transformers the oil should be filtered about every 12 months. In large installations a filter press for this purpose is an essential part of the equipment.

12. Influence of War Conditions.

The effect of war conditions has been to retard the development of, and to increase the difficulties in, the manufacture of electrical machinery. Quality of materials, in which there has been generally considerable depreciation, is felt more in transformer work than in any other class of electrical machinery, as high efficiencies are expected and high voltages are concerned. The efficiency is dependent chiefly on the quality of sheet iron, and the electrical safety factor of the apparatus depends largely on the quality of the insulating materials available. The figure of loss of transformer sheet iron obtainable in England has increased appreciably during the last three years, resulting in higher core losses and decreased efficiency (or increase in active material and cost if the efficiencies are maintained). The magnetic quality has not appreciably changed, but this factor is of relatively little importance in transformer design, as the magnetising currents amount usually to only a few per cent. of the full-load current.

Copper is the most stable of all materials used in electrical manufacture. Apart from increase in hardness which has at times been evident, introducing more difficulty in winding, copper has remained up to pre-war standard. Insulating materials have almost all deteriorated since the beginning of the war. The effects of this have had to be met either by increasing the thicknesses of insulation, with a corresponding increase in cost and lowering of efficiency, or by maintaining the cost and efficiency and lowering the safety factor and quality of the finished apparatus. Of these two courses the former is decidedly preferable, and has been generally followed.

The restriction of the import market in materials required for electrical work, necessitating the meeting of the demand almost exclusively by home production under very difficult conditions, has had an unavoidable effect on the quality of material. In this matter labour questions such as dilution, reduction in supply of skilled workers, and substitution of women labour, have also played an important part.

DISCUSSION.

Mr. H. G. **Furlong**: I do not agree that opportunities have not been afforded to the transformer manufacturers for making large transformers in this country. There have been and still are such opportunities, but manufacturers lay undue stress on difficulties of designing and making large units, possibly because their shop equipment or design of transformers lends itself better in the production of small units. There is no reason why three-phase transformers should not be made in single units of the same capacity as turbo-generators, as the space occupied and the total weight would be less and the capital and running costs also lower than for a group of small three or single-phase units. The transformer should be more reliable and less likely to fail than the turbo-generator. The failures due to transformers constitute not more than 1 per cent. of the total failures. The authors state that in very large stations three-phase units of 30,000 k.v.a. to 40,000 k.v.a. would be practicable, but that the question of handling will often be the determining consideration. If the crane is capable of handling the heaviest part of the turbo-generator, and the transformers are in the same room as the turbo-generator, it will be capable of handling the transformer complete. Therefore, there would be no necessity from this cause of using a group of smaller transformer either three or single-phase. Transformers above 5,000 k.v.a., 50 periods, three-phase, should certainly be forced-cooled, the best method being forced oil circulation through an external cooler. Thermostats can be fitted to the transformers so that in the event of the temperature becoming excessive, the attendant in the main station can be warned; or alternatively the thermostat can be arranged so that it will operate the switch relay and thus cut the transformer out of circuit. The three-phase transformer has higher efficiencies, lower capital cost, and requires less floor space than a group of three single-phase transformers. With regard to spares and continuity of supply, the single-phase transformer has no real advantage. The author's remarks regarding single-phase and small three-phase units apply more to turbo-generators where the risk of breakdown is much greater. With regard to sub-stations, it is usual for engineers to standardise the sizes of their transformers. A spare transformer, kept at their stores, could soon be installed in the event of a breakdown. Also spare coils could be kept to replace those burnt out. With a modern core transformer this should not occupy more than 12 to 24 hours. A shell transformer would have to be returned to the manufacturer for repair. Core-type and circular shell-type transformers have the merit of enabling coils to be in direct contact with oil and more easily cooled. Straight oil ducts of ample size, easily cleaned without dismantling can be readily arranged in core transformers, and the bracing of the latter is not difficult. The shrinkage of insulation on a shell type transformer is as great as on a core transformer and is not due entirely to pressure, but to electromagnetic interaction of primary and secondary coils. Repulsive action between windings is, in fact, the chief cause of shrinkage. Shrinkage is invariably of importance, as it is apt to cause coils to move when heavy loads are thrown on transformers. Insulation, one of the greatest problems to transformer manufacturers during the war, has been overcome by the larger firms installing their own plant and manufacturing insulation. There is very little to choose between core and shell-type transformers in this respect. I have not found that bracing the windings of core transformers is any more elaborate or costly than in the case of the shell type. As regards the use of springs the latter should not have to take electromagnetic strains, which are taken by fixed abatements, but should only take up shrinkage and hold the coils against abatements. The safety factors given are reasonable. If all engineers would work on the British standard rules and not subject transformers to overload, the factors could be reduced, price diminished and designs improved. Furnace transformers, which involve special design owing to frequency of short circuits, deserve mention. I have been responsible for designs ranging from 150 k.v.a. to 10,000 k.v.a. Shell and core types proved equally satisfactory. The 10,000 k.v.a. transformers were three-phase oil-immersed, forced-cooled units, core-type, 6,600 volts, 50 periods on the primary, and 115 volts 50,000 amperes on the secondary with an internal reactance of 12½ per cent. The transformers complete with tank and oil weigh approximately 26 tons, the dimensions being 9 ft. by 8 ft. by 9 ft. over the terminals.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

Mr. G. F. Sills: The authors draw attention to the importance of drying out transformers at the works, and in their oil. It is not usually realised by the purchaser that it is quite impossible to dry out on site as thoroughly as in vacuum in the works. The necessity for an adequate space round transformers is often overlooked. I have seen three instances lately of transformers placed in a pit. In one station there were two transformers with just enough space to allow a man to go down between them. The engineer-in-charge said he did not like going down there. Dissatisfaction has been expressed with water-cooled coils inside the transformer, but this is often because the right material has not been used for the internal cooling pipes. With copper or brass many brazed joints have to be made. Any minute pinholes in the brazing will cause trouble. A lead alloy which can be bought in long lengths and save the necessity of making any joints under the tank cover is the best material. Lead alloy will stand 250 lb. pressure, which is ample for anything, and there is no possibility of the water getting into the oil. This test will ensure the thickness of the pipe will last the life of the transformer. Comparatively impure water can be used, a matter of importance in stations in out-of-the-way places. In such case it seems better to put in smaller self-cooled units rather than air-blast-cooled transformers, which necessitate the use of fans and somebody to attend to them, even though the self-cooled type may cost mere in the first place. About eight years ago in the States and in Canada, it was standard practice to put in large single-phase transformers, but in Europe the three-phase was in favour. Now the reverse seems to be the case. The three-phase should go in the big step-up transformer stations where there is a large number of transformers, and a complete three-phase unit may be kept as a spare. In the smaller sub-stations use single-phase transformers with one spare single-phase transformer. In a large station with three-phase transformers it should be possible to save a considerable amount in the building. Are the efficiencies given with the transformer at its normal working temperature or cold? The former chiefly interests the purchaser. With reference to the method of taking up shrinkage, the disadvantage of the design shown with the springs in the middle is that iron is introduced between high-tension coils. The authors have made out a good case for the shell type, but this would be still better if butt joints were used, because of the ease of assembling and repairing and the more satisfactory method of bracing. In practically all core-type transformers bracing is absent. As regards the coils in the core-type being in direct contact with the oil and hence more easily cooled, in most cases the heat has to be transmitted through two or three layers to the oil. With a well-designed shell-type transformer and with a single layer coil, oil is brought in contact on at least one side of the whole coil. A core-type transformer with any type of single layer coil is weak mechanically. The authors refer to moisture and sludge in oil. If by using an expansion vessel with large transformers it is possible to keep the oil from sludging and in the best condition, also to keep the moisture out from the main tank, it is the right construction to use. Transformers fitted with this device are particularly free from breakdown. It is interesting to note that a 250 k.v.a., 500,000-volt transformer was made in this country seven years ago and is now in operation for testing purposes. It has actually been up to 475,000 volts. As regards switching in, buffer resistance should be embodied in the oil-switch, placed so that the circuit is made and broken through a resistance. This arrangement cuts down the current to quite a safe figure.

Mr. A. J. Cridge: My experience is that less than 10 per cent. of transformers manufactured are shipped in oil. Objections have been raised by the Railway Executive Committee to the transport of transformers in their tanks, whether with or without oil, except at owners' risk. Manufacturers should try to alter this view—possibly under the condition that the tanks should be of approved strength. In these days of expensive buildings, head room should be as small as possible. It has been suggested that the side of the tank should be removable so that the transformer could be taken out by lifting it a few inches from the floor, but there would be difficulties in making an oil-tight joint. The authors state that a three-phase tank *must* stand upright, while single tanks may be transported on their sides. Why? The long, narrow, three-phase tank should lie on a truck as well as the wider and shorter single-phase tank of the same height; and, the limiting size of three-phase transformers transportable by rail might be increased to 8,000 k.v.a. or even more. Some explanation of the curious rise in the weight per kilovolt-ampere for sizes above 3,500 k.v.a. at 55,000 volts, shown in the curve given by the author seems desirable. I agree with the emphasis placed by the authors on the provision of ample room round large transformers, the superiority of forced cooling over water cooling, and the desirability of adopting the B.E.S.A. specification. In one of the load curves presented the average load is 150 kw., power-factor 0·62, and therefore cables and transformer must be large enough for over 240 k.v.a. This shows the drawbacks to a large "idle" current A meter to record kilovolt-ampere-hours instead of kilowatt-hours would be most useful in this connection. Much has been said about bracing. In rectangular coils in shell-type transformers distortion may take place owing to expansion of the copper when heated by passage of current; freedom should be allowed for this expansion. Bracing may sometimes be overdone. With reference to the authors' recommendation to close the switch slowly, it seems impossible that there is any spark at the moment of making the circuit, especially under oil. Can the authors support their view by experimental evidence? The relative merits of butt joints (largely used on the Continent) and interleaved joints in core-type transformers deserve attention. A constant temperature is only reached very slowly. The temperature is sometimes regarded as constant when it rises by 1°C. per hour, but this may go on for five or six hours. The only preventive remedy for sludge is to use the best oil and avoid overheating. The oil expansion chamber is no use.

Mr. Watson: In the immediate future we shall use generating units of larger size. The transmission pressures in my district, about 6,000 or 11,000, will be put up considerably. The main transmission pressure between power stations may be at least 30,000 volts, necessitating step-up transformers between the alternator and the 'bus-bars, because you cannot conveniently generate at so high a pressure as 30,000 volts on the alternator. Generating units of 20,000 kw. capacity are now being installed. In the future units at least double this size will be used and the transformers will consequently have to be of a correspondingly large size. At 25 cycles transformers are 35 per cent. more costly and 40 per cent. heavier than at 50 cycles. My district is fortunately placed in having standardised 50 cycles. Single-phase units will probably be adopted for very large sizes by reason of the convenience and lower cost of providing spare units, even though three single-phase units occupy a larger space than one three-phase unit. The question of the lifting tackle inside the power station is less important than transport. Do the prices given for the large transformers include pumps, oil tanks and circulation arrangements? More information regarding regulating transformers would be useful, especially as regards cost and losses. Something requires to be done in regard to the standardisation of sizes of transformers, and the B.E.A.M.A. might consider the matter. In view of the high pressures used with these large units I should be glad to know what form of earth-shield is being employed.

Mr. F. H. Williams: I agree that in spite of the advantage of transporting in oil, this is not desirable for foreign shipment. With regard to the Crocodile trucks, 50 tons loading weight applies only to an evenly distributed load; the actual loading for a central load such as a transformer will be less. Transformers in trucks need not be transported vertically. A big transformer may be transported on its side. The ordinary shell-type transformer could be transported in a rectangular boiler plate tank, without oil, and provide it with a lifting cradle. I prefer the shell-type on account of its robustness; even if it gets rough handling after delivery there is very little chance of damaging the coils. What voltage do the authors propose to give for such transformers? Does the 50,000 volts apply to the shell-type or only to the core type? Are the costs given pre-war costs or present-day costs? I prefer the single-phase unit particularly when it is of large size. A serious breakdown in a three-phase unit may wreck the whole transformer and the cost of the rewinding is much greater than for a single-phase unit. If one phase breaks down the three phases have to be rewound. The water-cooled transformer of the cooling coil type was a very poor device. In all water-cooling the water should be at less pressure than the oil so that if there is any leakage it will be from the oil to the water. I do not see how that can be satisfactorily done with the water coil at the top of the transformer.

Mr. H. S. Binns said: A great claim is made for the robustness of the shell-type transformer, but the support in the type shown seems inadequate and the shrinkage in this type is quite as great as in any core-type transformer. Immediately shrinkage takes place the clamps (which the authors specifically state are not intended for taking up shrinkage) are no longer of service as a means of support. Their true function is to form abutments to prevent the coils splaying out on short circuit. The method outlined does not afford very rigid or robust method of construction. Further, the core laminations have no through bolts, being held in place with practically no compression by angle irons on their outer edges. It is, however, possible to make a thoroughly rigid and robust shell-transformer by other methods.

Mr. J. F. Shipley: In my experience, methods of packing are usually unsatisfactory. The matter receives attention from the chief packer, rarely from the engineer. If manufacturers would get their engineer to design the packing great improvements would follow. Transformers can be shipped in oil complete to and from big ports where there is an adequate quay and crane. But in the case of unloading at sea there must be separate packing cases for everything.

Mr. W. Parry: Will the authors give some data on road transport in trucks? Wide ducts must be used in tanks and transformers to secure a large flow of oil with a small head of pressure. Information comparing single-phase shell-types with three-phase shell-types would be useful. Is it true that a three-phase shell-type can be run with one phase broken down, if that phase is short-circuited? Three single-phase units might be put in one tank, thus economising space. "Copper-clad" seems a better term to use than "ironclad"; for the reactances so described some data on the losses would be useful. Lead alloy cooling worms without joints have been suggested for water-cooled transformers. Copper pipes could be used in the same way. The failure of some large water-cooled transformers on the Rand, described in The Electrician some time ago, was due to the pipes not being extruded correctly; thin patches existed on the walls and were worn through by grit in the cooling water. The potential across the spiral spring as shown by the authors is only about 100 volts; there is no danger in placing it in the middle of the winding. Oil can be put along both sides of the coil in both shell and core-types, but this involves using twice as much space for ducts. It is, however, unnecessary, owing to good conductivity of the intervening section. It is easier to clean out sludge in the core type. What is desirable is an insulation which will stand water: transformers can then be run in water instead of oil up to 100°C. Shell-type construction, of the type indicated, tends to produce internal "rumbling" on load, due to vibration of conductors in the windings and the large number of ampere-turns. It can be overcome by having windings absolutely tight by adjustable clamps acting over the whole of the end coil faces. In the illustration given by the authors the clamps only cover a part of the coils external to the iron core, and coils inside the iron tend to bulge out. The authors give the force exerted over the face of the coil clear of iron, but do not mention the bursting stress in the conductors. Is the latter of no importance? In regard to circumferential stress in the copper in core-type transformers, can the authors give the calculations determining when the elastic limit of copper is exceeded and radial coil supports are necessary? Such a large displacement between magnetic centres of high-tension and low-tension as 5 per cent. should not be allowed and can be prevented by proper design.

Mr. Ellis: Mr. Thompson and I may congratulate ourselves on having introduced another controversy into the transformer question, *i.e.*, the "spring control" controversy. It is possible to build the type of construction shown in the paper with a spring at the bottom and a spring at the top so that the coil should press the very centre of the leg and keep it quite symmetrical. That has been done on certain large transformers. As regards the question of the shell type versus the core type I may recall our statement that the discussion of the relative merits is usually prejudiced by the particular views and experience of individual manufacturers and power-supply engineers. I was brought up on core-type transformers and I brought a good deal of core-type prejudice into this controversy. I have not been wholly converted to the shell-type, but we have aimed at an impartial statement of the facts. I cannot now go into all the questions in detail; we will take the opportunity of replying in writing. The prices given in the Paper are present-day prices, but are only put there for guidance. The prices given with regard to the forced cooling transformer includes the full equipment. Reference was made to a device which prevents sludge. The controversy regarding oil expansion chambers or oil tanks has lost much of its interest owing to people realising the importance of having a decent non-sludge oil. We have been asked for information about the regulation transformer. It was impossible to deal fully with all such questions in this Paper, but at a future date we shall be able to deal with that matter. In view of the interlinking questions which are coming on we give at the end of the Paper sufficient indications of the general lines on which we should attack those problems. We deliberately left out furnace transformers. The paper was intended to be written from the point of view of a large central station and the question of furnace transformers merits complete treatment by itself.

Electric Welding: Its Theory, Practice, Application and Economics.[*]

By H. S. MARQUAND.

(*Concluded from page 302.*)

Summary.—In this article the author concludes his description of various methods of preparing welds and gives some further illustrations of various kinds of work that is now undertaken. He then passes on to the economies effected by machine welding, and to the testing and strength of electric welds.

Future Investigation.

There has now opened up a wide field of investigation work upon the economics and technique of electric welding, and in particular electric arc welding.

Firstly, then, there is the question of nitrogen and its effects, as we have already mentioned.

Again, we have stated that the deposited weld metal appears to be pure iron; but is it pure iron? The physical and mechanical properties are in reality considerably removed from those of pure iron, and the metal cannot be said to behave as pure iron. Where, then, lies the difference? Possibly this difference can be explained by saying that you cannot take work out of any material where it has not in some way first been put into that material. Wrought iron or mild steel certainly has work put into it before applying it to engineering use, but the deposited metal in the weld has not, as a rule, any mechanical energy stored up.

If a weld is well hammered and annealed, it certainly exhibits improved qualities mechanically and physically. However, the author is of opinion that the last word has not by any means been said upon this point.

Then there is the vexed question of protective coverings for metal electrodes to adequately protect the fused metal and the deposited electrode metal. In this country most authorities up to now have been strongly in favour of the refractory slag covered electrodes. This system is quite good, but the writer ventures to say that it is totally unnecessary and very expensive. What is the alternative? In America, very considerable success has been attained with the bare metal electrode. The average results obtained by a trained operator agree very closely in respect of mechanical tests with the average results obtained with special coated electrodes given an equally trained welder. One is forced, therefore, to ask where is the great advantage of special coated electrodes, and whether these slight advantages warrant the considerably greater expense in the production and use of the latter?

It is claimed that it requires greater skill to obtain with the bare electrode a thoroughly satisfactory weld than is required to obtain an equally good weld with coated electrodes; and, moreover, a weld made with a coated electrode has higher fatigue resisting properties than one made with bare electrodes.

The author is not at all convinced that these claims have been conclusively proved. At all events, the improvements in mechanical properties, if any, of the coated electrode and the reliability of welds made by the average operator, compared with the difference in results obtained with either system under the influence of the human element, leads one to the conclusion that the whole matter requires careful and scientific investigation.

It has been contended that the coating round the electrode can be made the vehicle of constituents which will give desired characteristics to the added metal.

The author ventures to state emphatically that no external covering of the electrode, whether in the nature of a refractory liquid flux, or a gaseous flux forming substance, can in any way influence the chemical or physical state of the weld apart from protecting the metals in fusion from the surrounding atmospheric gases.

The constituents intended to alloy with the deposited metal are on the wrong side of the arc.

Considerable experimental work with alloy steel electrodes have further persuaded the author of the truth of this latter statement. Research work is now going forward upon metal electrodes for a higher class of weld than ordinary mild steel.

The Alloy Welding Process, Ltd., have already completed

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[*] All rights reserved.

Table X.—*Electric Welding. Speed and Cost of Working. Metal Electrode System.*

These figures were obtained from a series of tests carried out under the supervision of Major James Caldwell, of the Welding and Labour Section, at the Admiralty. They were made indoors under good working conditions, and allowances should be made where conditions are not likely to be good and the work not easy of access.

Thickness of plate.	Feet per hour.	Units per foot-run at 1d.	Electrodes per foot-run.	Labour at 1s. per hour.	Total cost per foot.
$\frac{1}{16}''$	28·0	0·07	1·25	0·43	1·75
$\frac{1}{8}''$	30·0	0·18	1·4	0·4	1·9
$\frac{3}{16}''$	24·0	0·27	1·8	0·5	2·5
$\frac{1}{4}''$	22·0	0·45	2·0	0·54	3·0
$\frac{5}{16}''$	10·0	0·73	4·0	1·2	5·9
$\frac{3}{8}''$	7·5	1·6	5·5	1·6	8·8
$\frac{7}{16}''$	6·0	2·0	8·0	2·0	12·0
$\frac{1}{2}''$	5·0	2·4	9·6	2·4	14·4

some valuable work in this connection, and hope to shortly place on the market electrodes suitable for welding 50-ton steels.

It must be admitted that in the present state of our knowledge the results obtained with any system of arc welding to a very considerable extent depend upon the skill of the individual operator.

The best results that the author has yet seen were obtained by the British Arc Welding Company, Ltd., who use an electrode covered with a thin sleeve of flux, which under the heat of the arc forms a protecting atmosphere of inert gases. Their expert operators produce uniform welds in the nature of 32 tons tensile strength per square inch.

The polarity of the electrode has a marked effect upon the mechanical strength of the weld. Unless the work to be welded is very fine, or has a low fusion temperature, the metal electrode should be negative in polarity; furthermore, overhead operation is decidedly easier of accomplishment with the electrode negative.

SPEED AND COSTS OF WELDING.

It is exceeding difficult—and is in fact, impossible—to make any absolute statements in connection with costs and speeds on account of the many variables involved.

However, a fair idea of the comparative costs and speed of welding for the oxy-acetylene and the electric arc systems may be gathered from results of records taken of each process under as near as possible equal conditions, such as conditions of operation, thickness and form of material welded, position of work, each based on average prices for labour, materials and generation of gases per cubic foot and electrical power per kilowatt-hour.

For miscellaneous repair work accurate costs cannot be given, but the comparison under standard conditions will still more or less hold good.

It may be here said that as the mass of work to be welded increases, and the accessibility of the work decreases, also, while the conditions of operation become less favourable, such as exposure to the open air, line of weld vertical, or above the operator, opposition of work to free expansion and contraction, or near presence of rivets, studs, &c., the figures for cost and speed become more favourable to electric arc welding.

Tables X., XI. and XII. show the speed and cost of butt welding steel plates varying in thickness from $\frac{1}{16}''$ to $\frac{1}{2}''$.

It will be observed from Table XI. that the cost per foot-run decreases in proportion to the increase in section of the metal welded; the same applies in a less degree with the metallic arc system (Table X.). In actual practice on heavy repair work this proportionate decrease in cost exists to a very much greater extent, owing to the heavy standing charges which are more or less constant, bearing a smaller proportion to the total cost.

In oxy-acetylene welding this condition of affairs can generally be said to be the reverse. From Table XII. it will be seen that the proportionate cost increases with the increase of section of the material welded. The consumption of oxygen and acetylene gas rapidly increases as the section of weld increases. This is due to the greater power of the work being welded to conduct away the heat being applied to it externally to fuse the metals.

In the case of arc welding, the heat is generated internally in the metal itself, and at a rate far beyond that at which the metal can conduct it away from the point being welded. Thus, it is easy to see from this consideration alone that arc welding has a very big advantage over its contemporary system.

The cost per foot-run of $\frac{1}{2}$ in. plate is shown to be :—

Oxy-acetylene welded	18·0d.
Electric arc (Benardos)	10·0d.
Electric arc (metal electrodes)	14·4d.

In the latter case the cost of the electrodes used should be about half, owing to the fact that in these tests, and also in the tests shown in Tables I., II. and III. in section on "Machine Welding," the electrodes used were specially coated, and were very expensive. (This coating made no appreciable difference to the speed of welding.) Thus, the cost per foot-run with the metallic arc system should more nearly approach that given for the Benardos system.

In speed of welding, the electric arc system it will be seen has the advantage. In average practice the Benardos

Table XI.—*Electric Welding Arc System (Bernados). Table of Cost and Speed.*

Thickness of plate.	Length of weld.	Time.	K.W.H. at per hour.	Labour at 1s. per hour.	Filling in metal.	Carbon used at 4d. foot.	Feet per hour.	Total cost per foot run.
$\frac{1}{16}''$	12″	2 mins. 50 secs.	0·7d.	0·57d.	0·08d.	0·05d.	21·0	1·4d.
$\frac{1}{8}''$	12″	2 ,, 45 ,,	0·8d.	0·54d.	0·08d.	0·05d.	22·0	1·4d.
$\frac{3}{16}''$	12″	4 ,, 5 ,,	1·25d.	0·85d.	0·15d.	0·10d.	14·0	2·3d.
$\frac{1}{4}''$	12″	5 ,, 2 ,,	1·5d.	1·0d.	0·3d.	0·12d.	12·0	2·9d.
$\frac{5}{16}''$	12″	7 ,, 10 ,,	2·1d.	1·4d.	0·45d.	0·15d.	8·3	4·1d.
$\frac{3}{8}''$	12″	10 ,, 55 ,,	3·1d.	2·1d.	0·6d.	0·2d.	5·5	6·0d.
$\frac{7}{16}''$	12″	14 ,, 5 ,,	4·2d.	2·7d.	0·9d.	0·3d.	4·2	8·1d.
$\frac{1}{2}''$	12″	17 ,, 0 ,,	5·0d.	3·4d.	1·2d.	0·4d.	3·5	10·0d.

Figures were obtained from actual tests. Time given is total time, and includes swaging of weld after welding. Time during which current is used is approximately 50 per cent. of total time for weld.

Table XII.—*Welding by Oxy-Acetylene. Costs and Speeds.*

Thickness.	Length.	Oxy used.	Acetylene used.	Cost oxy.	Cost acetylene.	Cost filling wire.	Time taken. Min.	Sec.	Cost labour at 1s. hr.	Feet per hour.	Total cost.
$\frac{1}{16}''$	12″	0·44	0·34	0·2d.	0·34d.	0·12d.	3	—	0·1d.	16·0	$1\frac{3}{4}$d.
$\frac{1}{8}''$	12″	0·74	0·57	0·32d.	0·51d.	0·45d.	4	55	0·1d.	12·2	$2\frac{1}{2}$d.
$\frac{3}{16}''$	12″	1·4	1·0	0·72d.	0·9d.	0·45d.	5	20	1·6d.	11·0	3·1d.
$\frac{1}{4}''$	12″	3·2	2·46	1·6d.	2·2d.	0·5d.	8	20	1·6d.	7·5	5·9d.
$\frac{5}{16}''$	12″	5·6	4·3	2·8d.	3·8d.	0·9d.	9	37	1·9d.	6·2	9·4d.
$\frac{3}{8}''$	12″	7·14	5·5	3·57d.	4·5d.	1·2d.	12	15	2·4d.	4·9	11·6d.
$\frac{7}{16}''$	12″	9·3	7·1	4 65d.	6·39d.	1·5d.	15	55	3·2d.	3·77	15·7d.
$\frac{1}{2}''$	12″	11·5	8·8	5·75d.	7·92d.	1·5d.	—	20	2·87d.	4·18	18·0d.

Oxygen at 4s. 6d. per 100 cubic ft. Carbide at 4d. per lb. equals 9d. per cubic foot. Filling wire at 0·04d. per foot, $\frac{1}{16}''$; filling wire at 0·15d. per foot, $\frac{1}{8}''$; filling wire at 0·3d. per foot, $\frac{3}{16}''$.

system is far quicker than the metallic electrode system, though, of course, it is not so universally adaptable. In the tests shown in Table XII. the value of the current used was much lower than was possible without detriment to the weld, especially was this so in the case of the $\frac{5}{16}$ in. to $\frac{1}{2}$ in. plate. Thus, the speed is shown to be very much lower than is usual and possible.

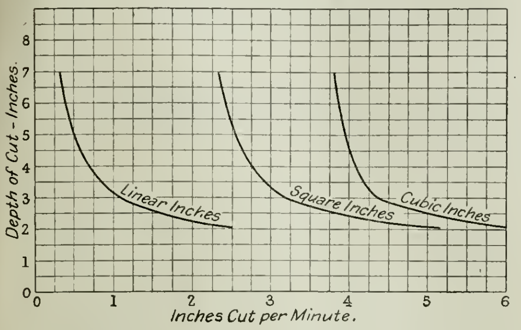

FIG. 87.—RATE OF CUTTING CAST-IRON PLATES (LENGTH OF CUT GREATER THAN DEPTH) WITH 1 IN. DIAMETER CARBON ELECTRODE AT 625-650 AV. AMPS., 45-65 ARC VOLTS (CUT MADE PROGRESSIVELY IN ONE DIRECTION).

To give some idea of the saving to be derived by resorting to electric welding for reclaiming worn or broken parts of machinery, &c., the cost of repair of several of the illustrations as shown in these articles is given in Table XIII. It must be borne in mind that the figures given represent the cost to the consumer and is, therefore, the gross cost plus the repairers' profit, &c. Moreover, the labour charges in the district in which the repairs were carried out were very high.

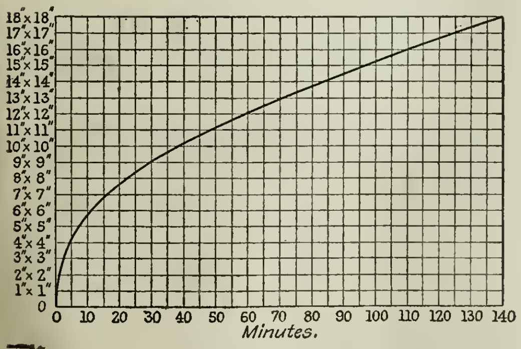

FIG. 88.—RATE OF CUTTING CAST-IRON SQUARE BLOCKS, 1 IN. DIAMETER CARBON ELECTRODE, AT 625-650 AV. AMPS., 45-65 ARC VOLTS. POSITION OF KNEE IS DETERMINED BY ELECTRODE DIAMETER, LENGTH AND CLEARANCE REQUIRED BY OPERATOR WITH GIVEN HOLDER.

Before concluding these articles on Welding, it may be of interest to briefly refer to

CUTTING OF METALS.

In the field of cutting it must be admitted that the oxy-acetylene flame is pre-eminently the more satisfactory for cutting iron and steel.

The action produced by the gas flame is that of rapid oxidation, with the removal of a minimum amount of material.

The electric arc, on the other hand, does not render such a fine line of cut as with the gas flame, as it virtually burns the metal away.

Table XIV. shows a few figures of cutting speeds using the electric arc for cutting mild steel sections.

Table XIII.—*Giving Approximate Cost to the Consumer of work Illustrated in these Articles. The Cost of Labour varies from 1s. 8d. to 8s. an hour. Allowance must be made, moreover, for Conditions under which Work was carried on.*

Illustration Fig.	Cost.	Remarks.
49	£0 15 0	Per flange, inclusive of mandling.
52	£4 10 0	Tank 2 ft. diameter, 24 ft. of weld.
52	£3 2 0	Three flanges and two branches and the main joint.
53	£2 15 0	......
55	£34 0 0	Diameter of anchor 15 in., cut in two, scarfed, welded and reinforced.
57	£2 18 0	Half bearing broken away.
58	£2 0 0 to £3 10 0	Annealing covers, approx. 18 ft. of fracture to be cut away and welded up solid.
58	£12 0 0 to £15 0 0	Truck suspension bars.
58	£1 10 0 to £3 15 0	Motor yokes.
58	£0 10 0 to £2 0 0	Fractured cylinder packets, cylinder walls, broken flanges, joints, &c.
59	£0 17 9	Average.
60	£0 10 0 to £1 10 0	Increase in diameter $\frac{3}{8}$ in., and key wages filled in.
62 63	£2 0 0 to £12 0 0	Depending on accessibility and extent of fracture.
65	£1 1 0	Average per spoke.
66	£1 7 0	Cut away by carbon arc and new piece fitted and welded in 10 hours 47 minutes.
69	£5 0 0	Average wear.
70	£9 0 0	Per average wear.
71	£7 0 0	Fractures cut out and welded and reinforced.
72	£1 5 0 to £2 10 0	......

Table XIV.

Size of section cut in inches.	Area cut, sq. in.	Cutting current in amps.	Cutting time, minutes.	Cross-sec. cut per min., per 100 amps.
8·0" ×8·0"	64·0	810	27·0	1·89
8·0" ×8·0"	64·0	600	41·75	1·645
8·0" ×8·0"	64·0	320	98·0	1·31
6·0" ×6·0"	36·0	810	14·50	1·975
6·0" ×6·0"	36·0	600	21·67	1·78
6·0" ×6·0"	36·0	320	44·33	1·63
4·0" ×4·0"	16·0	600	5·62	3·06
4·0" ×4·0"	16·0	320	10·08	3·226
2·0" ×4·5"	9·0	600	2·53	3·72
2·0" ×4·5"	9·0	320	5·05	3·49
1·375" ×3·25"	4·47	320	2·25	3·99
12·0" ×1·0"	12·0	400	3·0	1·0
12·0" ×0·5"	6·0	320	2·17	0·9
1·0" ×0·375"	0·375	320	1·25	1·15
shaft 8" diam.	...	425	50·0	3s. 4d.*

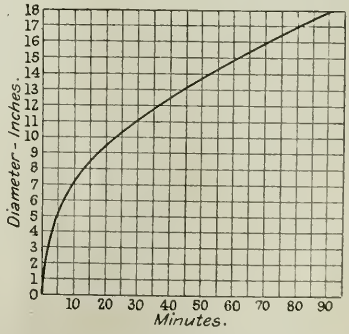

FIG. 89.—RATE OF CUTTING CAST-IRON CIRCULAR CROSS-SECTION 1 IN. DIAMETER CARBON ELECTRODE, AT 625-650 AV. AMPS., 45-65 ARC VOLTS.

The average rate of cutting is thus 0·45 sq. in. per minute per 100 amperes.

Cast iron, however, contains carbon combined with the iron, and in the free state, in such large percentages that the gas flame cannot directly burn through. The metal must be actually melted, and therefore the electric arc here more than holds its own, owing to its very great intrinsic heat value.

---

* Cost of current and electrodes.

Figs. 87, 88 and 89 show a series of curves for cutting cast iron by means of the electric arc.

Heavy risers on iron or steel castings can be quickly and cheaply cut away with the arc, and hence, in the foundry, arc generating sets are now finding an ever-extended use.

Very much more could be written upon the subject of electric welding; however, the author ventures to hope that these few notes on the various systems and their application will find a place in the interest of engineers generally, and that some suggestions may be gleamed from them that will ultimately lead to profit.

In conclusion, the author wishes to acknowledge with thanks the information and illustrations supplied by interested firms, who very kindly rendered their utmost assistance.

The Shipping, Engineering and Machinery Exhibition at Olympia.

The Opening Ceremony.

On Thursday, September 25th, the above exhibition was opened by Lord Weir, and his speech at the luncheon, which followed the opening ceremony, showed that he had devoted considerable thought and attention to the difficulties at present existing in the engineering world.

Commencing by explaining that he proposed to address the gathering as an engineer, and not as a politician, Lord Weir went on to deal with the unrestful spirit which at present exists among labour, and to a certain extent particularly engineering labour, and said: "There is nothing contributing more to fog and obscure the situation than the lack of sincerity and frankness. Sincerity of conviction, a reasoned, constructive policy, and, based on these, resolute action seem to me the essentials in building up the new world which the Prime Minister has sketched. He has shown us the outside view—the general arrangement; we want the sectional drawings which will show us how it is going to work. . . . In the labour world to-day we find two movements—one seeking to improve existing conditions, with legitimate aspirations and ideals; the other a definite movement for something labelled nationalisation. In face of this position it is surely clear that those whom we elect to govern us must, in holding office, decide for a policy of improvement built on present foundations, or for one of demolition and experiment." Lord Weir explained that those bidding for the reins of government must either visualise a plan for running the country without the wage and capital system clearly and definitely to justify the experiment, which would involve dire consequences to the happiness of this generation; or, on the other hand, they must realise the fantastic impracticability of their schemes and shut them out from influencing constructive plans for the future. He then passed to the subject of the ironmoulders' strike, and dealt out some trenchant criticism on the methods of this union. He stated that "Our national position is not precarious enough for them; they must stab it in the back. They are on strike because they are selfish, and demand priority of consideration of their own wages question before those of other trade unions. . . . They decline to allow freedom to anyone except a moulder trained for seven years to work a moulding machine which can be learned in a few days by anyone. There has been less progress in iron foundry practice in the last 20 years in this country than in any other branch of engineering, due to restrictive customs. To-day the labour cost of certain dry sand castings in Great Britain is double that in the U.S.A., and the American moulder is earning double the wage of the British moulder."

Passing from the workers' side of the difficulty to that of the employers' share in improving future conditions, Lord Weir advocated the policy of conferences between persons selected to represent the employer and employees. He advocated that the employer should bear in mind the human factor, which was bound to enter into all successful negotiations. He called upon the trade unions to eliminate those elements of their policy which tend to retard progress. They must readjust their views to existing conditions and take a broader view. Passing from the trade unions, he dealt with the responsibility of the Government, and aptly described the Government as the base of a triangle, of which the other two sides were represented by employers and labour. In conclusion, we would quote Lord Weir's emphatic words: "It is the business of the State to ascertain and maintain the means by which our national life can be increased and developed, and I would submit that it is the duty of the Government to ask the trade unions for a statement of the means which they in their representative capacity are taking to solve the problems of production, and equally to ask employers' organisations what steps they on their part are taking toward the upbuilding of our national welfare."

The Exhibition.

At the opening time the exhibition itself reflected the difficulties of labour, transport, &c., which had existed. Many stands were not completed, and the hammering was gaily going on in a last minute rush to get things completed. Even on Saturday there were still some stands in process of erection, and final touches to the equipment were being made by exhibitors. However, the exhibition is distinctly representative of the industries concerned—shipping, engineering and machinery—and there is much of interest to the electrical engineer, the electrical manufacturer and the electrical contractor. In fact there was more of an electrical nature in the exhibition than we anticipated there would be, and the attendance on Thursday and Friday was good; but, naturally, the deplorable railway strike will have an adverse effect while it lasts. In order that these notes may go to press in time for this issue it is not possible for all the interesting exhibits to be described individually, and further notes will be given in forthcoming issues.

Messrs. Matthews & Yates, Ltd. (Stand No. 5) are showing a very representative series of their well-known cyclone fans for ventilating, cooling and forced and induced draught purposes.

Electrical Apparatus Company (Stand No. 16).—Motor control gear, ironclad switch gear and electricity meters are displayed by the Electrical Apparatus Company at this stand. They are showing a standard type 6 h.p. direct-current motor panel, also a complete 20 h.p. portable motor panel, the starter of which is of the slow motion type. The slow motion being obtained by means of a pawl carried on the starter lever, which moves in a guide way provided with alternate camming and arresting shoulders. The starter allows a quick forward movement, but provides a dead stop on the centre of each segment, so that it is impossible to start up the motor too rapidly.

An inching type pillar panel is exhibited controlling a 14 h.p. Crompton motor coupled to a Heenan & Froude dynamometer. This allows the apparatus to be fully demonstrated under varying conditions of load. Another device calling for mention is a series relay starter, automatic in operation and so designed that the rate at which the starting resistance is cut out is dependent upon the rate of acceleration of the motor. It essentially consists of an electromagnetic controlling device, which controls the operation of a number of contactors, so that they can only close in correct sequence and cut out the starting resistance step by step.

The provision for a specially designed pendulum movement on the master switch makes it impossible for any step of the resistance to be cut out in less than a predetermined period, and thus eliminates any possibility of damage to the motor controlled. Examples are also shown of the firms A. C. Motor Control Gear, A.C. Switchgear and Electricity Meters.

The Telephone Mfg. Company, Ltd. (Stand 29).—This exhibit comprises a complete range of various types of automatic inter-communicating telephones, suitable for all classes of work. A novel exhibit is the "New System" secret auto-line finder and indicating inter-communicating telephone. Another piece of apparatus attracting attention was the "laryngophone"—a telephone without a mouthpiece, specially adapted for the use of divers. The telephone is really a war-time development, and has hitherto been used for communication between pilot and observer on aircraft. Its special feature is that it permits spoken messages to be transmitted in spite of any amount of noise occurring in the neighbourhood and when ordinary speech is inaudible.

Submersible Motors, Ltd. (Stand 47).—In conjunction with this exhibit, which comprises a range of submersible electric motor pumps of various sizes, there are in the yard outside the main hall two 4 in. submersible motor pumps in operation under full working conditions, and driven from an oil engine generating set. The pump is submerged, and delivers to a height of 75 ft., whilst the other works on a suction lift of 32 ft.

Laurence, Scott & Company, Ltd. (Stand 58).—Here can be seen a complete electric equipment for deck winches. A variable-speed reversing motor is operated in conjunction with specially designed control gear, and complicated and inefficient mechanical gearing is eliminated. The speed of working is made equivalent to that of steam winches by an electric load discriminator, which allocates the speed in accordance with the load. The equipment is watertight and designed to withstand the rough usage which it is likely to receive at the hands of the dock labourer.

Siemens Bros. & Company, Ltd. (Stand 72).—This firm, in conjunction with their allied company (Siemens Bros. Dynamo Works, Ltd.), have a very representative exhibition of apparatus particularly applicable to shipping requirements. It comprises cables, loud-speaking telephones, an electrically-operated revolution counter, a navigation light indicator; also a 24 in. "Suez Canal" pattern searchlight projector, switch panels, ships' fans, motors, small switchboards, a generating set and dry cells. They are also exhibiting a complete wireless telegraph station as used on board ship.

Scholey & Company, Ltd. (Stand 122).—Two exhibits are shown here of rather divergent types, one the Cope's automatic boiler feed control apparatus, which is an exceedingly simple and effective gear for automatically controlling feed water, and has proved its reliability and efficiency in numerous instances, both in this country and abroad. The other exhibit is an exceedingly neatly designed and well-made electric drill, manufactured entirely in this country and sold under the trade name of Kutmore. The No. 1 size of this drill is claimed to be the smallest two-speed electric drill at present on the market. It should be of considerable utility in wood-working factories, shipyards and engineering workshops generally, and would be quite suitable for use by female labour.

Marconi's Wireless Telegraph Company, Ltd. (Stand 135).—In reality this firm have two stands, on which are shown 1½ kw. ship installations with emergency sets, representing the usual equipment on a modern liner. Demonstrations are given by transmitting messages between these two stands. A short range wireless telephone set, having a range of 10 miles, is also shown, together with a wireless direction finder; the latter in operation. Owing to limited space, the aerials are much smaller than is usual, and consist of two nearly closed rectangular loops fitted at right angles to each other. These loops complete their circuit through two coils, also fixed at right angles, and arranged symmetrically with regard to a "search coil." A highly sensitive receiver is connected to the search coil. By means of this search coil the resultant field of the two fixed coil, which corresponds to the maximum spiral intensity, can be found. A pointer attached to the search coil and moving over a scale of degrees indicates at once the direction of the transmitting station.

The London Electric Firm (Stand 243).—Considerable attention is attracted to this stand in the evening when the 20 in. searchlight projector is in operation, and the exhibit comprises a very representative display of searchlight apparatus, particularly adapted to shipping and navigational purposes.

S. G. Heath & Company, Ltd. (Stand 257).—In addition to the display of many types of electric fans, particularly adapted to ship purposes, the outstanding feature of this stand is the electrically-operated syren. Three sizes of this apparatus are shown. Type A having a sound raduis of ¼ mile; a single-headed type, with a sound radius of 1 mile; and a double-headed type, yielding a sound which will carry 3 miles. The energy consumption of these three types is respectively 150 watts, 1,700 watts and 2,500 watts. In comparison with steam hooters, these syrens are claimed to be just as effective, and should certainly lead to a reduction in waste of steam and therefore coal.

It is particluarly interesting to notice the number of firms that are exhibiting electrical heating and cooking appliances, amongst which was found Messrs. the Bastian Electric Company, Ltd., Belling & Company, F. Husband, Ltd., Jackson Electric Stove Co., Ltd., Quain, Limited, Berry's Electric, Ltd., and these exhibits will be dealt with in a later issue.

(*To be continued.*)

The Electrical Properties of Aluminium.*

By W. JAEGER, K. SCHEEL and L. HOLBORN.

In consequence of the war, when aluminium was largely used as a substitute for copper, its physical and chemical properties were carefully examined. The present Paper contains particulars as to the specific resistance and temperature coefficient, and also as to the expansion and mechanical strength. Three kinds were analysed—viz., Al II., containing 1·6 per cent. of impurities, mainly iron and silicon; Al III., containing 1·2 per cent. of impurities; and Al IV., containing 0·4 per cent. The two former were commercial brands; the last was specially procured. Three wires were drawn from each sort, which had diameters of 1, 3, and 6 mm. The mean values of the specific resistance of the three wires of the different materials, measured in units of 10^6 ohms per centimetre were 3·11, 3·1 and 2·92 respectively. Thus, the specific resistance of the purest sample was slightly the lowest, and its temperature coefficient was a little higher, somewhat in the same proportion. The question of expansibility and mechanical strength does not specially affect the value of the metal electrically, except indirectly; but particulars of the tests are given by the authors. Suffice it to say that the impurities cause no notable differences in expansion, and the same is largely true of the mechanical strength.

The electrical resistance of a metal is not determined only by its chemical constitution, but also by its structure. If the hard-drawn wire is heated, it becomes softer and its resistance decreases. If the temperature is still further raised, the resistance ultimately begins to increase, and finally exceeds its initial value. The temperature at which this change takes place varies with the nature of the conductor, and depends on its fusing point. The temperature-coefficient of the resistance at the same time varies in the opposite sense, and it has often been noticed that it varies inversely as the resistance But this relation is only an approximate one. The chemical composition is a factor; the pure metal has a low specific resistance and a high resistance coefficient; impurities tend to reverse this state of affairs. While the specific resistance of a metal depends on its nature, the resistance-coefficient of all pure metals is nearly the same, if we exclude the magnetic conductors, and has a value at ordinary temperatures of about 0·004, referred to the standard temperature of 0°C. About the point of chemical purity it reaches its maximum value, and is more sensitive to impurities than the specific resistance. For experimental purposes, the resistances were made of wires 0·2 mm. to 0·25 mm. thick; another variety of the metal, called Al V., was specially prepared, which contained only 0·1 per cent. of impurities. The highest resistance-coefficient was obtained at 250 deg. for all the varieties; in the case of the purest sample it was 0·00426, as compared with 0·00412 at the start, and with the other samples the figures were similar. Curiously enough, the figures for the most impure sample, which contained 1·6 per cent. of impurities, were almost exactly the same as for the most pure sample in respect of resistance-coefficient, those for the other samples being slightly higher. The changes are explained by alterations in the structure. Above 250 deg. the re-crystallisation of the metal sets in. Photographic reproductions are given showing microscopic sections at different temperatures, these sections being taken from rolled sheets, prepared from the sample containing 0·4 per cent. of impurities, after being etched with hydrochloric acid. These sections show a progressive crystallisation after 250 deg.: at 600 deg. the crystals are large and very irregular.

As a note to this Paper, it may be added that R. Apt calls attention to the same question in another contribution ("Elektrotechnische Zeitschrift," No. 23, 1919). He gives a short account of results which have been obtained as the result of the labours of a French committee of investigation (*see* "Revue Générale de l'Electricité, Vol. III., No. 23, p. 823). Apt gives a table which contains the material facts. These tend to show that the purest specimens have not necessarily the highest conductivity, a fact which has been already noticed in practice. Sample A had one-tenth of the carbon-content of sample B, and one-fifth of the carbon-content of sample C. But A had much more iron and silicon than B and C; the relative amounts of impurities in A, B and C respectively were 1·65, 1·35 and 0·5 per cent. Yet A had the lowest specific resistance, C the next and B the highest. From this it appears that carbon is the impurity which most largely affects the resistance, while iron and silicon are not harmful provided their amounts do not exceed certain limits. Carbon, on the other hand, tends to increase the mechanical strength.

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* Abstract of a report from the "Reichsanstalt."

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The German Electrical Industry During the War.

The efforts of the censor in Germany prevented anything in the way of important information in respect of electrical matters from reaching us during the period of the war; but now from time to time more or less unofficial reports arrive, showing how matters stood. As was to be expected, there has been little time or opportunity for any development of radical novelties; such development as has taken place has been mostly under the stress of dire necessity. Needs must when the devil drives, in accordance with the old adage. And it has long been known that in Germany many substitutes were tried for copper, as well as for countless other things for which humanity has decided that no proper substitutes are available. This phase of their industrial activity is, therefore, largely without interest for us. For example, although the question of aluminium as a substitute for copper has been debatable, the war has suggested to them other much less suitable metals, which have been makeshifts, if not failures. And in the matter of insulating materials, countless experiments have been made with no abiding result.

It may, however, be of interest to deal with some other points. There has been much done in the way of portable lamps and batteries for use in the trenches, and this may remain fruitful in the days of peace. Incandescent lamps remain much on the same footing as before, though gas-filled lamps are almost exclusively used for the internal illumination of large rooms. The preparation of the filament from a single crystal, and in any length, is, perhaps, to be noted as a novelty; the use of a slight admixture of thoria in tungsten is already known. These single-crystal filaments are said to be so flexible that they can be wound round a pin, even while they are cold, and they do not lose this property even after they have burnt in the lamp for a long time. From the absolute point of view, the efficiency of these lamps is still very low, and there is a recrudescence of vapour lamps of one kind and another; and it may well be that this is the only possible direction by which we can approach the almost infinite possibilities which theory holds before us in the dim distance. Among these is to be noted the Nernst vapour lamp, in which an arc passes between carbon electrodes in a vapour of zinc chloride or zinc bromide. An experimental lamp on these lines is said to give 3,000 c.p., with a consumption of 4 amperes at 120 volts, corresponding to an efficiency of 0·16 watt per Hefner candle-power. Then there is the neon arc lamp, using an alloy of thallium and cadmium as electrode, the discharge passing through a rarefied atmosphere of neon and helium. These lamps are suitable for direct current at 220 volts, and give a yellow-red light, not generally suitable for ordinary purposes. There is also a neon glow lamp of very low candle-power, suitable for such uses as indicators, signals, &c.; and there are suggestions for the commercial exploitation of luminescence phenomena in connection with radio-active substances, for which the demand is likely to be only limited.

From this it seems that while attempts of one kind and another have been made on what may be called the laboratory scale, nothing in the department of electric lighting has resulted which can be regarded as of great importance. And difficult as it has been to look ahead with any certainty during the last five years, it has always been tolerably plain that a time of war was not the season for that work of patient experiment which precedes most invention. It might, perhaps, have been expected that in the field of electro-metallurgy something would have been done on novel lines, especially in view of the notorious shortage of certain metals, such as copper and aluminium. But though the need was great, the attempt to make something out of nothing failed, as usual. Even in the days of Pharoah, the elementary fact was known that bricks could not be made without straw, and one of the main difficulties of the Germans was the lack of suitable ores; work was, therefore, mostly confined to the exploitation of already established principles, and to the often vain attempt to separate metals electrolytically from their gigantic scrap heaps.

Review.

Induction Coils in Theory and Practice. By F. E. Austin. (London: E. & F. N. Spon.) Pp. 64. 5s. net.

The subject matter of this little book is stated in the preface to be the result of the author's experience in directing the courses in radio and buzzer training, Dartmouth Training Detachment, National Army, U.S.A., its aim being to explain fundamental principles in such a way as to enable anyone to construct induction coils to meet various requirements. The chief value of the book lies in the simple explanation which it gives of the laws of electromagnetic induction, which should commend the book to the private student, and in the practical hints which it provides for the amateur desirous of constructing his own induction coils, spark coils for ignition, coils for telephones, and Tesla coils.

The explanation given of the action of an induction coil is very unsatisfactory. The author adopts the standpoint that the theory of the induction coil is the same as that of the ordinary transformer, and in consequence some of the essential features of the action of induction coils are entirely overlooked. Thus, in the discussion of the secondary potential on p. 29, no mention is made of electrostatic energy in the secondary circuit or of the influence of the capacity of the secondary coil. On p. 32 the condenser capacity required to give the best results is stated to be connected with the interrupter frequency f, and the primary self-inductance L by the relation $C=1/4\pi^2f^2L$. On p. 34 the primary current is stated to be given approximately by dividing the applied pressure by $\sqrt{R^2+(2\pi fL)^2}$. Neither of these results is applicable to an induction coil as ordinarily worked by a battery and interrupter. The optimum capacity depends largely upon the secondary coil as well as upon the primary, and the value attained by the primary current depends not upon the frequency of the interruptions but upon the duration of contact. The secondary potential of an induction coil can be accounted for not by treating the coil as an ordinary transformer supplied with periodic currents having the interrupter frequency, but by consideration of the natural oscillations which it is the function of the interrupter to set going at each break. The theory of the induction coil in fact resembles that of the oscillation transformer or Tesla coil, the only difference in principle between the two arrangements being in the manner of exciting the oscillations.

Apart from such errors in the fundamentals of the subject the explanations and descriptions given in the book are clear and concise. The book is adequately illustrated by diagrams and by numerical examples. Of the latter, examples 2, p. 14, and 3, p. 15, are incorrectly worked out. E. T. J.

New System of Railway Working Particularly Applicable to Tubes.

By W. AITKEN, M.I.E.E.

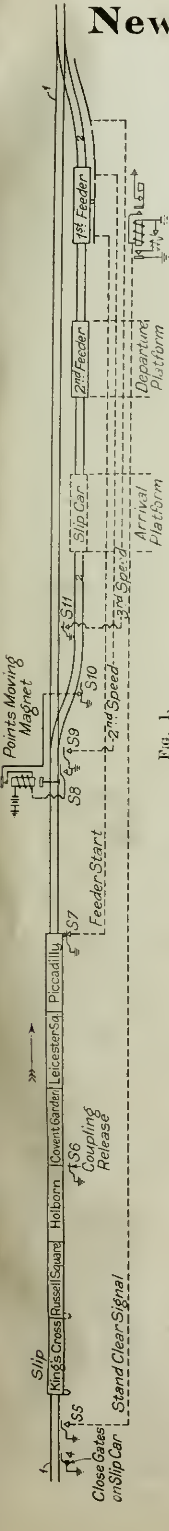

Fig. 1.

The frightful struggle to get into a Tube train and the impossibility of getting a seat at an intermediate station during the beginning and end of the business day, have led the author to believe that the present system is inadequate to cope with the traffic of the future. It has practically reached its maximum efficiency. New cars, with additional side doors, and additional trains will slightly reduce the congestion, but will not cure it. The trains cannot be lengthened beyond the extent of the platforms.

The remedy, with the present system, lies in providing additional tubes. These undesirable features led to the consideration of other ways of dealing with the traffic-carrying problem.

Of first importance is the separation of the incoming from the outgoing traffic. The delays at present are due to arriving passengers having to struggle through the crowded mass of "straphangers," then through the crowd on the platform, before departing passengers can enter. The straphangers may desire to leave at the next station and, naturally, do not wish to pass to the rear of the car. In consequence, only about half the number of people who get off can get on, or time does not permit of them entering, and they must wait for another train, and until good fortune permit of them entering.

It follows that if the out and in traffic are to be separated one class must enter at one end of the train or car, and the other class leave at the opposite end.

To facilitate such separation and at the same time greatly increase the carrying capacity of the Tubes, running the trains without stop is advocated, and adding "feeder" cars, for passengers outgoing from a station, to the front of a train and detaching slip-cars containing passengers incoming to a station from the rear of the continuously running train. The former would be run out of, and the latter into, loop-lines or sidings, at which there would be separate departure and arrival platforms with separate ingress and egress corridors. The loop-lines would take the place of the present platforms.

Additional loading cars, or secondary feeder cars, would be at the loading part of the departure platform so that passengers would pass from the corridors directly into these cars.

When a train is signalled from a suitable point these cars would pass forward to the departure point, where they would be under the automatic control of the incoming train. The last slip-car would then become the loading car.

The cars of a train would be associated with particular stations of the circle served, it taking a series of trains to serve all stations. For example, No. 1 train might serve every fourth station, other three trains filling up the intervening stations (the intervals would really be varied to suit the traffic), and a short train of two or three cars to serve the local traffic between adjacent stations.

As there is no relationship between the length of a train and a station platform, an express train can be of any length, the controlling factor being the time taken to get from a feeder to a slip-car, if the next stop is the destination.

Passengers arriving by feeder cars must, therefore, immediately pass along the train to the cars associated with their destination station (the corridors must, therefore, be kept clear, and straphangers confined to a "pen" or reserved part of each car, and the car should, preferably, have tip-up seats). The intervals between stopping stations on express trains will allow time for this. On local trains there will be only one or two cars to pass through. "Moving platforms" in the car corridors or other devices may be provided to expedite this if necessary.

It is believed that by such a system trains may be placed at half-mile intervals on the circle track, and passengers picked up and set down every three to four minutes at any station, and at selected stations at half these times.

The number of slip and feeder cars arriving at or leaving a station would vary with the traffic requirements at different periods of the day, and these might be controlled over a "train-despatching" telephone circuit.

The time taken to travel between stations would be greatly reduced. A passenger on an express train travelling to a particular station might change at a main stopping station, then travel forwards or backwards by a local train. Again, an express train might serve different stations on the return journey, and a passenger might run round the loop end to the station required.

Fig. 1 shows an outline of the arrangement, in which one or more cars are detached from the rear of the train to set down passengers, and one or more cars attached to the front of the train for oncoming passengers. Reference 1 is main-line track, and 2 the siding or loop-line, having arrival and departure platforms. There is another similar main-line track with loop-line (not shown) for traffic in the opposite direction. The main-line train consists of six cars, one to each of six stations, the rear one being the slip-car, soon to be detached and run into the siding to the point marked "slip-car" at the arrival platform. The first feeder car is just about to leave the platform siding and pass ahead of the incoming train. The second feeder is at the departure platform to be loaded. It in turn will be passed forward to the position vacated by the first feeder, and the slip-car will be advanced and become the second feeder.

Each car should be self-contained and complete in itself so as to perform its share in hauling the train, and run independently as a detached or feeder car. All switching devices should, therefore, be electrically controlled in parallel over a circuit wire so that any one, as in a detached car, may be operated, or all operated in parallel when connected as in a train. An impulse sending dial as used on subscribers' instruments in automatic telephony is a suitable device for operating the different switches to control variations of speed, starting, stopping, and the like. The different combinations of impulses would set a selector switch to complete a momentary circuit through the particular apparatus, which would then be held energised in a local circuit until other impulses caused a change.

The operation of the system should be, preferably, as nearly wholly automatic as possible. Considerably in advance of a station a switch 4 should be closed by a contact spring or stud on a car which would cause the gates, between the car to be detached and the train, to be closed either manually or automatically. The train would in a similar manner cause the switch S5 to be closed to give a stand-clear signal at the first feeder, so that the gates may be closed and the car in readiness to be automatically started at a given time. The switch S6 would then make contact with a spring or stud on the rear car to automatically release the coupling to detach the rear car. Switch S7 would then be closed to start the feeder car. S8, when depressed, would complete a circuit for the points-moving-magnet, a retaining circuit being closed over switch S10. The points are then closed so that the slip-car passes into the siding. The slip-car in passing opens the switch S10 so that the points magnet de-energises and the points return to the through position. The train after closing switch S8 closes switch S9 to increase the speed of the feeder, then closes S11, to cause the feeder car to run at such a speed that the train will overtake it without serious impact. The coupling up may be manually or automatically completed.

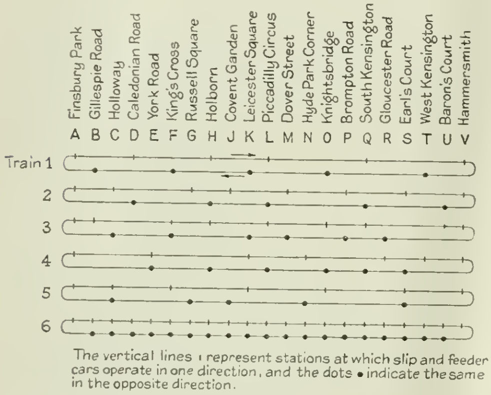

Fig. 2.

In the following illustrative application of the invention, the Piccadilly Tube has been selected, because it is the one with which the author is most familiar, but no attempt is made to meet the actual traffic requirements, as these are only very generally known.

It has been assumed that the great bulk of the traffic is from the extremities of the line towards the centre in the morning and from the centre outwards in the evening. It, therefore, has been considered necessary that every train of a series must take up and set down passengers at the terminal stations. In a series of trains there are five express trains (Fig. 2) each serving from 11 to 11 stations in the circle, and a local train serving all stations. Eight stations are served by out and in service of two out of the five express trains, the balance of 13 being served by one train each way. All, of course, are served by the local train.

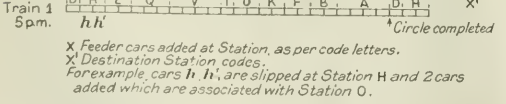
Train as made up at A
D H H H L L L Q Q Q V T O O O K K K F F F X
D H L Q V T Q K F B A D H L Q X'
Train 1
9 a.m
Circle completed
D H H L L Q Q Q Q V V V V T O Q X
D H L Q V T O K F B A D H X'
Train 1
5 p.m.
h h'
Circle completed
X Feeder cars added at Station, as per code letters.
X' Destination Station codes.
For example, cars h, h', are slipped at Station H and 2 cars added which are associated with Station O.

Fig. 3.

The "up" stations served by a train are usually different from the "down" stations. A passenger at B or F station desiring to travel to L or Q in train 1 may pass round by the terminal station A, but preferably, would wait for train No. 3. A passenger at E wishing to travel to station L would leave train 1 at K and proceed by local to L. For Q, would leave train 1 at R and come back by local to Q. The diagram is self-explanatory.

The local train would consist of three cars, *i.e.*, sufficient to serve the stations between express stopping stations. At any station one car would be slipped and another added by which passengers arrive. For the third station beyond, a passenger would remain in the feeder car; for the second he would pass to the adjacent car, and for the first stopping station he would pass through one intermediate car. The local train would be restricted to such short-distance travelling.

A uniform fare should, preferably, be charged for any journey made wholly or in part on the express trains, to allow a passenger, *e.g.*, at F, as already described, to make the journey in either of two ways. It might be quicker to travel three-quarters round the circle and change carriages in the express, than to change into a local train. A smaller uniform charge should be made for a journey on the local train.

Fig. 3 shows how a train is made up at the start, and how it is changed by slipping and adding cars round the circle, and how it may be modified to meet the varying traffic conditions. From this it will be seen that a passenger may travel from end to end of the line, or round half the circle from any point, without changing cars, in an express train.

In a modification the feeder and slip-cars are attached and detached from the same end of the train, when the passengers must pass each other, when entering the trains and passing into the slip-car.

The circuits are shown as functioning arrangements only—close-circuit working would probably be necessary. Details of signalling, circuit closing by ramps or other devices, automatic couplings, and the like, require more familiarity with the "state of the art" than the author—who is not a railway engineer—can claim.

Factory and Workshops Report.

The annual report of the Chief Inspector of Factories & Workshops for 1918 has been published and contains important sections on hours of work, accident prevention, labour-saving appliances, welfare work, the use of electricity in factories, and industrial poisoning. In an introduction the Chief Inspector states: "The prominence given to safety, health and welfare, including reduction in the hours of labour, has perhaps been the principal feature of the work of our department, not only during the past year but also during the whole period of war. The experience gained had great effect upon the conditions of industrial employment. It has shown that an increase in the ordinary hours of work does not necessarily mean an increase in production, that the more the comfort and welfare of the worker is studied and provided for the greater is his output, and that attention given to health and the prevention of accidents means greater efficiency and reduced charges." After dealing with the effects of the war upon industry, it is stated that "the increased amount of machinery used, together with the adoption of new types of machines, coupled with the increased number of persons employed in factories and the introduction of female labour into processes hitherto confined to men, would naturally have led one to expect a corresponding increase in the number of reportable accidents. This has not been the case. On the contrary, many of the inspectors' reports point to a decrease. The difficulty in obtaining labour and materials for fencing probably accounts for some increase in the more serious machinery and fatal accidents, while the drop in the non-machinery cases may be due to a variety of causes, chief of which I would suggest is the greater care exercised by managers and foremen in works in which women were largely introduced, and the extension of what has come to be known as the safety first movement."

"Few questions affecting the industrial worker have been brought more prominently forward during the war than that of welfare. The strain thrown upon all engaged in manufacturing industry during the war rendered immediate attention to the health and welfare of the worker absolutely essential, and the improvements brought about were largely due to (i.) the conditions attached to the emergency orders issued by the Home Office relaxing the statutory periods of employment, (ii.) the reports and memoranda issued by the Health of Munition Workers' Committee, (iii.) the establishment of a welfare section in the Ministry of Munitions, and (iv.) the powers given to the Home Office by the Police, Factories, &c. (Miscellaneous Provisions) Act of 1916 to make welfare orders. Under the Act of 1916 orders have been made applicable to certain industries, and others are under consideration. These orders are being supplemented and explained by pamphlets giving detailed advice."

An abstract of the Report of the Electrical Inspector will be given in our next issue.

Thoughts About the Strike.

By E. J. P. BENN.

(Chairman of the Industrial Reconstruction Council.)

Writing as late as last Thursday night, we committed ourselves to the definite opinion that a strike was impossible, thus showing a faith which we shared with the whole populace in both Mr. Thomas and the Government. Whether the blame for the breach of faith which has occurred will ultimately lie with the railway leaders or with Ministers is still to be discovered. The strike is, first and foremost, a strike against official higgling and departmental methods generally. For six weary months the men's executive has been humbugged by Whitehall, and the sudden decision to take the plunge on Friday night last was directly traceable to exasperation at these methods. The official report of the final interview with the Prime Minister shows that it was Sir Eric Geddes himself who applied the spark to the highly explosive atmosphere, and that the spark took the form of an injudicious aside to the Prime Minister.

Had the railway men come out next February with the same case, with the points of the case the same as they are to-day the whole country would have been with them. Coming out as they did, six months before their grievances can possibly become operative, the country is solid to a man against them. As the "Westminster Gazette" points out, it is necessary in this dispute to distinguish very carefully between the cause and the methods. The cause, so far as it is understood to date, is good. The methods are intolerable, and on this account every good citizen is driven into irreconcilable hostility to the N.U.R. We hope that the Prime Minister's explosion about an anarchist conspiracy is over-stating the case. We decline to believe, although it is, unfortunately, possible that we may prove to be wrong, that the railway men are the dupes of the revolutionaries.

Opinion on industrial questions may be roughly divided into two groups: there are those who hope and pray for an ordered progress, which will result in a steady uplifting of the rank and file of Labour and the creation of an ever increasing confidence between all the parties to industry. There are also those who may be described as industrial militarists, who, whether they confess it or not, really believe that the interests of Capital and Labour are opposed to each other, a creed which they sum up in the expressive phrase, "Well, the fight must come, and better get it over." The railway strike is a triumph for the latter party. It comprises both advanced Socialists and reactionary employers. These persons, whose views are as wide apart as the poles, have played each other's game in the last week, and we have them, and them alone, to thank for the present state of affairs.

The position is rendered both interesting and impossible by the fact that both parties are represented in the Government. Mr. Lloyd George goes to the City Temple and talks of a new world, in which there will be justice for labour; the while Sir Albert Stanley, the brothers Geddes and Sir Robert Horne are manœuvring with phrases in Whitehall in order to rob the porter of eleven shillings a week next April. It is quite impossible to make the two attitudes square with one another, and the railway men, realising this impossibility, have precipitated the present crisis.

The pity of it is that by this shocking blunder, Labour is going to lose much of the progress that it has made during the last few years. The war has brought about a great uplifting of the position of the working classes, and this strike is going to undo that work. Whatever may be the nominal result of the strike, it is a blunder from the Labour point of view; indeed, if the impossible were to happen, if Mr. Thomas were to win in the present dispute, it would be the most expensive win that any leader ever secured. The uplifting of Labour has not been a matter of money, or wages, or other material things. It has been an uplifting in public esteem, an uplifting in public sympathy. The Whitleyites were gradually absorbing the nation. Men and women of every class were coming to look upon Labour as partners in industry; public opinion was ready for the next big step, and now, thanks to Mr. Thomas or Sir Eric Geddes, it matters not which, all that work has been undone, and we are back in the bad old times.

The Government is reaping what it has sown. The Prime Minister is as much responsible as anybody for the deliberate and definite deception of the working people as to the real position. After five years of destruction in a period of unprecedented shortage, he has used language which is very naturally interpreted by working men as meaning more of this world's goods for themselves. The facts are that everybody must, for a time, be contented with less of this world's goods. That is a proposition so simple as to need no apology for its statement. Yet politicians have, by beating profiteering and similar silly drums, deliberately fostered the opinion [illegible] was plenty of everything, and that the working man was [illegible] of his share. In such a case is it any wonder that the workman gets suspicious when he finds that Cabinet Ministers are deliberately plotting to reduce his money?

From the point of view of those with whom the Whitley Movement is peculiarly associated—those whom we have dubbed Whitleyites—the whole thing is the subject of the keenest disappointment. Some little satisfaction may be found in the fact that the Whitley Movement has so far not touched the railway and transport world. The Triple Alliance, it will be remembered, declined to be a party to the Industrial Conference, and the railway companies have always declined to take a hand in those Whitley Councils established in the trades which impinged on railway work. Whitleyites may, therefore, say, for what it is worth, that their movement has not even been considered by the parties so far involved in the present dispute.

The danger is, however, that the strike may spread, and no man can say what may happen by the time these lines appear in print. At the moment of writing, speculation hangs on the view which Labour generally may take with regard to the rights and wrongs of the case. The members of other unions are being vigorously canvassed by their forward members, who hope to press them into it. One circular which is before us as we write, addressed to the men in a producing trade whose connection with the railway work is the remotest, says: "The above fight is our fight. The Government and the class from which it is drawn are admittedly determined to defeat the N.U.R. We are convinced that if the N.U.R. is defeated, the other unions will be defeated in turn." This shows the dangerous view, and if trade unionists can be persuaded in sufficient numbers to accept it, then we may expect to see sympathetic strikes in all directions. In that event the "fight to a finish" fraternity would rub their hands with delight. The industrial militarists would have won, the State would be bound by all the rules to accept the challenge, and the new world, of which Mr. Lloyd George talks so glibly, would be a very poor edition of the Mid-Victorian era.

There is, of course, an end for the time of all progress in the matter of reconstruction. The much-advertised economy campaign collapses at a stroke, and, instead of Government expenditure going down, it takes a sudden bound upward. The announcement with regard to out of work pay for all those affected by the strike may be good politics, but it is thoroughly bad business. The fight with the railwaymen promises to cost as much per day as the fight with the Germans. Meantime, food control and every other control runs along merrily with an added excuse for activity. The chances of industrial revival are further removed than ever. Exportation is practically stopped, the exchanges everywhere have moved further against us, and six months' work has been ruined in a week. The nation will have a long reckoning with the railwaymen.

It would be short-sighted to overlook the world-wide effect of this disastrous stoppage. Strikes, riots, and revolution are the order of the day the world over. Peoples who are not so practised in self-control as ourselves have been to some extent restrained in their inclination for excesses by the glorious example of the British, who, until last Friday, had avoided any serious form of trouble. To-day every enemy of society anywhere, every agent of the forces of disorder, can draw advantage from the example of the English railwaymen. While we in this country are practically free from any risk of the use of violence, the death roll among less phlegmatic populations will be increased as a direct result of the railway strike.

Lord Salisbury used to say that in order to understand foreign politics it was necessary to have a big map. A rule of a similar kind might well be adopted which would lay it down that before forming opinion on a political question it is always wise to consult a foreigner. It is surprising how useful it is to get a foreign opinion on a domestic question. One's mind is apt to be warped or overloaded with the details of a political dispute, with the result that the main issues are likely to become less distinct. Following this rule, we sought a conversation with a well-informed American, and, as usual, we were not disappointed in the new light which we secured. The American railroads, like all industries in the States, started out with the problem of high wages; they have never had low wages, for there has never been a surplus of Labour. A fundamental problem in the establishment of any industry in America is how to overcome the high rate of remuneration secured by Labour. This is really the explanation of the high state of efficiency to which the Americans have brought mechanical appliances of all kinds. A hundred tons of coal are moved in America as one unit. The 10-ton railway truck is unknown, and right through the whole business everything is planned with a view to efficiency and to labour-saving. Starting from this basis our American friend argues that we shall only attain efficiency in railway matters through high wages. He very rightly despairs of improvement until it is absolutely essential, and high wages provide the necessity.

The immediate concern is how to get out of the present mess. People who talk about a fight to a finish are simply leading the country to red revolution. There must, of course, be a definite victory for the Government on the strike issue, which is something different from the wage issue; some sort of a confession must be secured from the strike leaders which will render a repetition of their petulant action impossible. On the other side, some way must be found of giving to Labour generally the firm assurance that the Government is no party to a conspiracy to reduce wages. We shall never get the new world through lower wages, and we had far better make up our minds to maintain rates and concentrate on efficiency. If our industrial magnates would all follow their best instincts and be led by those among them who have some real powers of imagination, they would put all their thoughts into machinery, equipment and other efficiency problems, and dismiss from their minds the hankering after protection and low wages, which, to come right down to the bottom, is the root cause of the present difficulty.

The Prime Minister should call a halt in the present methods and should find some simple way of engendering confidence. Confidence is the essence of the matter. A chat with any sound trade unionist at the present moment will disclose the fact that the men have no confidence. They suspect a trick, they fear an attempt to rob them of their hard-earned position. If the Prime Minister were to insist upon the dropping of all the minute mathematical manipulations and complicated arguments about percentages, which are the stock-in-trade of our officials, and which only lend colour to the suggestion that there is a "dodge" to get wages down, and substitute for all these things some simple formulæ capable of general understanding, the atmosphere would alter in a moment. Simple formulæ should not be incapable of invention, but they must be really simple; they must not be drafted by dialectical hair-splitters. What should be the difficulty about an understanding, backed up, if necessary, by an official order, that right throughout the whole realm of industry and employment a full month's notice must be given of any proposed alteration in wage rates? For our part we would not object to a period of three months' notice. It may even be possible to provide that no reduction in anybody's rate could be made except with the authority of the Court of Arbitration. The advantage of such an arrangement would be immediate; everyone would know where he stood. The workers want security; such an announcement would give it to them. Things would be stabilised for a time, and there would be an armistice, or a truce, which is all that industry requires at this moment. The formulæ would go on to state that a strike notice brought this arragement to an end, and each union would then know that while its present money was secure a strike would bring them face to face with the possibility of a wage reduction.

Electrical Manufacturers' Scholarships.

The Westinghouse Electric & Mfg. Company, of Pittsburgh, have recently established four annual war memorial scholarships of $500 each. These have been awarded as the result of competitive examinations. The awards have been awarded to the following: Herbert S. Pahren, employed as order clerk in the Cincinnati office of the Westinghouse Company, and a graduate of the Hughes High School, who has selected a technical engineering course at the University of Wisconsin. Arthur Marthens began work as a messenger boy before completing his studies in the Turtle Creek Schools. Mr. Marthens, while working in the cost department, prepared himself in a technical night school to enter college, and has chosen a course of electrical engineering at the Carnegie Institute of Technology. Paul O. Langguth, employed as draftsman in the engineering department, has selected an electrical engineering course as the University of Pittsburgh. Andrew P. Lesniak, employed in the production department, has selected a course in mechanical engineering at the University of Pittsburgh.

Two classes of scholarship are provided—viz., (*a*) for sons of employees of the company or its subsidiaries who have been employed for five years or longer. (*b*) For employees who have been continuously employed for at least two years, and who shall not on Sept. 1 have exceeded the age of 23. Not more than two class (*b*) scholarships will be awarded in any year. Each scholarship carries with it an annual payment of $500 for a period not to exceed four years, the payment to be applied toward an engineering education in any technical school or college selected by the successful candidate with the approval of the Scholarship Committee. The scholarships have been established as a memorial to those employees of the company and its subsidiaries who entered the service of their country during the war. Four awards will be made each year, so that after three years this company will be maintaining 16 of these scholarships in the best technical schools of the United States.

Correspondence.

CONSUMERS' SUBSTATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of August 15, 1919, I note your editorial on the subject "Industrial Consumers' Substations." You speak particularly of the progress made in this line in America and draw attention to the necessity of providing for heat dissipation.

This subject has already received very careful consideration. The guiding thought in all such installations is *Safety First.* After that follow *reliability* and *economy.* Provision for heat dissipation is prominent under each of these heads and has therefore received the closest study. It is taken care of, where possible, by the installation of the transformers out doors, placing indoors such as is necessary of the switching equipment, control apparatus and meters. Arrangements are standardised as far as possible, but varying conditions still call for many different arrangements. Sometimes the control apparatus is placed in existing buildings and other times buildings are erected for housing it. Sometimes the transformers are placed on the ground and the control apparatus on a platform above, while in other cases the arrangement is inverted.

Where it is not possible to place the transformers outside, the rooms in which they are placed are well ventilated, arrangements preferably being made so that the entering air impinges immediately on the transformers and afterwards passes out through ventilators in the roof. As the size of the installation is increased, the natural draft can be increased by the use of flues extending to a considerable elevation above the roof. When this is insufficient, resort must be had to artificial ventilation. In one particular case, the installation of six 500-k.v.a. units in a basement, ventilation was provided by the installation of ducts in the concrete floor. Air was pumped into these ducts by two ½-h.p. fans. Flues extending to the roof provided an escape for the air. In this particular case better adapted space was exceedingly valuable for manufacturing purposes and the installation of the transformers in this place utilised a detached space which would otherwise have been of very little use. lowered installation costs due to its central location and thereby saved in losses far more power than is used by the fan motors. It has proven very satisfactory, the ventilation being more than sufficient to maintain the transformers below normal operating temperature.

I forward you this information to show that the problem of heat dissipation has been appreciated in this country, in fact was appreciated 10 years ago, and careful progressive study of this factor has been contributary to the satisfactory installation and operation of large industrial sub-stations under the diversified conditions met with in practice.—I am, &c.

H. Goodwin, Jr.

Schenectady, U.S.A., Sept. 10.

Power & Mining Engineering Dept., General Electric Company.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Engineering" Directory. (London: "Engineering," Ltd.) Pp. 119.

"Electric Power Transmission Principles and Calculations." By Alfred Still. (London: Hill Publishing Company.) Pp. xviii.×407. 17s. 6d. net.

"Text-Book on Wireless Telegraphy." By R. Stanley, B.A. Vol. I., pp. xii.×471; Vol. II., pp. ix.×357. (London: Longmans, Green & Company.) 15s. net each.

"Hydro-Electric Power Stations." By David B. Rushmore and Eric A. Lof. (London: Chapman & Hall.) Pp. x.×822. 28s. net.

"Essentials of Alternating Currents." By W. H. Timbie and H. H. Higbie. (London: Chapman & Hall.) Pp. viii.×374. 8s. 6d. net.

"Principles of Transformer Design." By Alfred Still, M.Inst.C.E. (London: Chapman & Hall.) Pp. xii.×216. 10s. 6d. net.

"Fuel Economy." By W. H. Booth, F.G.S. (London: S. Rentell & Company.) Pp. 92. 2s. 6d. net.

"Electric Spark Ignition." By J. D. Morgan. (London: Crosby Lockwood & Son.) Pp. 88. 8s. 6d. net.

I.E.E. Regulations for the Electrical Equipment of Ships.

These rules, which have been in process of compilation since May 1916, have now been issued They take the form of a booklet running to 77 pages of text, the pages being 6½ in. by 4 in. The price is 3s. 6d. in dark blue cloth covers, 2s. 6d. in American cloth and the same price in paper covers. The last-named can be supplied, if desired, punched for insertion in Messrs. Walker's loose-leaf pocket-book, No. 64.

Our space will not permit of a complete abstract and in any case it is difficult to abstract rules of this kind ; but in what follows we give some idea of the contents and some of the chief regulations.

The first subject considered is that of generating plant, particulars being given of standard steam engines and standard internal combustion engines. The rules in this part have reference to rating regulations, field regulators, general construction, &c.

SWITCHBOARDS.

The rules then deal with switchboards and kindred matters. Materials are dealt with generally, on ordinary lines. If semi-insulating materials, such as marble or slate, are used, all conducting parts are to be insulated from the slate or marble with mica or micanite, and the slab is to be similarly insulated as a whole. Omnibus bars and ordinary connecting conductors are to be so proportioned that their average temperature will not rise more than 54°F. above that of the surrounding air and no part is to rise more than 9 deg. above the average. Schemes of colouring for conductors are specified. In regard to main switchgear, the requirements are set out in a general way according to the various systems that may be employed. Means are to be provided for indicating the state of insulation of the system to earth. Fuses are divided into two grades, namely, for ordinary duty and heavy duty. Ordinary duty fuses must protect the circuit without damage when a current 33 times the fusing current flowing under the normal pressure of the circuit is suddenly thrown on. Heavy duty fuses must protect a circuit when a current 330 times the fusing current is thrown on.

CONDUCTORS.

With regard to conductors, not more than two joints are to be made during manufacture in any one of the individual wires forming 1,000 yards complete cable, and no joint is to be within 12 in. of any other joint in the same ring and all joints made or manufactured are to be brazed or electrically welded. No cable is to have a conductor of less sectional area than 0·0015 sq. in., except for wiring of metal fittings. The sectional area of the conductor of the cable for such fittings must not be less than 0·001 sq. in. All conductors having an effective sectional area exceeding 0·0033 sq. in. must be stranded. The drop in voltage allowed is 2 volts plus 3 per cent. in the case of lighting and 2 volts plus 5 per cent. in the case of power.

The cable employed may be either vulcanised rubber or paper insulated. The V.I.R. cables may be (1) braided, (2) lead covered, (3) lead covered and armoured and (4) braided and armoured. The paper insulated cables may be (1) lead covered and (2) lead covered and armoured. Rules are given in regard to armouring and tests of dielectric. A system of colours is specified for the identification of cables.

Flexible cords are to be insulated with vulcanised rubber and provided with a protective covering of (*a*) silk braiding, (*b*) glacé cotton braiding, (*c*) hemp, cotton or jute braiding, thoroughly compounded, (*d*) wire armouring comprising flexible braiding or spiral of galvanised steel or phosphor bronze wire in addition to the covering specified in (*c*), (*e*) hard cord braiding in addition to the covering specified in (*c*), or (*f*) tough rubber sheathing applied directly to the laid-up insulated cores.

The ends of all cables having a sectional area of 0·007 sq. in. and above are to be provided with a soldering socket. Cables may be (*a*) run in wood casing (any class of cable) in dry situations or (*b*) may be armoured cables and lead covered cables when not run in wood casing, in which case they are to be secured by metal clips having smooth or rounded edges ; the electrical resistance between any two points of the metallic envelopes of such cables must then not exceed 2 ohms. Such clips are to be spaced in accordance with the table given in the Rules. Armoured cables having a sectional area of 0·25 sq. in. and upwards may be carried on metal hangers. If cables are exposed to mechanical damage they are to be protected by sheet iron plating or by heavy gauge screwed conduit. No elbows are to be used, and no bend is allowed having a smaller radius than 2½ times the outside diameter of the conduit. Cables in machinery spaces or where inevitably exposed to the weather or to the action of sea water are to be lead covered and may be armoured in addition, with or without braiding over the armour. Braided cables of the same polarity in wood casing may be bunched. Joints during erection are to be made by means of joint boxes. All cables passing through ducts or watertight bulkheads are to be provided with deck tubes or watertight glands as the case may be.

EARTHING.

Various rules are given of the usual type in regard to sub-division and control of circuits. Earthing connections are to be of copper having the same sectional area as the working conductor, but not less than 0·003 sq. in. for all sizes up to 0·007 sq. in. Above this size a conductor of not less than 0·007 sq. in. must be provided for every 50 amperes of working current or part thereof. Rules are given for the prevention of interference with magnetic compasses. Certain rules are also given in regard to secondary batteries.

FITTINGS.

In regard to fittings, rules are given providing for ample passages, freedom from stress on the conductors, avoidance of dust, moisture, &c. All weatherproof fittings whether fixed or portable are to be so protected as to withstand immersion under a 3 ft. head of water before fixing. After fixing they must be capable of withstanding the application of a stream of water ejected from the open end of an ordinary wash deck hose under a head of 15 ft. for a period of a quarter of a minute, the outlet of the hose being 6 ft. away from the fitting. Open type fittings are not to be used in spaces where inflammable or explosive dust or gases may be present, or near combustible materials. Weatherproof portable fittings must have all metal parts connected to earth by means of a third conductor in the flexible cord. If this cord is of metal armouring, the armouring may form the earthing conductor, provided it is sufficiently connected at either end. Such fittings are to have strong metal guards in metallic contact with the rest of the uninsulated metal in these fittings. Open type portable fittings with metal frames must have all their metal parts, other than the lamp-holder or lamp-holders, connected to earth. Open type portable fittings with non-metal frames need not be earthed, provided that the guards are not in, and cannot come into, metallic contact with the lamp-holder or lamp-holders. Such fittings are to be made of treated hard wood, or of some suitable composition capable of standing rough usage in service. Lamp-holders are to be of the Goliath type for lamps consuming more than 300 watts. Lamp-holders in open type portable fittings are to be insulated from the fittings by means of insulating material. All plugs and sockets having a rated capacity exceeding 5 amperes are to be provided with an interlock switch.

MOTORS AND OTHER APPLIANCES.

Motors above ⅓ B.H.P. must conform in all respects with British standardisation rules No. 72 of 1917. Motors fitted in compartments in which the temperature is liable to exceed 120°F. must be either of the pipe ventilated type connected by ventilating ducts to the spaces in which the temperature is not liable to exceed 120°F. or of the various forced draught type connected to fans supplying air at or below that temperature.

Switch parts and protective devices of control gears must be so proportioned that their temperature shall not rise more than 54°F. above that of the surrounding air when working with normal current. All live parts must be enclosed by metal covers which are to be clear of such live parts by not less than ¾ in. Those portions of the cover in proximity to working contacts must be lined with incombustible insulating material. Resistances must be so proportioned that no accessible part shall rise to a higher temperature than 130°F.

Those parts of heating and cooking appliances which have to be handled in their operation must not become heated to a temperature exceeding 130°F. All connections between elements and main terminals, unless self-supporting or rigidly fixed, must be continuously insulated with porcelain beads. All appliances for pressures exceeding 150 volts, whether portable or fixed, must be provided with a terminal or other suitable means for earthing all uninsulated parts. All appliances are to be protected by a fuse on each insulated pole. They must be controlled as a whole by a switch, which in the case of portable appliances must be fitted on a bulkhead. Every portable appliance must have at least one section of the element controlled only on the live side of the wall plug or other similar connection between the flexible conductor and the fixed portion of the circuit. Non-luminous appliances must be provided with a visual indication to show that current is passing through. No appliance taking more than 1,000 watts is to be portable.

All apparatus for internal communications must be constructed to take the full pressure of the source of supply, without the interposition of any external resistance : and if the pressure of supply exceeds 25 volts, all circuits and accessories must be designed in all respects in accordance with the rules for lighting and power circuits.

Some rules are given in regard to lighting conductors and also in regard to wiring for oil ships.

The insulation resistance before putting an installation into service must not be less in megohms than 10 divided by the number of lamps on the circuits, except that the insulation resistance of any final lighting sub-circuit need not exceed 1 megohm. The insulation resistance between the case or framework in every live part of each individual dynamo, heater or other appliance complete must not be less than half a megohm.

Heating and Cooking Notes.

The "Britannia" Electric Fire.

A new type of electric heater which possesses novel features has been designed and is manufactured by the English Electric Company, Ltd. The element is of the radiant type and spiral formation, and is supported on a series of fireclay fingers or bridge pieces, which are fixed to a curved, brightly-polished metal reflector. The element is, therefore, practically suspended in air, so that the fire quickly attains a radiant temperature. The curved shape of the reflector, and consequent curving of the element, tends to increase the radiation of heat in an outward direction, and ensures a more efficient distribution of heat than a flat reflector. It is claimed that the element has been tested in regular use over a period of three years and proved satisfactory. We should have thought that the weight of the element when suspended between fingers without supports would have caused sagging, and consequent local heating, resulting in a burn-out; but apparently this trouble has not occurred during the three-year test period.

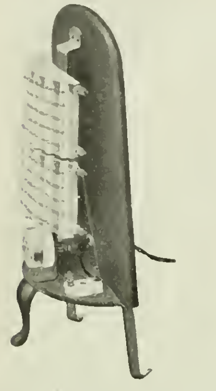

Fig. 1.—View of 2 kw. Fire, showing Two Heaters and the Rotary Switch.

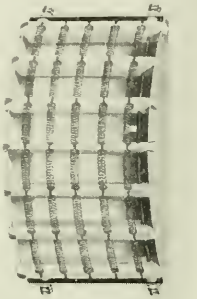

Fig. 2.—View of Heater, showing Curved Front and Arrangement of Porcelains.

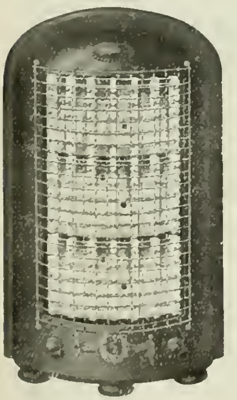

Fig. 3.—Type F.C. 3 kw. Fire.

The element and reflector are mounted in a plain pressed-steel frame, finished in egg-shell black and copper relief. The elements are made in standard size to consume 1 kw., and frames are made to take one, two and three elements, thus giving a series of three sizes of fire. The internal wiring is of heavy-gauge copper wire, neatly arranged; but we would draw the makers' attention to the efficacy of fish-spine insulated beads. In the 2 kw. and 3 kw. fires the wiring is so arranged that the I.E.E. rules are complied with, and one element is switched on by means of the wall plug switch, and the other elements being controlled by a rotary switch mounted at the bottom of the front of the radiator frame. The prices are certainly reasonable in these days of high costs for labour and materials, being 25s., 50s. and 70s. respectively for the 1, 2 and 3 kw fires. Flexible cord is charged extra, and supplied in two grades—viz., asbestos-covered three core and heavy vulcanised twin wire. For spares, the spirals and porcelains can be purchased separately or as a complete element, credit being allowed for complete old elements if returned. We notice that a two years' guarantee is given in respect of faulty material or workmanship; but the clause does not make it quite clear whether the element is guaranteed to last without failure for two years. It would surely be better practice for manufacturers to drop the guarantee plan and to supply a spare element with every fire sold. The user could then promptly replace a broken or burned out element without waiting. It may be a certain satisfaction to receive eventually a free replacement of a broken element; but, under present conditions, there is often an annoying period when the fire is out of use whilst a new element is being obtained. Elements have a nasty habit of failing when a cold spell of weather occurs.

It is pleasing to notice that due attention has been paid in designing the frames and elements to facilitate packing and ease of assembly or renewal of parts. The standard pressed parts of the frames will, when the fires are dismantled, pack in together, thus economising packing space. Similarly, the elements can be dismantled and a dozen packed into quite a small case.

Instructions are sent out with shipments of dismantled fires carefully explaining the method of assembly. Illustrations show in Fig. 1 a 2 kw. fire with front case removed, Fig. 2 shows the element as a complete unit, whilst Fig. 3 illustrates a 3 kw. fire completely assembled. Every detail, even to rotary snap switches, is of British manufacture.

The Railway Strike and Coal Supply.

In consequence of the railway strike, the Board of Trade have made a series of Orders under the Defence of Realm Regulations, with the object of maintaining the supply of coal and fuel for household purposes, &c., and we give below an abstract of the principal of these Orders.

Under the terms of the Coal and Fuel (Emergency) Order, 1919 (dated Sept. 26, 1919), the Controller of Coal Mines (Sir Evan D. Jones) has declared a state of emergency to exist, and consequently the following provisions of the Order will continue in force until further notice :—

It shall not be lawful, without the previous consent in writing of the Local Fuel Overseer, (*a*) to purchase, obtain or acquire, or for a registered coal merchant or licensed coal dealer to sell, deliver or dispose of more than 1 cwt. of coal in any week for consumption in any premises coming within the scope of the Household Fuel and Lighting Order, 1919; or (*b*) to purchase, obtain or acquire any coal for consumption in such premises where the quantity of coal available exceeds 10 cwt.

The above provisions do not apply to coal sold, supplied, delivered or otherwise disposed of for the purpose of the trade or business of distributing coal.

The Local Fuel Overseer may direct that any supply of gas or electricity covered by the principal Order be cut off where there is reason to believe that the supply is being abused or used in excess so as to prejudice the interests of the public.

Where the principal Order is in conflict with this Order, this Order shall prevail, but otherwise the principal Order remains in force.

Infringements of the present Order are summary offences against the Defence of the Realm Regulations.

The Local Fuel Overseer, who has power to transfer registered customers from one coal merchant to another, may (with the assent of the Controller) take any action necessary for the enforcement of the provisions of the Order, or the Controller may take such action.

By the Lighting, Heating and Power (Emergency) Order, 1919, dated Sept. 26, 1919, the Board of Trade has ordered that all lights of the following classes and descriptions shall be extinguished and such lights shall not be lighted at any hour :—

(*a*) Sky signs, illuminated facias, illuminated advertisements and other lights used outside or at the entrance to any premises for advertisement or display; (*b*) lights used inside any shop for advertisement or display when the shop is closed for serving customers.

The Order does not apply to any public street light or any other light approved by the Chief Officer of Police as necessary in the public interest.

"Witton" Carsak Cells.

The "Witton" Carsak cell, manufactured at the General Electric carbon and battery works at Witton (near Birmingham), is a Leclanché cell for which exceptional efficiency is claimed.

The depolarising material is of fine grain, pressed into a solid block under heavy pressure, and contains no resinous binder. A fluted rod battery plate, so constructed as to ensure a large surface of contact with the depolariser, is forced into the block at high pressure, and maintains intimate contact with the depolarising material. The absence of a resinous binder and the large active surface of the carbon rod ensures a low internal resistance. This is further reduced by the substitution of thin porous canvas sacking, in place of porous china or carbon, as the container in which the block is placed. To obtain the best results it is advisable, though not absolutely necessary, to use the special curved Carsak zinc plates. The substitution of a "Witton" Carsak is stated to result in a gain of approximately 0·15 ampere-hour per penny of cost and 15 ampere-hours per lb. of material. The life of the cell is claimed to be two to three times that of the ordinary porous pot types, and the risk of breakage is small. The low internal resistance (stated to be only one-tenth that of the corresponding porous pot type) and the large area of active depolariser surface, render the cell specially useful for work in which high current-density is required. Owing also to the extra capacity per lb., a greater effective capacity can be shipped for a given weight. The cell is made in three sizes: 3 pints, 2 pints and 1 pint, the 2 pint size being that most generally required.

Baily Electric Furnaces.

The very full and interesting programme which was arranged in connection with the visit of the Institute of Metals to Sheffield, included one item of particular interest to the central station engineer and the electrical manufacturer. Two cinematograph exhibitions were given by Mr. Verdon O. Cutts, of Sheffield, and showed electric furnaces in operation, melting non-ferrous metals and alloys, annealing and heat-treating steel and non-ferrous products. These were Baily furnaces of the United States, which are being introduced on this side of the water by Mr. Cutts' firm. They are of the resistance type, and therefore a power factor as high as 98 per cent. The load obtained is also steady and is in sharp contrast with the steel furnace of the arc type.

The melting furnaces are of three distinct types, viz., the pit, tilting and tapping types, and range in size from 40 kw. up to 1,000 kw. A brief description of a typical round pattern tilting furnace, which figured largely in Mr. Cutts' pictures, will serve to illustrate the essential features of design and construction. The furnace is provided with specially wound transformers of 105 kw, capacity. It consists essentially of a 7 ft. diameter steel shell, mounted on trunnions and brackets for tilting. The shell is suitably lined with refractories, the hearth being located at the bottom of the furnace and bowl shaped. The domed roof is suitably encased and capable of being raised and lowered by one hand wheel. Kieselguhr is used between the casing and the lining as a heat insulator, and the roof framework is provided with a circular fin which dips into a sand seal. Over the furnace hearth is situated an annular trough of carborundum firesand which contains the resister material. Fixed electrodes enter this trough at two points diametrically opposite. These serve to make the permanent electrical connection to the resister bed. A charging and working door of the plug type is provided, and this constitutes the only opening to the furnace, the pouring spout being located immediately below. The furnace can be poured without opening the door. A ribbed cast-iron plate, hung from a counter-weighted lever enables the doorway of the furnace to be partially closed when the swing plug door is opened for the purpose of working the hearth. This shields the operator from the intense heat of the furnace, and decreases the loss of heat.

The necessary heat is generated by the resistance of the carbonaceous material in the trough to the passage of the electric current. Special transformers having their primary side suitably wound for the electric supply available form an integral part of the installation. They are provided on the secondary side with a number of different voltage taps. This arrangement in conjunction with a selective oil-break switch of special design gives a fine degree of control.

The heat generated in the resister trough is transmitted to the hearth by direct radiation and indirectly from the arched roof. The direct radiation from the lower part of the trough is obtained by mounting the trough on piers, this leaving a considerable area of the trough bottom exposed to the hearth. It is interesting to note that this heating element has a radiating surface of over 40 sq. ft.

It will be obvious that a furnace so designed must necessarily be rather large compared with its output. That described above has a normal hearth capacity of 15 cwt., and a melting rate of approximately 6 cwt. per hour. In proof of its flexibility as a unit, Mr. Cutts is able to cite instances of its commercial use with charges ranging from 5 cwt. to over 30 cwt., and under favourable conditions the melting rate is considerably increased. It is further evident that a furnace of this type must be somewhat sluggish in operation, and it is conceivable that this may be regarded as a disadvantage. It is, however, this feature which renders the furnace susceptible to very precise temperature control, which is a most desirable quality for non-ferrous work.

The reduction of metal losses in melting is of considerable importance. Melting records of numerous electric furnaces in regular commercial operation melting yellow brass scrap show a total loss of less than 1 per cent. These records are taken over considerable periods and under normal shop conditions. This not only makes for the conservation of metal and the elimination of waste, but also minimises the danger of occupational disease due to the emission of zinc fumes from the furnace. It will therefore be evident that the furnace is particularly suitable for melting bronze, brass, aluminium, zinc, anti-friction alloys, &c., and especially those metals which readily oxidise and volatilise.

The electrodes, being embedded in the furnace walls and resister bed, are fixtures and inaccessible to the atmosphere. Consequently, there is practically no erosion or electrode consumption. Incidentally, they require no adjustment which makes for simplicity of operation. The energy consumption with this size of furnace is stated to vary between 300 kw. and 350 kw.-hours per ton of yellow brass scrap melted.

The tapping type of furnace is rectangular in shape and fitted with two or more straight resister elements. The larger sizes have motor-operated doors with an electrically-operated charging device. Two typical examples may be mentioned. The first is a furnace of 500 kw. capacity which has a hearth capacity of 3 tons of aluminium. This same furnace has a capacity of 9 tons of brass and a melting rate of 2 tons per hour, when supplied with 600 kw. transformers. The second is a 1,000 kw. furnace having a capacity of 200 tons of zinc per day, with an average current consumption of 74 kw.-hours per ton. In this instance the metal dross amounts to 2·43 per cent.

The melting furnaces described were developed as the result of experience with furnaces installed for heating without melting for such operations as annealing, heat treatment, &c. These heating furnaces are exactly similar in type to those used for brass melting. They are usually rectangular in shape with arched roof and straight resister elements running along each side of the interior of the furnace over the hearth. The precision with which the furnace temperature and atmosphere are controlled enables a steel or other product to be subjected to the exact heat treatment specified by the laboratory. Where there is an appreciable amount of repetition work, or work of approximately the same bulk for similar treatment, automatic furnaces are employed. In such cases the only manual labour required is to place the castings, forgings, or other pieces, on to the charging platform of the furnace. All subsequent operations, including the actual charging, heating, quenching and passage through the drawing furnace, are controlled by means of pyrometers or a time-element device. Thus the human element is completely eliminated and the furnaces are rendered practically fool-proof. The installation thus partakes more of the nature of a heat-treating machine than that of a furnace only, and a machine-like precision is rendered possible. One such installation used for heat treating forgings consists of a hardening furnace provided with 600 kw. and a drawing furnace of 300 kw. capacity, with quenching tank situated between the discharge end of the first furnace and the charging end of the second furnace. The cycle of operations may be described briefly as follows: When the piece or pieces nearest to the discharge end of the hardening furnace have reached a pre-determined temperature, thermocouples operate automatic gear through relays, and the doors of the first furnace are opened. The electrically-operated pusher places the cold pieces for treatment into this furnace, thereby ejecting those at the discharge end which have attained to the desired temperature. These are received by a hydraulically-operated manipulator which places them into the quenching medium, at the same time closing the motor-operated doors. The time taken in quenching is governed by a time relay. The manipulator then withdraws the material from the quenching tank and places it in front of the charging door of the drawing furnace. In doing so, the doors of this furnace are opened, and immediately the material is pushed into the furnace, the completely heat-treated pieces being ejected at the discharge end and the doors closed.

Other automatic furnaces have been constructed for the heat treatment of steel balls for bearings, small finished machined aeroplane parts, cast steel anchor chains, draw-bar knuckles and a variety of other work.

For work requiring very gradual heating and cooling, and where large output is essential, the installation is of the car type, with pre-heating chambers and hood for slow cooling. One such installation which is used for the annealing of sheets, steel strip, &c., is over 200 ft. long. Two lines of cars are provided, each travelling in opposite directions. The cold material, as it enters, is pre-heated by the hot material approaching the discharge end of the track. This makes for economy of operation to a very marked degree. It has a capacity of 150 tons per day, and operates at temperatures up to 1,400°F.

One interesting fact mentioned by Mr. Cutts is that the ability to give the precise heat treatment which these furnaces render possible, has enabled one firm to use plain carbon steel where they previously found it necessary to use special alloy steels.

Rust-proof Coatings for Iron and Steel.—A circular issued by the Bureau of Standards (Washington) describes a variety of metallic coatings which are intended to protect iron and steel from rust. Zinc appears to be the metal most favoured in this respect, partly because of its electro-positive properties and also because of its freedom from toxic effects—an important consideration in the case of such articles as food-containers, &c. Various methods of testing coated materials are discussed and preference is given to the "salt spray" method, according to which the article coated is exposed to a fine mist of saturated salt solution and the length of time necessary to cause corrosion noted.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1919 Specifications.

130,924 Bodell & Williams. Locking apparatus for locking electric light glow lamps to holders. (12/3/19.)
130,933 Heyworth. Means for readjusting the timing of the spark of a magneto-electric machine. (7/4/19.)
130,936 Hartmann. Rectifiers for alternating electric currents. (14/11/18.)
130,942 Scintilla Firm of. (High-voltage current distributing apparatus for electric ignition apparatus of internal-combustion engines. (18/9/18.)
131,005 Leyland Motors & Thomas. Electric starting and ignition of aeroplane engines and the like. (10/9/17.)
131,018 Beauvais. High-frequency electric installations. (14/12/17.)
131,026 Thompson & British Westinghouse Electric & Mfg. Co. Electrical transformers. (25/3/18.)
131,028 Grylls & Heape. Electric arc lamps. (27/3/18.)
131,030 Sperry. Feeding and rotating means for electrodes of searchlights and the like. (27/3/17.)
131,054 Brillouin. Telephone installations, particularly for wireless telegraphy. (8/10/17.)
131,055 Brillouin. Telephone installations, particularly for wireless telegraphy. (8/10/17.)
131,056 Latour. Audion or lamp relay or amplifying apparatus for use in telephony. (15/4/16. Divided application on 5,363/17.)
131,057 Mullard. Electrical resistances. (6/4/18.)
131,061 Fleming. Electric furnaces. (9/4/18.)
131,066 Turner. Electrical signalling apparatus. (12/4/18.)
131,076 Ledanois. Sparking plugs for explosion motors. (23/4/18.)
131,092 Latour. Audion or lamp relay or amplifying apparatus. (30/4/17. Addition to 5,363/17.)
131,106 Western Electric Co. (Western Electric Co.) Electric selectors, particularly for automatic telephone systems. (3/7/18.)
131,113 Robinson & Chamney. Telephone repeater systems. (17/7/18.)
131,144 Robinson & Chamney. Telephone repeater systems. (17/7/18.)
131,116 Macintosh. Direct-current starting switches for electric motors. (31/7/18.)
131,117 Tudor Accumulator Co. & Spencer. Secondary electric batteries or accumulators. (2/8/18.)
131,129 Railing, Farthing & Winstanley. Electrical heating apparatus. (12/8/18.)
131,131 Armstrong, Whitworth & Co., Chicken & Thain. Electrical signalling apparatus. (12/8/18.)
131,135 Collie. Means for making temporary connections with electric supply cables (13/8/18.)
131,136 Wilkinson & Fearnley. Current collectors for electrically-propelled vehicles (13/8/18.)
131,156 O'Leary. Electrical motors. (16/8/18.)
131,162 Norton & Robinson. Electrical fuse distribution box. (21/8/18.)
131,166 Bloxam. (Russische Akt. Ges. L. M. Ericsson & Co.) Method and means for operating distant devices by means of electromagnetic waves. (21/8/18.)
123,972 Ridoni & Soc. Talco E. Grafiti Val Chisone. Manufacture of natural graphite electrodes. (6/3/18.)
131,180 Stell. Electrical apparatus for detecting or indicating the presence of high-tension or extra high-tension sparks or discharges. (31/8/18.)
131,185 Lo-Thermo Patents, Ltd., Longbottom & Greenhalgh. Dynamo-electric machinery. (10/9/18.)
131,191 Bonella & Damey. Electrical switch. (16/9/18.)
131,204 Fletcher & British Westinghouse Electric & Mfg. Co. Alternating-current dynamo-electric machines. (17/10/18.)
131,230 Electric lamp-holders. (10/1/19. Patent of addition not granted.)
131,239 Callegaris. Electric switches. (17/2/19.)
131,249 Glatz. Electric fuse plugs. (21/3/19.)
131,258 Williams & Williams. Thermo-telephonic receivers. (3/5/19.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

August 20, 1919.

20,442 Birket & Parker. Gravity controlled mercury contact maker.
20,460 Siemens, Collyer & Petithory. Selective devices for automatic telephone systems.
20,478 Claremont & Scholer. Securing electric cables to walls, &c.
20,491 Schlesinger. Incandescent lamps.
20,505 Thornton. Switches.
20,506 Ross, Courtney & Co. & Fuller. Electric couplings.

August 21, 1919.

20,513 Gardner. Electrical indicators for railways, &c.
20,518 Imbery. Electric furnaces for heating rivets, &c.
20,531 Automatic Telephone Mfg. Co. & Flynn. Alternating-current relay.
20,535 Simplex Conduits, Ltd., Waterhouse & McLaughlin. Fuses.
20,540 Western Electric Co. Signalling systems.
20,542 Daglish, Lorkin & Swift. Electrode holders.
20,544 Cooper. Dynamos.
20,580 Pe[illegible]ot. Remote control switch.
20,601 Abbot, Turner & Co. Resistance units.

August 22, 1919.

20,605 Barry. Obtaining current of two periodicities from one generating unit.
20,627 Automatic Telephone Mfg. Co. & Hudd. Relays.
20,628 Automatic Telephone Mfg. Co., Harrison & Smith. Telegraph printing systems.
20,635 Byrne. Locking device for electrical mechanism.
20,644 Shanks & Walker. Magneto-electric devices for operating clutches, &c.
20,645 Shanks & Walker. Magnetically operated friction clutch.
20,622 B.T.-H. Co. (Cie France Thomson-Houston.) Electric hoisting or winding apparatus.
20,669 M.L. Magnet[illegible] Syn[illegible]. & Wa[illegible]. Electric ignition apparatus.
20,687 Ernier. Electric furnaces.
20,688 Smalley. Electric ovens.

August 23, 1919.

20,722 Hayes. Automatic electric water heater.
20,739 Beau[illegible]rt. Electric hooters.
20,760 Western Electric Co. & Deakin. Senderless automatic telephone satellite systems.
20,775 R[illegible]nbaken. Current distributors of ignition systems, &c.
20,776 R[illegible]baken. Magnetos.
20,790 Haslam & Stratton. Miners' electric safety lamps.
20,791 Haslam Stretton & Jones. Miners' electric safety [illegible].

August 25, 1919.

20,808 B[illegible]. Rails for railways, tramways, &c.
20,820 Eastern Telegraph Co., Fraser, Smith & W[illegible]. Receiving perforators.
20,830 C[illegible]s[illegible]y. Extensible electric lamps for vehicles.
20,877 V[illegible]en Wat[illegible]. Electric lighting apparatus for [illegible] &c. (19/9/18. Switzerland.)
20,883 Naamlooze Vennootschap Philips Gloeilampenfabrieken & Lely. Incandescent lamps.
20,885 Krone. Electric alarm for door security [illegible].

Commercial Topics.

Electrical Supplies for Holland.

It is reported that there is a wide field in the electrical industry in Holland for exporters of electrical material, especially for electric motors, electric lighting plant and apparatus. The market for optical instruments and photographic apparatus has also enormously increased of late years. Before the war the demand for these things was almost exclusively met by imports from Germany, but during the last 2 or 3 years German supplies have dwindled. There should also be a demand for textile machinery, while the Dutch Colonies should offer a good market for light railway plant.

* * * *

The Export Credit Scheme.

A further announcement has been issued by the Board of Trade on the credit scheme in respect of exports to Finland, the Baltic provinces (Lavia, Esthonia and Lithuania), Poland, Czechoslovakia, Jugoslavia and the areas in Russia to which the scheme for insurance against abnormal commercial risks applies. The Government are prepared, through the Export Credits Department of the Board of Trade, to consider applications for advances up to 80 per cent. of the cost of the goods to the seller (including freight, insurance and the commission paid to the department by the seller). As already announced the advances will be made subject to certain conditions, and the present statement gives the Department's commission, interest charges and the margin of security that will be required. Applications accompanied by a banker's guarantee of sterling payment of a bill will receive preferential consideration. Forms of application and other particulars can be obtained from the Export Credits Department, 10, Basinghall-street, London, E.C.2.

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Import Restrictions.

A good illustration of Government methods and of the injurious effects of the import restrictions upon the trade of this country is given in a letter to "The Times" of the 25th ult. The correspondent, who signs himself "Fed-up," states that "on Aug. 23 the Board of Trade issued a list of commodities the import of which was to be prohibited as from Sept. 1, except under special licence. The last article mentioned on the list was gauges. Considering there are numerous kinds of gauges, such as scientific gauges, glass gauges, pressure gauges, &c., each differing from the other as much as chalk from cheese, we immediately inquired at the Import Restrictions Department which gauges it was the intention of the Board to restrict. The Deputy Controller of the Import Restrictions Department informed us on Aug. 23, Aug. 28 and on various occasions since, the last time being as recently as Sept. 22, that his Department was still without instructions from the President of the Board of Trade, and that no one knew the President's intentions. Meantime, the Customs are holding up all gauges pending special licences being issued. These are, however, easily obtainable and freely granted, though loss of time and interest on money and a great deal of inconvenience are caused to traders. It seems hardly credible, but it would appear that the President of the Board of Trade—in a moment of inspiration, no doubt—inserted in his list of import restrictions certain articles without himself knowing the meaning of his words."

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The Engineering Trade of Chili.

After Brazil and Argentina the most important industrial country in South America is Chili, and strenuous efforts should be made to extend British trade with that country. There is room for expansion in various directions, for in pre-war days the Germans held the premier position in the electrical field, with the United States and Great Britain next in order: but in railway and structural engineering the United States took the lead. Next month a diplomatic mission from Chili will arrive in this country, in return for a similar British mission sent out to the leading South American states in 1918, and a good opportunity will be given of demonstrating the resources and export capacity of this country. At present the Public Works Department of the Chilian Government is considering a number of important constructional undertakings, including new railways, schemes of water supply and sewerage, repairs to docks and jetties, irrigation works, roads, telegraph lines, &c. The first undertaking to be proceeded with will be the completion of the new railway between Santiago and the principal port, Valparaiso, by way of Casablanca. The estimated cost will be nearly £2,500,000 and the line will probably be a steam one, although strong efforts are being made to induce the contractors to adopt electric traction. The existing line between Valparaiso and Santiago will, however, be converted to electrical operation in the near future. Other railways will be built, and improvements of existing ones carried out, so that there will be a good demand for rolling stock, signalling apparatus, telegraph material, &c.

Before the war the importation of railway supplies and equipment into Chili was considerable in importance. In the year 1913 a large number of freight cars were received (of a total value of about £700,000). Great Britain supplied only £243,906 worth, but the United States supplied £325,176. In regard to passenger cars the value of Great Britain's share was £243,245, but the greater part came from the United States; of cars for portable railways, representing a total value of £1,427,974, Great Britain supplied goods of a value of £180,598, against imports from the United States of a value of £749,901. In parts and accessories the United States supplied considerably larger quantities than those received from the United Kingdom. Great Britain has, however, long held the first place in structural iron and steel exports to Chili, and it might easily regain its premier position in other classes of engineering imports with the aid of energy and enterprise.

Electricity Supply.

Colwyn Bay Corporation has increased the charges for electric current by another 33⅓ per cent.

Swansea Corporation has applied for authority to borrow £30,000 for extensions of mains and services and £20,000 for future extensions.

Sanction to a loan for the electric lighting of the Whiplatter Hospital has been applied for by Keswick Urban Council.

Southampton Corporation has increased the charges for electricity by a further 40 per cent.

An inquiry will be held at Annfield Plain to-day (Friday) into the Urban Council's application to borrow £17,700 for electric street lighting.

Bedwas Urban Council, which proposes to apply for a provisional electric lighting order, has asked Mr. Arthur Ellis to prepare an electric supply scheme.

An inquiry will be held to-day (Friday) into the application of Basingstoke Council for sanction to borrow £12,000 for additional plant at the electricity works.

Brighton Lighting Committee recommends the restoration of street lighting to the pre-war scale, which will involve an increase in the annual charge for lighting of over £6,000.

An inquiry was held at York yesterday (Thursday) into the application of the Corporation for sanction to borrow £46,610 for hydro-electric works at Linton Lock.

An adjourned inquiry was held at Manchester on Tuesday into the application of the Corporation for sanction to borrow £1,042,000 for the Barton electricity works. It is also proposed to apply for a loan of £50,000 for sub-station plant.

The Electric Supply Corporation has applied to the Board of Trade for an order to allow an increase of 2d. a unit on the maximum price of electricity in Chelmsford.

The Erith Council has increased the charge for electric current by a penny a unit to light and power, except consumers with long term contracts.

Kingstown Urban Council recently applied for sanction to a loan for an electric supply scheme, but the L.G. Board have asked for plans and estimates of the proposed scheme.

Norwich Corporation has received sanction to borrow £67,000 for additional electric generating plant. An application has been made for sanction to a loan of £10,000 for mains extensions.

Todmorden Town Council has received sanction to borrow £7,500 for capital expenditure in connection with the scheme for obtaining a supply of electricity from the Yorkshire Electric Power Company.

The Committee of the North of Scotland College of Agriculture, Aberdeen, has abandoned the proposal to utilise a local waterfall in generating electricity, and it has been decided to instal gas-driven plant.

An inquiry was held at Gelligaer yesterday (Thursday) into the application of the Urban Council for sanction to borrow £3,057 for the electric lighting of the village of Fochriw.

Messrs. May & Hawes have recently prepared a report on an electricity supply scheme for Guisborough, and a special meeting of the Urban Council has been summoned to consider the proposals.

Haslingden Council has advanced by a further 25 per cent. the cost of electricity for lighting and heating (making 75 per cent. on pre-war rates), and current for traction has been increased ¼d. per unit, making the total charge 2¼d.

The charges for electric current have been increased by Poplar (London) Borough Council by a further 15 per cent. for public lighting and 20 per cent. for private lighting, making total increases of 65 per cent. and 50 per cent. respectively.

Hove Lighting Committee will endeavour to make arrangements for supplying electricity to the proposed new houses in the borough, provided the Board of Trade will sanction the carrying of the necessary mains and services on the overhead system.

Saltburn Urban Council has adopted a scheme of public electric lighting, and in addition to the ordinary street lamps there will be 16 200 c.p. lamps on the promenade, and two 400 c.p. lamps in Station-square and Regent-circus. The extensions will cost over £1,500.

The Hindhead & District Electric Light Company, Ltd., has applied to the Board of Trade for an order authorising such an increase in the charges for electric current as will enable the company to pay a dividend of 4½ per cent., being three-quarters of their pre-war dividend.

Stirling Council has increased the charge for electric current for private lighting from 7d. to 7½d. a unit; 25 per cent. has been added in the charge for power, and for heating current and slot meters there is an increase of ½d. per unit, the prices being now 2d. and 7½d. respectively.

The Leicester Watch Committee have decided to adopt electric lighting for the new Coleman-road estate. In due course the committee will carry out considerable extensions of electric street lighting, as they consider electricity not only a better, but a cheaper illuminant than gas.

The Leicestershire & Warwickshire Electric Power Company have decided to exercise their power to supply electricity within a period of two years to Atherstone, a mining town of 8,000 inhabitants near Nuneaton. A site for a sub-station has been acquired.

Chester Electricity Committee has appointed a sub-committee to confer with representatives of the Newton Parish Council in regard to the supply of electricity in Newton, and the city electrical engineer (Mr. S. E. Britton) has been instructed to prepare a plan for supplies of current to outside areas, including that of Newton.

Llandudno Urban Council is considering terms for the supply of electricity in bulk by the North Wales Power & Traction Company, and provided a satisfactory agreement can be entered into the Council will shut down its generating station, thus effecting a considerable economy in generating costs.

An accident occurred on the 24th ult. at the Colne Electricity Works, resulting in the curtailment of the lighting service. The top of an engine cylinder was blown off and considerable damage caused. Arrangements have been made for a temporary connection with the neighbouring town of Nelson.

Aylesbury Corporation has authorised the Electricity Committee to supply electric current to small dwellings for three lamps for 6d. per week, plus 20 per cent., providing suitable arrangements for wiring can be made between the landlord and the tenant. In order to test the consumption of current by electric ovens, the electrical engineer (Mr. Turnbull) has been authorised to obtain on hire different types of oven.

The accounts of the Carlisle electricity department for the year ended March 31, 1919, show revenue £39,378 (compared with £34,987 in previous year), gross profit £11,816 (£12,167) and net profit £923 (£1,295). Works costs were 0·67d. (0·56d.) per unit, and total costs, including 0·43d. (0·39d.) for interest and sinking fund, were 1·66d. (1·37d.). Maximum load was 2,604 kw. (2,703 kw.) and load factor 24·4 (24·8) per cent. Units generated were 7,261,483 (7,381,278) and sold 5,560,321 (5,879,532).

The members of the Cardiff Electric Lighting and Tramways Committee have accepted the resignation of Mr. Arthur Ellis, the general manager of the tramways and city electrical engineer, and the question of finding a successor has been referred to a small sub-committee in consultation with Mr. Ellis.

On the advice of Mr. Ellis the Committee has increased the price of electricity from 50 to 75 per cent. above pre-war rates.

The accounts of the Kings Lynn electricity department for the year ended March 31, 1919, show revenue £12,897 and expenditure £8,064, leaving gross profit £4,833, and after providing for capital charges, special charges, income tax, &c., the net profit was £1,924, compared with £2,146 last year. Costs per unit were 2·15d. (1·88d.) exclusive, and 3·16d. (2·76d.) inclusive of capital charges, war allowances, &c. Maximum load was 495 (503) kw., and load-factor 17·05 (17·48) per cent. Units generated were 808,126 (832,683), and sold 48,818 (49,310).

For the year ended March the income of the Norwich electricity department was £80,386 (compared with £72,608 in the previous year), and expenditure £46,864 (£39,484), or £49,190 (£41,494) including public lamp maintenances, war allowances, &c. Interest and sinking fund required £20,453 (£20,412), leaving a balance of £11,318 (£10,731) to carry to appropriation account, out of which £1,999 has been spent on two electric vehicles and certain sums applied to defraying excess expenditure, &c., amounting to £1,088. Total costs were 1·134d. (0·930d.) per unit. Motors connected are equal to 6,804 h.p. (6,576 h.p.).

At present there is a brisk demand in Liverpool for the supply of electric current for private lighting and for industrial power purposes. The new wooden houses at Knotty Ash are being wired, and it is probable that the new Corporation brick dwellings will also be fitted for electric lighting. In addition, there appears to be a good demand for electricity for cooking, heating, ironing and vacuum carpet cleaning in the better class of private houses as they effect an economy in labour and fewer servants will be required.

The members of Epsom Urban Council are concerned about the position of their electricity undertaking under the Electricity (Supply) Bill, and a deputation will wait upon the Minister in charge of the Bill in order to get an explanation of the position of Epsom in the event of the measure becoming law. Recently the Council applied to the Board of Trade for permission to have their provisional order so amended that any purchaser of the undertaking could have it for 42 years as from the date of purchase, and not 42 years from the date of the original order, but this was refused.

The accounts of Poplar (London) electricity department for the year ended March 31, 1919, show revenue £133,351 (compared with £107,366 in previous year), total cost of production £94,812 (£74,697), gross profit £38,538 (£32,687), and net profit £8,983 (£7,297). Total working expenses were 1·6d. (0·87d.) per unit sold. Maximum load was 8,600 kw. (8,150 kw.), and load factor 30·44 (30·85) per cent. Units generated and purchased were 26,427,676 (25,101,075), and sold 21,526,200 (20,505,024). Mr. J. H. Bowden (engineer and manager) says, in his report, during the year the capacity of the plant was brought up to 13,250 kw., and the cost per kilowatt installed reduced to £24. 10s., including all e.h.t., and d.c. distribution. The electrical plant insurance account has proved satisfactory, and the showrooms have proved an unqualified success.

The accounts of the Rochdale electricity department for the year ended March 31, 1919, show revenue £79,234, and gross profit £26,303. After providing for interest, sinking fund, &c., and war bonus and allowances to men on military service (£2,445) their remained a profit of £3,378. Depreciation required £2,672, and the surplus, £706, has been placed to reserve. The maximum loads were d.c. 1,185 kw. (against 1,415 kw. in previous year), a.c., 4,445 kw. (5,780 kw.), and d.c. for tramways 1,173 kw. (1,166 kw.) Units generated were 16,881,540 (15,579,912), and sold 14,511,933 (16,193,410). The report of the Electricity Committee states that during the year there were large additional demands for power, and that considering the high cost of generating plant, and in view of the possibility of the Government initiating a national scheme for the supply of electricity, the Committee resolved to meet the demands by purchasing in bulk from the Lancashire Electric Power Co., with which an agreement has been entered into for 10 years.

Electric Traction.

BLACKPOOL Corporation have approved plans for the extension of the tramway offices in Coop-street.

NELSON Council has applied to the Board of Trade for sanction to borrow £25,000 for a new tram shed.

SOUTH SHIELDS Corporation are applying for a light railway order to authorise the construction of an electric railway in the South Shields Harton and Whitburn districts.

The Blackpool & Fleetwood Tramroad Company is appealing against the decision of the FLEETWOOD magistrates that the tramcars of the company should be licensed by the Fleetwood Urban Council.

An application on behalf of the workers in the GLASGOW tramway depot for an advance in wages to a minimum of £4 per week has been refused, but the Corporation has no objection to the application being referred to arbitration.

At a special meeting of the Barrow Town Council last week it was decided to take over the local tramway undertaking of the British Electric Traction Company. It was also agreed to apply for sanction to borrow £120,000 for the purchase.

A tramway accident, which occurred at North Shields on Saturday, resulted in injuries to 16 persons. A tramcar, which was coming down Borough Bank, got out of control and dashed down hill. At the bottom of the hill the car left the rails, ran into a wooden erection and turned over. Only three persons were seriously injured.

MORECAMBE and LANCASTER Town Councils have agreed to purchase the line of the Lancaster Tramways Company between Morecambe and Lancaster for £8,000. The company will be allowed to run a motor 'bus service for nine years, but the trams, track and rails become the property of the Corporation.

PONTYPRIDD Council have decided, by a majority of one vote, to apply for Parliamentary powers to extend the local tramways to Rhydfelin and Upper Boat. Mr. W. E. Low, engineer and surveyor, gives the comparative cost per mile of the construction of a sleeper track and the track constructed as part of the carriage-way was £6,600 and £16,500 respectively. These figures represent the actual work of track-laying. The length of the new track to Upper Boat will be 1½ miles.

The question of the purchase of the local tramways has been under discussion for some time by STOKE-ON-TRENT Council, but it has now been decided to accept the offer of the Potteries Electric Traction Company to sell the tramways and light railways in North Staffordshire for £737,890. The payment of this amount will be spread over about 30 years, and the payments of principal and interest at 5 per cent. will amount to £48,000 per annum. The purchase is to include £75,737, which has been accumulated by the company as a renewal fund, all omnibuses and plant in connection with the omnibus services, &c.

NEWCASTLE-ON-TYNE Corporation has issued a statement showing the income and expenditure of the Corporation tramways during the past six years. The income for 1913-14 amounted to £265,285, and to £467,921 in 1918-19; but the expenses were £147,550 and £306,490, and the gross profit £117,735 and £161,431 respectively. The surplus of £93,969 for 1918-19 was disposed of as follows: Insurance reserve £1,363, relief of rates £14,000, service allowances to men £13,178, and income tax £20,427 The amount placed to reserve during the last financial year was £45,000, against £25,134 in 1913-14. Motor men's and conductor's wages in 1913-14 were £49,028 and in 1918-19 £111,911. Track maintenance in 1913-14 accounted for only £8,780, while in 1918-19 the cost was £13,924. For maintenance of cars £39,577 was expended in 1918-19, compared with £12,836 in 1913-14. By granting the latest demand of the men the wages bill would be increased by £50,000 a year.

Imperial and Foreign Notes.

The Malvern (Victoria) automatic telephone exchange is now in operation.

The proposals of the NEW ZEALAND Budget for the coming year provide for special development work, including improvements in water and electric power supply, an extension of the educational system and a scheme for building homes for the people.

According to recent CUSTOMS DECISIONS, the electric motor-generator of a combination high frequency and ionisation outfit, is subject to import duty of 20 per cent. in NEW ZEALAND if of foreign manufacture and 10 per cent. if British, and the duties on the switchboard (with fittings) forming part of the same outfit are 30 per cent. and 20 per cent. respectively. Electrodes used in electrotherapy (British or foreign) are admitted free.

SAAVEDRA (Argentina) municipality are taking steps to secure a supply of electricity for the town.

The ITALIAN GOVERNMENT propose to pass legislation making the electric lamp industry a Government monopoly. It is reported that "the manufacture of lamps will remain free, but the Government will buy all its production at a fixed price and provide for sales, &c."

As the United States Government has practically abandoned the project of laying a cable across the Pacific Ocean, in order to couple the Philippines, Japan and China, the cable will be laid by the Commercial Pacific Cable Company, and we understand that the contract has been placed with the Telegraph Construction and Maintenance Company, of London and Greenwich.

Miscellaneous.

At BLACKPOOL, on Friday, Robt. Smith was charged with stealing copper cable and lead value £50, from Bispham electricity works. All the material has been recovered. As others are implicated, a remand was granted.

The Eastern Telegraph Company announce that the telegraph rates between the United Kingdom and Japan, Chosen, Formosa and Japanese Saghalien have been reduced as follows: Ordinary telegrams, 3s. 4d. per word; deferred telegrams, 1s. 8d.; press telegrams, 1s. 1d.

The New Peto and Radford Accumulator Company, Ltd., and Peto & Radford, Ltd., are being wound up voluntarily, and Mr. F. G. Hart, 12, Heddon-street, Regent-street, London, W.1, has been appointed liquidator.

In regard to the arbitration inquiry into the claims of the ELECTRICAL TRADES UNION that the same holiday conditions already agreed to for workers in the general electricity undertakings of the London district should be applied to the men employed in the electricity departments of the railway companies in the London area, the award of the Court is that the claim has not been established. The railway companies contended that the men concerned formed part of the general body of railway workmen, and that their holiday conditions should be regulated by those governing the general body.

There is no doubt that INCREASED PRODUCTION is essential if the country is going to maintain its leading position as a great power and to pay the war debt, &c. There is need of propaganda work in order to impress upon all and sundry the need of increasing the output, and we are glad to learn that at a conference in London on Friday of representatives of employers and of the leading trade unions it was decided to form the Higher Production Council in order to foster increased production. It advocates the Priestman or bonus scheme, which has been in successful operation in engineering works over two years. Sir Samuel Waring is president of the Council, Mr. E. J. P. Benn chairman of the Executive Committee, Rear-Admiral Hall treasurer, and Mr. E. M. Howe secretary.

At a conference of employers and trade unions associated with electrical undertakings in the Western Counties, it has been decided to form a DISTRICT INDUSTRIAL COUNCIL, and the area formed by the National Council has also been approved. The Council, which will meet at Bristol unless otherwise decided, will consist of 12 members on each side. It has also been decided to form a District Council of 24 members for Devon and Cornwall, and a committee of six has been appointed to draw up rules. The committee is composed of the following: Mr. L. A. Hards (Cornwall Electric Power Company), Ald. J. Taylor (Torquay), Mr. W. S. Knight (chairman of Electricity and Street Lighting Committee, Plymouth); and Messrs. J. W. France (Electrical Trades Union), G. Neilson (Dockers' Union) and A. G. Peters (Steam Engine Makers).

On Sept. 26 the executive and management of the Edison Swan Electric Company, Ltd., of Ponder's End, Middlesex, gave a hearty send off to Mr. G. L. Just, manager of the company's Melbourne branch, on the eve of his departure for Australia, after a two months' visit to this country. Mr. Just was the guest of honour at a dinner held at the Abercorn Rooms, Liverpool-street Station Hotel, Mr. J. W. Elliott (joint sales manager) presiding. There were present Messrs. J. S. Child (joint sales manager), J. J. C. Bacon, C. E. Hiatt, T. S. Read, C. A. Smith, E. H. Miller, A. F. Caine, F. Charles Raphael, J. Cooper, John R. Sells, G. W. Tuffill, H. J. Evans, W. F. Ingamells, C. Cummins Cherry and L. Rabinovitch. After the toast of the King had been honoured, the health of Mr. Just was drunk, and Mr. Child, on behalf of his colleagues, presented Mr. Just with a handsome gold cigarette case suitably inscribed. The gift was acknowledged in felicitous terms, and the evening's proceedings were of a very enjoyable nature.

No effort is being spared to make the Birmingham section of the BRITISH INDUSTRIES FAIR a great success. The Board of Trade are sending out over 100,000 invitations to buyers at home and abroad, and it behoves manufacturers and traders to see that the exhibits in every trade are fully represented. The management of the Birmingham section are making efforts to avoid any weakness in this direction, but one of their greatest handicaps is the apparent inability among potential exhibitors to realise the actual position. In Birmingham, the Chamber of Commerce and Municipality are jointly responsible for the organisation of the section, and if it is fully realised that this is really a national affair, we think it will prevent that unrepresentativeness of the various grouped exhibits, which will eventuate if the leading concerns in each industry do not place their products on view in either one or other of the three centres over which the Fair is divided—London, Birmingham and Glasgow. In short, if the British Industries Fair is to impress the buyers of the world with the wide range of our manufacturers' activities and the high standard of their products—if, in fact, it is to serve its purpose fully—there must be no hesitation among possible exhibitors, and there truly should be none among those who think nationally and not parochially.

In a communication to the London Telephone and Telegraph Advisory Committee of the London Chamber of Commerce on the TELEPHONE SERVICE, the Postmaster-General states that the defects in the exchange service were not in general due to circumstances for which individual operators could be held responsible, but to the after effects of the war upon the numbers and experience of the operating staff, combined with a large increase in calls. The daily number of calls in London has risen from less than a million at the time of the Armistice to about a million and a quarter. Large increases in wages have been granted to operators during the war. A telephonist in London who at 18 years of age was formerly paid 16s. a week, rising to 28s. a week, now receives (inclusive of war bonus) 37s. 10d. a week, rising to 52s. 2d. Every effort was made to obtain a sufficient supply of recruits without unduly lowering the standard. In London, during the year ended June 30 last, out of 28,000 applicants for employment only about 2,600 satisfied the tests and could be accepted for employment. Measures have been taken to secure and train additional operators and to give special training to the less experienced operators now in the service.

Over £2,000,000 is to be expended on the development of the exchange system in the United Kingdom during the current financial year. In the City, where the shortage of plant is acute, a new building to relieve the London Wall exchange is approaching completion, and the first portion, providing for 1,700 subscribers, should be available for use in December next.

Tenders Invited and Accepted.

Glasgow Parish Council require tenders by Oct. 24 for 12 months' supply of electric lamps and fittings, bell furnishings, &c. Forms of tender from the Inspector and Clerk, 266, George-street, Glasgow.

The Deputy Postmaster-General, Brisbane (Queensland) will receive tenders until noon Oct. 22 for supply of paper-insulated, lead-covered, steel-armoured cable (schedule 475) for the Australian Commonwealth, Postmaster-General's Department.

The Mersey Railway Company require tenders by noon Oct. 9 for the supply of metallic and carbon filament lamps and fittings, signal wire, ironmongery, &c. Forms of tender from the manager and secretary, Central Station, Liverpool.

Tenders are required by Jan. 20 for the supply, &c., to the Australian Commonwealth Postmaster-General's Department, State of Victoria, of Automatic Telephone Switchboards at Collingwood, as per schedule 1,583. Tender forms, &c., from the High Commissioner, Room 406, Australia House, Strand, London, W.C.

Edinburgh Corporation require tenders by Oct. 13 for the electric lighting installations in dwelling houses under the Gorgie housing scheme. Specifications from the City Electrical Engineer, Dewar-place, Edinburgh.

Walsall Corporation has accepted the tender of Walter Scott, Ltd., for the supply of 210 tons of tramway rails

Willesden Urban Council has placed an order with Messrs. Ransomes, Sims & Jeffries, Ltd., for the supply of 11 electric vehicles.

Swansea Electricity Committee has also accepted the tender of Ransomes, Sims & Jeffries, for an electric vehicle at £1,363.

Messrs. F. Reid Ferens & Company have secured the contract for the supply and erecting of poles, cables, &c., in connection with the extension of overhead street lighting at Cambois, in the Bedlingtonshire urban district.

Oldbury Urban Council has accepted the following tenders: Shropshire, Worcestershire & Staffordshire Electric Power Company, restoring electrical system, &c., at the Sewage Disposal Works; Bryan Donkin Company, electric blower; General Electric Company, motors; Pulsometer Company, stereophagus pump.

Appointments Vacant and Filled.

Middlesborough Corporation require a manager of the local tramways and motor 'bus undertaking. Further information from the Town Clerk. Applications by Oct. 11.

A tutor in electrical engineering is wanted for correspondence courses in engineering. Applications to "Engineering," care of University Book Co., 48, Southampton-row, London, W.C.1.

A lecturer on engineering subjects is required at the Handsworth (Birmingham) Technical School. Salary £200 to £280, with £78 war allowance. Particulars from the Principal.

A workshop instructor is required in the electrical engineering department of the City and Guilds (Engineering) College. Salary £160 plus bonus of £100. Applications to Prof. T. Mather, F.R.S., Exhibition-road, London, S.W.7.

A chief assistant is wanted to lecture on electrical engineering subjects and to assist in the testing laboratory, Faraday House. Commencing salary £250. Applications to the Principal, Faraday House, Southampton-row, W.C.1.

An assistant secretary is required for the electricity department of the Shanghai Municipal Council. Salary 400 taels per month. Applications by Oct. 13 to Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's-gate, Westminster, S.W.1.

Applications are invited by the London County Council for the position of charge shift engineer at the Greenwich generating station. Salary £250–£10–£300 a year, plus war bonus of 20 per cent., plus £90. Applications to the Clerk of the London County Council, Spring Gardens, S.W.1, by 4 p.m. Oct. 20.

Applications are invited for the position of lecturer in electrical engineering at the University of Cape Town. Commencing salary £350, rising after three years' service by annual increments of £25 to £450, plus war bonus of £76 for a married man or £50 for a single man. Applications to the Secretary, Office of the High Commissioner for the Union of South Africa, 32, Victoria-street, Westminster, S.W., by Nov. 30.

The following appointments are vacant at the Municipal Technical Institute, West Ham:—A chief lecturer in electrical engineering (salary £300—£10—£450 per annum), demonstrator in engineering (£150—£10—£180) and an assistant lecturer in chemistry (£200—£10—£300), plus war bonus. Application forms and further particulars from the Principal of the Institute, Romford-road, Stratford, London, E. 15.

Dr. J. G. Stewart has been appointed lecturer in engineering at University College, London.

Mr. Nichol has been appointed assistant general manager and Mr. A. P. Bins district engineer of the Tasmanian Government hydro-electric department.

Business Items.

Capt. A. H. Law has resigned the position of managing director of Messrs. C. A. Parsons & Company, Ltd.

The new address of the Improved Solidite Company, Ltd., is Advance Works, Jews-row, Wandsworth, S.W. 18.

Bertram Cecil Tozer and Herbt. Jas. Harris, motor and electrical engineers, London-road, Leigh-on-Sea, Essex, have dissolved partnership. Mr. Harris will continue the business in future as the Leigh Motor Works.

The partnership between Reginald Tricker, Bernard Wortman and Chas. Fras. Killelea (trading as the Tricker Electrical Installation Company), 2, Aspen-place, Hammersmith, London, W. 6, has been dissolved.

The parnership between Fredk. Geo. Baxter and Bernard Wortman (trading as the West London Dynelectric Company), electrical engineers, 110, Glenthorne-road, Hammersmith, London, W. 6, has also been dissolved.

Messrs. F. J. Shenton & Company, Ltd., 68 & 69, Shoe-lane, London, E.C. 4, have issued their price list of English electrical accessories, including switches, lampholders, adapters and plugs, porcelain, fuse-boards, &c.

Mr. Percival F. Brittain, of Brittain's Electric Motor Company, Cannon-street, London, E.C.4., has joined the Board of the Automobile, Aircraft and Engineering Insurance Company, Ltd., which is affiliated with the General Accident, Fire and Life Assurance Corpn.

In Heat Treatment "Bulletin" of the Automatic & Electric Furnaces, Ltd., particulars are given of the Wild-Barfield pouring furnaces. A table of the cost of current consumption and output of various size furnaces is also included.

John Fras. Carr and Thos. T. D. Geesin (trading as Carr, Geesin & Company), electrical and mechanical engineers, 1, Montague-street, Russell-square, London, W.C., have dissolved partnership. Mr. Geesin continues the business.

The Ministry of Shipping have for disposal a large quantity of new shipbuilding machinery, including planing, drilling, punching and shearing machines, wood-working machine tools, &c. Further particulars may be obtained from Room 100A, Ministry of Shipping, St. James's Park, London, S.W.1.

The Electrical Alloy Company, of Morristown, N.J., have opened a British branch at 5, Chancery-lane, London, W.C., under the management of Messrs. Williams & Bell. The company manufacture and supply various high resistance wires and ribbons, known as calido, rayo, &c., pure nickel, magno-nickel for sparking plugs and grade A monel metal.

Mr. Francis Harrison seeks leave to amend the specification of letters patent No. 12,054/1913, granted to Clara Alice Harrison for "Improvements in and relating to incandescent lamps." Particulars of the proposed amendment are given in the "Illustrated Official Journal" (Patents) of Sept. 24, and notices of opposition must be given within one calendar month from that date.

Capt. P. Dunsheath, O.B.E., M.A., B.Sc., late R.E., has been appointed by Messrs. W. T. Henley's Telegraph Works Company, Ltd., to take charge of their research department. Capt. Dunsheath has been engaged in the engineer-in-chief's office of the Post Office for a number of years, and has spent the greater part of the war in France with the Royal Engineers, Signals.

The Record Electrical Company, Ltd., of Broadheath, Altrincham, has issued a leaflet giving particulars of its combined ohmmeter and generator for insulator testing. The generator is removable for inspection and can be interchanged with another in a few minutes. If damaged the handle can be replaced in a moment. The resistance frames form a unit and can also be replaced in a few minutes and the other parts can be similarly dealt with; in short, every component is a complete unit in itself, and is removable without disturbing neighbouring components.

The latest publication of the Electrical Development Association is a pamphlet (E.D.A. 13) which contains the unsolicited testimonials of a householder who claims to have solved the domestic help problem with the assistance of electricity. The householder adopted electricity for heating, cooking and other domestic purposes, with the result that a considerable economy of time and labour was effected. The letters are a striking testimony to the efficiency and economy of electricity in the household. Copies of the publication, which is still in the press, can be supplied by the Association at 10s. per 100.

Companies' Reports, &c.

It is announced that the boards of the Nitrogen Products & Carbide Company and of the Albey United Carbide Factories, Ltd., have completed negotiations for the amalgamation of the two companies.

The directors of the Northern General Transport Company propose to pay an interim dividend on the ordinary shares of 2½ per cent. (6d. per share) for the half-year ended June 30 last.

The warrants for payment of interest on the 4½ per cent. first debenture stock of the South Metropolitan Electric Light & Power Company, Ltd., for the half-year to the 1st inst. have been posted.

The directors of the Shanghai Electric Construction Company announce an interim dividend of 6 per cent. (12s. per share), less tax, for the past half-year, payable on the 1st prox.

Messrs. Ward & Goldstone, Ltd., propose to make an issue of 80,000 £1 7 per cent. cumulative and participating preference shares in order to provide capital for improvements, &c. The company recently purchased the works of the Churchill Tool Company at Pendleton and contemplate early removal to the new premises.

The directors of the Dundee, Broughty Ferry & District Tramways Company report that the profit for the past year, including £83 brought forward, was £5,653. The balance for disposal is £3,400, and it is proposed to pay a dividend on the ordinary shares at the rate of 5 per cent. per annum, less tax, to place £1,000 to reserve, and to carry forward £344.

The South African Carbide & By-Products Company, which has been formed with a capital of £307,500, divided into £300,000 7 per cent. cumulative participating preference shares of £1 each and 150,000 ordinary shares of 1s. each, is offering the preference shares to the public. The company is promoted by the Chemico Electric Company for the manufacturing of calcium carbide and of extracting motor spirit, tar oil and other by-products from coal and shale at Ballengeich in Natal.

The sixth ordinary general meeting of the Southern Brazil Electric Company, Ltd., was held on the 25th ult., when the chairman (Mr. F. H. Tootal) gave a review of the conditions in Sao Paulo. He was pleased to say that everything now justified the belief that they were about to enter upon a much more satisfactory state of affairs. Their big construction work had been practically completed, what remained to be done being the normal extension of lighting and power supply, for which there was a steady demand owing to the general prosperity. Revenue had increased progressively since the beginning of the year, and promised to develop further before its close. Brazil generally, and more particularly the State of Sao Paulo, had emerged from the war with greatly increased agricultural and commercial prosperity.

New Companies.

BANBRIDGE GAS & ELECTRICITY COMPANY, LTD. (4,783).—Private company, reg. in Dublin Sept. 16, capital £10,000 in £1 shares, to acquire the business of the Banbridge Gas Company. J. N. Finney is governing director. Reg. office : Reilly-street, Banbridge.

COUSINS, LTD. (159,027).—Private company, reg. Sept. 23, capital £2,000 in £1 shares (1,990 cumulative 10 per cent. preference), to carry on the business of manufacturers, importers and exporters of and dealers in hardware, machinery and tools, electrical and mechanical engineers, &c. First directors are W. E. Christie and H. Christie. Reg. office : 41, Charterhouse-square, E.C. 1.

HARRIS, UNDERHILL & COMPANY, LTD. (158,794).—Private company. Reg. Sept. 15, capital £2,000 in £1 shares, to carry on the business of mechanical, constructional, electrical, hydraulic and general engineers, machinists, toolmakers, &c. First directors are : E. O. Lenham, A. E. John and J. Harris. Secretary : J. Harris. Reg. office, West India House, Baldwin-street, Bristol.

JAMES KILPATRICK & SON, LTD. (10,625).—Private company. Reg. in Edinburgh Sept. 12. Capital £15,000 in 5,000 7 per cent. cumulative preference and 10,000 ordinary shares of £1 each. To acquire the business of electrical and general engineers, contractors, &c., carried on under the style of " James Kilpatrick & Son," at Paisley. First directors are : W. R. Scott, J. Kilpatrick and T. White. Secretary : J. Winning, Terrace-buildings, Paisley.

KELVINDALE ELECTRIC MFG. COMPANY, LTD. (10,639).—Private company. Reg. in Edinburgh Sept. 22. Capital £5,000 in £1 shares. To carry on the business of electrical, mechanical, consulting and contracting engineers, &c., and to adopt an agreement between A. A. Schaschke, M.A.M.E.E., and W. R. C. Murdoch. Solicitor : W. R. C. Murdoch, 98, West George-street, Glasgow.

LONDON ASBESTOS & MOTOR COMPANY, LTD. (159,006).—Private company, reg. Sept. 22, capital £1,000 in £1 shares, to acquire from D. G. Shrubsall all or any of the patents and patent rights, agencies and representations specified in an agreement between himself and H. J. Buller, and to carry on the business of engineers, manufacturers of asbestos, rubber goods, motor cars, &c. First directors are D. G. Shrubsall, R. E. Alexander and H. J. Buller. Reg. office : 17, Dacre-street, Westminster, S.W. 1.

PROVINCIAL WIRELESS COLLEGES, LTD. (158,778).—Private company. Reg. Sept. 13, capital £200 in £1 shares, to carry on a school or schools for the teaching of inland, cable and wireless telegraphy and telephony, and general electrical and specific wireless telegraph and telephone technology, &c. First directors : H. A. Flick and F. Davies (both permanent). Reg. office, 39, St. Giles-street, Norwich.

STOCKS, LTD (158,939).—Private company, reg. Sept. 19, capital, £4,000 in £1 shares. Objects ; to carry on the business of mechanical, motor electrical and general engineers, manufacturers of and dealers in motor cars, cycles, &c. First directors are E. Stocks and A. H. Taylor, Secretary, G. Nicholls. Reg. office : 7, Mint-street, Lincoln.

STOCKWELL & OHMS, LTD. (158,844).—Private company. Reg. Sept. 16. Capital £1,000 in £1 shares. Objects : To carry on the business of manufacturers of and dealers in electrical machines, instruments and accessories, mechanical and electrical engineers, &c. Reg. office, 32, Rodney-street, Pentonville, N.1.

SWIFTIC TOOLS, LTD. (158,866).—Private company. Reg. Sept. 17 capital £2,000 in 1,990 ordinary shares of £1 each, and 200 founders' shares of 1s. each. To carry on the business of mechanical and electrical engineers, founders, tool makers, &c. First directors are : Mrs. W. V. Schove and A. C. Schove (both permanent). Secretary : Winifred V. Schove. Reg. office, College Hill Chambers, Cannon-street, E.C.4.

TREDELECT DYNAMOS, LTD. (158,598). Private company, reg. Sept. 20, capital £60,000 in £1 shares (15,000 7 per cent. cumulative participating preference), to take over the English patent rights for the Tredelect Car Lighting Dynamos and Cut-outs, with the English business of the Tredelect Engineering Company, Ltd., &c. First directors are H. A. Bartlett, H. C. H. Smyth and G. F. A. Norman. H. A. Bartlett may retain office while holding 1,000 shares.

VICKERS (AUSTRALIA) LTD. (159,053).—Private company, reg. Sept. 23, capital £10,000 in £1 shares. Objects: to carry on the business of manufacturers of and dealers in steel, iron, brass and metals, shipbuilders, armament manufacturers, electricians, &c. Reg. office : Vickers House, Broadway, Westminster, S.W.

WILSON & VASS, LTD. (158,491).—Private company. Reg. Sept. 3, capital £3,000 in £1 shares. Objects : To carry on the business of dealers in, owners and hirers of pleasure and commercial vehicles, electrical and general engineers, &c. First directors are : D. Wilson and J. Vass. Reg. office, Burn-lane, Hexham, Northumberland.

Prices of Metals, Chemicals, &c.

			Tuesday, Sept. 30	
Copper—		Price.	Inc.	Dec.
Best selected.........	per ton	£110 0 0	—	—
Electrolytic bars ...	,,	£121 0 0	—	—
H.C. wire bars	,,	£120 0 0	—	£1 0 0
Sheet	,,	£146 0 0	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	per lb.	1s. 8$\frac{3}{16}$d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 11d.	—	—
Sheet, basis	,,	1s. 2⅜d.	—	—
Wire, basis	,,	1s. 2¼d.	—	—
Pig Iron—				
Cleveland No. 1 ...	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	33 10 0	—	—
Lead Pig—				
English	,,	26 15 0	—	—
Foreign or colonial	,,	25 12 6	—	—
Tin—Ingot	,,	274 10 0	—	10s. 0d.
Wire, basis	per lb.	0 3 6½	—	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £21.

,, (Roll Brimstone).—Per ton £21.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £41.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6d.

Shellac.—475s. December delivery 460s.

Rubber.—Para fine, 2s. 6¼d. ; plantation 1st. latex 2s. 6d. lb

Thirty-Seven Years Ago.

[From The Electrician, Sept. 30, 1882.]

Electric Lighting for Manchester.—The City Council have been recommended to apply for a provisional order to supply electricity for public and private purposes within an area co-extensive with the City of Manchester.

Liverpool Docks.—A correspondent laments the absence of telephonic communication with the Alexandra Docks at Liverpool, and remarks how useful such a means of conveying intelligence between the docks and merchants' offices would be. He suggests that the Liverpool Telephone Exchange Company should take the matter up.

Electrical Teaching in Germany.—" The Times " Berlin correspondent says that, in view of the great and growing importance of the subject, lectureships on electrical science and its applications have been established at Stuttgart, Aix-la-Chapelle, Karlsruhe and Hanover, and this winter students will be specially instructed in the same subject in the University of Berlin.

THE ELECTRICIAN:

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Notes.

The Railway Strike.

Now that the railway strike, after nine days of unparalleled dislocation, has terminated, all sections of the community will be counting the cost and estimating the gains or losses according to their point of view. What has been the total cost to the nation ? That is a figure which will doubtless be estimated by various writers before long, but actually it will be difficult to arrive at any correct figure, and the effect may be felt for a long time to come. The result of such disturbances is to threaten our commercial activity in foreign markets, and there is every prospect that unless conditions adjust themselves more favourably before long we shall practically lose such valuable markets as China and others in the East and elsewhere. The gain to the railwaymen has been very small, merely the extension of the time during which wages cannot be reduced by six months. Is this small gain worth the struggle that has taken place ? The reply must certainly be an emphatic "No." Moreover, Mr. G. H. ROBERTS, who was present at the negotiations, stated last Tuesday in a lecture before the Industrial League and Council that these terms could have been secured by negotiation on the Friday when the strike began, but the N.U.R. refused to continue the discussion. This fact throws a still greater responsibility upon the N.U.R. executive. On the other hand, there has been some gain to the public in general. There will now be a truer appreciation of the proper state of public feeling, which will result in greater stability, and will show those who would head for revolution that the community as a whole will not take such efforts in the passive attitude which is characteristic of the unfortunate Russians. With regard to the gain to the railwaymen no one will begrudge the extra six months, except in so far as it may be considered an encouragement to illegal and irresponsible action. The actual amount in wages will probably not amount to very much, but there is a broader question. Every other industry will now naturally claim that no reduction in war bonus should take place in their industries during the same period, even though the cost of living may come down. This would not much matter were it not for the fact that the level of wages reacts upon the cost of living, and that a reduction in the cost of living is retarded if the level of wages is maintained beyond what is in any sense reasonable. In this connection it must be remembered that the mere £ s. d. value of wages is much less important than the purchasing value. It has been the common experience that increases given in wages during the war have directly reacted upon the cost of living, and the converse must be borne in mind.

The Political Aspect.

ON the broader question of the strike as it affects the community we agree with Mr. W. A. APPLETON, secretary of the General Federation of Trade Unions, that the strike would never have taken place if the men had been balloted upon the question at issue. Mr. APPLETON takes much broader views than many of his colleagues, and it is worth while here to quote his words in the recent quarterly report of the General Federation :—

> November, 1919, to May, 1920, will be fateful months ; unless sanity returns and production increases, they will be tragic months. . . . Some of the strikes have had a distinctly political origin. Political strikes must either fail or end in revolution. They are not against the capitalist, but against the community. It is not the capitalist who suffers, but the people. Against such strikes the Government must protect the people, or it must surrender its functions. The effect of such strikes is to decrease production and increase the price of all commodities.
>
> In view of the national situation and the possibility of a grave shortage, it is imperative that trade unionists should face the facts. The outstanding ones are that the war is over ; that competitive laws as between nations are now forcefully operating ; that food and raw materials required for the sustenance of the men and women of Britain must be bought from countries over whose merchants our Government has no control ; and that these commodities must be paid for with goods, and not paper.

When Parliament reassembles steps should be taken to secure the community from strikes of the character of the one we have just experienced. It should certainly not be in the power of a dozen men to throw one of the most vital services of the country out of action at a moment's notice, and so long as such means are adopted the man in the street will consider that strikes which are so engineered are more political than industrial. Moreover, so long as agreements are lightly broken, Labour will bear the stigma attaching to transactions that are not moral, and, in the long run, Labour will suffer on this account whatever the immediate gain.

The Throttling of Export Trade.

IN our issue of May 30 we commented upon the difficulties experienced by Australian traders in dealing satisfactorily with British-made electric lamps and similar goods. The conditions imposed by the Australian authorities were found to have a most restricting influence. Although it appears that the conditions to which we have referred may be ameliorated, we gather from a further letter we have just received from the General Electric Engineering Company, of Perth, Australia, that the regulations are still a very great bar to importing goods from England. Not only is the duty excessive, but the Customs authorities have the right to go back twelve months, and make any surcharge they think fit on a shipment which has been sold. For example, if a shipment of imported goods is sold and the required duty is paid, the Customs have the right for twelve months to make a further charge on the ground that the home consumption price was higher than stated by the importer when the goods were cleared. The method adopted is simply to charge the extra duty, and the onus of disproving the assertion is thrown upon the importer. It appears to us that this is a most extraordinary method of applying import duties, and one that makesit almost impossible for the importer to carry on business with this country. Surely British manufacturers should take up the matter vigorously with the Australian authorities, and place it upon a proper basis; otherwise the net result can only be the loss of the Australian market in many lines, which will in future be supplied by other countries not subjected to these absurd restrictions.

Mr. Ram's Report on Factories.

The annual report of Mr. G. S. Ram, Electrical Inspector of Factories, makes interesting reading this year as usual, and will be found in abstract on another page. To a large extent it is a record of progress and development during the war. There are not so many cases of bad design to which attention has to be drawn, though even now (and often actually in the case of Government factories) omissions of a serious kind have been found. For example, in certain of the factories which were required to run night and day no provision was included to enable the isolation of various parts of switchgear for overhauling, and consequently the necessary work could only be carried out under difficult and dangerous conditions. It seems extraordinary that in any such works isolating switches and similar devices should have been omitted. Another point is that electric motors are still to be found without terminal boxes, and consequently loops of unprotected cable are left where they are liable to damage. An interesting minor development, to which Mr. Ram calls attention, is the provision of localised lighting in workshops by means of small 10-watt lamps, such as are used in motor-car headlights, with specially designed reflectors, attached to fittings having a universal joint so that the lamp may be placed in any position. Since the pressure is only 10 or 12 volts, being supplied from a small transformer, the wiring may be concentric, the metal tube of the fittings forming the return conductor, and being earthed at the transformer. This allows simple mechanical methods to be adopted, and excellent illumination can be secured, as high as 15 ft.-candles at a distance of 15 in. from the lamp. Moreover, with such a low voltage the system is extremely safe, and consequently has much to recommend it.

Regulations for Sky-signs.

We notice that, with the prospective revision of lighting regulations, the question of restoring the right to use illuminated sky signs on the Embankment is attracting attention. In view of the probable shortage of coal during the coming winter, it is thought probable that the restoration of these lights may not be sanctioned at present. On the other hand, sooner or later considerations of economy will no longer prevail, and the question arises whether pre-war conditions will apply to illuminated signs. Many people consider that elaborate and brilliant signs of this nature are a nuisance, and it is to be noted that the Advertisement Regulation Act empowers local authorities to frame by-laws to prevent advertisements impairing the natural beauties of the landscape. Presumably these powers could be applied to night signs. We are in agreement with those who dislike the undue prominence of such signs, which can hardly be considered to enhance the appearance of a city by night. During the war period their absence has been something of a relief. It seems unfortunate that, while there is invariably money to be spent on the use of light for these purposes, the employment of illumination for the beautification of a city by night would be considered by many to be an extravagance. In any case, we think that the erection of these signs in prominent places ought to be subject to supervision, both with a view to avoiding disfigurement and in order to eliminate glare likely to interfere with the guidance of traffic by night. There seems no reason why new signs, at least, should not be subjected to judicious control, so that advertisers may be encouraged to use light in a more artistic manner than in the past.

Faraday House "Journal."—The issue of this Journal for the Michaelmas Term contains, in addition to a number of interesting items of domestic news, an article on "The Temperature Coefficient of Copper" by the Principal, Dr. Alex. Russell. Attention is drawn to the difference between the constantmass and the constant-volume temperature coefficients.

Midland Electrical Engineers' Ball.—It has been decided to revive the Midland Electrical Engineers' Ball, which will be held at the Grand Hotel, Birmingham, on November 13th. Mr. R. A. Chattock has consented to act as chairman, Mr. W. Y. Anderson hon. treasurer, and Mr. G. J. Bish, hon. secretary. Tickets may be obtained from either of the foregoing. It is anticipated that the occasion will enable many old friends to meet again. All electrical engineers are urged to attend in order that the function may prove to be as great a success as those which have preceded it.

The Industrial League and Council.—This body, in which are incorporated the Industrial League and Industrial Reconstruction Council, has arranged for a series of lectures to be given on alternate Tuesday afternoons at 4.30, in the Council Chamber of the Guildhall. The first of these lectures was given last Tuesday by the Rt. Hon. G. H. Roberts, M.P. (Food Controller), on "Some Trade and Labour Problems," and was of particular interest at the present moment. Other lectures will be given by Prof. Ripper, Dr. Russell Wells, Sir Auckland Geddes, Sir George Paish and the Rt. Hon. Lord Emmott. Tickets for the series can be obtained on application to the Secretary, 66, Victoria-street, S.W.

Determination of Free Carbon in Rubber Goods.—A new publication of the Bureau ot Standards, Washington (Technologic Paper No. 136), summarises some experiments by Messrs. A. H. Smith and S. W. Epstein on the above subject. The method consists essentially in removing the rubber and much of the organic matter by treatment with nitric acid. Constituents other than carbon, which remain and would show ignition losses, are removed, in so far as possible, by treatment with various solvents. Because of the attack on carbon by nitric acid, the ignition loss represents about 105 per cent. of the carbon originally present. Thus corrected, the results, though not absolutely accurate, are sufficiently so for commercial work.

Choice of Varnish for Insulating Materials.—The Choice of varnishes for coils, &c., forms the subject of a note in the "Electrical World," slow-drying varieties being in general preferred. An important consideration is that the dielectric resistance increases directly with the length of baking or drying period, the slow varnishes imparting the highest degree of insulation and flexibility and producing a tough, flexible film which may also be depended upon for mechanical strength and extreme durability. Black varnishes are claimed to be better for work where a transparent coating is not absolutely essential because they produce a more flexible and highly insulating film than clear varnishes of the same class. Varnishes should not crystallise under prolonged vibration, and their mechanical structure should be elastic and homogeneous. A table giving the characteristics, uses, drying time and solvents of several varnishes is also presented.

Colouration of Arc Lamp Globes Under the Action of Light.—It is well known that arc lamp globes tend to assume a purple colouration under the action of light, a phenomenon due to the presence of manganese which is used to counteract the greenish colouration which would otherwise take place owing to the effect of ferrous salts in the glass. Mr. M. Luckiesh, writing in the "Electrical World," suggests that in specifications for arc lamp globes it should be prescribed that no manganese is to be used. This would avoid the colouring effect (which may involve ultimately 50 per cent. absorption), and for outdoor globes the slight greenish coloration would not be of great consequence.

Locating Sources of Oil by Electrical Means.—The idea of using current transmitted through the earth as a means of locating metal ores is familiar, the idea being that the greater conductivity of these metalliferous regions can be clearly indicated, and the area mapped out. The location of oil deposits, which according to the "Electrical Review" (U.S.A.) is now being investigated electrically, presents a converse problem. In this case the insulating properties of the oil diminish the current and oil-bearing regions are detected accordingly. In view of the great depth to which it is often necessary to bore for oil (which may exist simultaneously with an almost oil-free area above) the method would seem to have limitations, but it has doubtless possibilities in dealing with surface oil-areas.

Value of Photographic Records.—The "American Machinist" remarks that many American industrial concerns have been led to realise the value of photography during recent years. In connection with the Liberty Loan campaign and the Red Cross and other appeals many special decorative displays and unique exhibits were arranged, yet few records now survive. Photography is of great value as a means of circulating information regarding special mechanical contrivances. The cultivation of photography as a regular element in machine shop work is well worth while. Memory plays so many tricks that exact photographic records showing shop practice are often useful at a future period, especially in recording progressive changes in shop arrangements and preventing a return to methods which have been tried in the past and discarded.

Aluminium Production and Electricity Supply in Germany.—In a Paper by Dr. R. Tröger in the "Zeitschrift des Vereines deutscher Ingenieure," the production of aluminium, at the beginning and end of the war respectively, in units of 1,000 tons was estimated as follows:—Germany, 1, 40; Austria, 11, 25; England, 7·5, 12; France, 18, 20; Italy, 1, 7; Norway, 1·5, 16; United States and Canada, 28, 73. The development in Germany was thus exceptionally great, and many new plants have been laid down. In 1916 three large works were started, the Erftwerk, the Vereinigte Aluminiumwerk A.G., and the Innwerk, requiring 1,200,000,000 kw.-hrs. per year (43 per cent. of the whole electric energy available in Germany in 1913). To meet the heavy power demands several large electricity supply plants were coupled up. However, the charge on the capital invested is heavy and the general industrial outlook is serious. It is suggested that the State, already largely interested in the capital of the plants, will have to nationalise the electricity supply. All the large electricity supply stations which now feed aluminium works would then be interlinked, and neighbouring districts would take their supply from these united stations.

The Formation of Clouds by Aeroplanes.—As is well known, suggestions have been made at various times for the formation of artificial clouds by aircraft in order to conceal themselves from observers on the ground. The Zeppelins appear to have made use of this device by emitting specially generated smoke from the exhaust of the engines. Some recent experiments made by the United States Army, however, suggest that under favourable conditions the mere passage of an aeroplane through the air may result in the formation of a temporary cloud more or less surrounding the machine. The "Engineer," commenting on these experiments, remarks that the creation of such a cloud appears reasonable, for, given an appropriate degree of atmospheric humidity, it seems natural to expect that the local changes of pressure produced in the vortex and other disturbances in the air accompanying the flight of the machine would result in a temporary condensation of the atmospheric water vapour and the consequent formation of a "cloud." That the formation should be sufficiently marked to be observable at a distance, as apparently it has been observed, is more to be wondered at than that the cloud should be formed. It is stated that in the United States Army high-speed wind tunnel at Dayton the phenomenon has been noticed on a small scale, and that it is being applied instead of the usual smoke or lycopodium powder method to make the flight vortices visible to the human eye and the lens of a camera.

Apparatus for Determining the Presence and Amount of Combustible Gas in Air.—An interesting contribution to knowledge on the above subject, by Messrs. E. R. Weaver and E. E. Weibel, is included in a scientific Paper recently issued by the Bureau of Standards, Washington (No. 334). The detection and automatic indication of the presence of combustible gases in air is a problem of great importance in many industries, and several forms of apparatus for the purpose, based on the behaviour of a heated wire in contact with such gases, are described. The three chief forms are the compensated bridge indicator, the glowing wire indicator and the bimetallic indicator. The first-named device uses a balanced Wheatstone bridge made up of four platinum wires, two of which, on opposite sides of the bridge, are rendered inactive by a thin coating of some material not causing surface combustion. The bridge is unaffected by variations in room temperature, but is put out of balance by the presence of combustible gases which affect the temperature of the heated active wires. The glowing wire indicator merely uses two short lengths of platinum wire, one active and one inactive, supplied with current from a portable battery. By rheostats the currents can be varied, and the wires made to glow with the same intensity, but a difference is at once revealed when gas is present. The third device is a bimetallic strip, which is caused to bend by difference in temperature owing to the effect of combustible gases. The instruments and the theory on which they are based are discussed in detail, and the communication well deserves study by mining engineers and others interested in the subject.

Obituary.

We regret to record the death of Mr. B. A. Raworth, joint editor of "Engineering," which took place at Sutton, Surrey, on the 30th ult. Mr. Raworth was educated at Owen's College, Manchester, and served his pupilage with Messrs. Wren & Hopkinson. For a time he was private assistant and draughtsman to Sir Joseph Whitworth, and from 1872 to 1874 he was with Messrs. Siemens Bros. at Woolwich. In the latter year he joined his brother, the late Mr. J. S. Raworth, in developing cotton-spinning machinery. In 1880 he returned to London and joined the staff of Sir Lloyd Wise as chief technical assistant; in 1882 he became attached to the staff of our contemporary "Engineering," and in 1906 he became joint editor of that journal. From 1901 to 1904 he contributed a number of valuable articles on electrical subjects to "Traction and Transmission," a monthly supplement to "Engineering." Mr. Raworth was a member of the Institution of Mechanical Engineers, of the Iron and Steel Institute, and of the Institute of Metals.

Arrangements for the Week.

FRIDAY, Oct. 10th (to day).

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At the Shipping, Engineering and Machinery Exhibition, Olympia, London, W. Lecture on "Some Hydraulic Exhibits," by Dr. H. S. Hele-Shaw.

ELECTRO-HARMONIC SOCIETY.

8 p.m. At the Holborn Restaurant, London, W.C. Smoking Concert.

SATURDAY, Oct. 11th.

BIRMINGHAM & DISTRICT ELECTRIC CLUB.

7 p.m. At the Grand Hotel, Colmore-row, Birmingham Paper on "Notes on Private House Electric Lighting Installations," by Mr. C. M. Walter, A.M.I.E.E., and Mr. R. G. Marsh.

MONDAY, Oct. 13th.

ELECTRICITY SUPPLY COMMERCIAL ASSOCIATION

7 p.m. At Caxton Hall, Westminster, London, S.W. Mass Meeting will be held.

The Three-Electrode Thermionic Valve as an Alternating Current Generator.*

By Prof. C. L. FORTESCUE.

(Concluded from page 390.)

As a very good first approximation, which is good enough for most designing purposes the following assumptions may be made :—

(*a*) The power expenditure arising from the passage of the exciting current from the valve through the part *Ob* of the inductance may be neglected in comparison with the whole loss due to the main oscillating current.

(*b*) The power abstracted from the circuit to operate the grid may be neglected in comparison with the loss due to the main oscillating current.

(*c*) The resistance component of the voltage across each part of the inductance may be neglected in comparison with the reactance component; *i.e.*, the relative phases of the voltage and current may be taken as differing negligibly from 90 deg.

(*d*) The amplitude of the incipient oscillation may be assumed to be so small that the characteristic curves may be taken as straight lines over the whole range under consideration.

With these assumptions the conditions necessary for the maintenance of oscillations can be calculated easily. Let δI be the R.M.S. value of the incipient alternating current in the inductance. The corresponding R.M.S. voltage, δV, across the whole inductance is

$$\delta V = L\omega \, . \, \delta I \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

where $\omega = 2\pi$ times the frequency.

Let the voltage across the part aO of the inductance be some fraction of δV, viz., $a \, . \, \delta V$, and that across the part Ob some other fraction, viz., $b \, . \, \delta V$; the only limitations to a and b being

$$a + b \ngtr 1 \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (2)$$

Let k_1 be the rate of increase of the current at the positive electrode with respect to the increase of the grid voltage, and k_2 the rate of increase with respect to the voltage at the positive electrode. The alternating component of the valve current through the part Ob of the inductance is then

$$k_1 a \, . \, \delta V - k_2 b \, . \, \delta V.$$

If δW denotes the mean power supplied to the circuit, then

$$\delta W = b \, . \, \delta V(k_1 a \, . \, \delta V - k_2 b \, . \, \delta V)$$
$$= (k_1 ab - k_2 b^2)\delta V^2 \quad . \; . \; . \; . \; . \; . \; . \; . \quad (3)$$

With the foregoing assumptions, the power expenditure in the circuit is $\delta I^2 \, . \, R$, R being the effective resistance of the oscillatory cicruit.

The conditions necessary for a small oscillation to build up to a large one are, therefore,

$$(k_1 ab - k_2 b^2)\delta V^2 > \delta I^2 \, . \, R \quad . \; . \; . \; . \; . \; . \quad (4)$$

But $\delta I = \delta V / L\omega$, and so the condition becomes

$$k_1 ab - k_2 b^2 > R / L^2 \omega^2 \quad . \; . \; . \; . \; . \; . \; . \; . \quad (5)$$

And putting $\omega^2 = 1/LC$, which is nearly true, the condition reduces

to $$k_1 ab - k_2 b^2 > RC/L \quad . \; . \; . \; . \; . \; . \; . \; . \quad (6)$$

or $$Labk_1 > RC + Lb^2 k_2 \quad . \; . \; . \; . \; . \; . \; . \quad (6\text{A})$$

With power valves the term Lb^2k_2 is sometimes much greater than the term RC, and when this is the case the approximate conditions for the maintenance of oscillations become $a/b > k_2/k_1$, which is simply an expression of the requirement that the oscillation line must lie as shown in Fig. 10, and not as in Fig. 12.

Equation (3) is also of interest in that it gives a value for the "negative resistance" of the valve. Putting $\delta V = L\omega \, . \, \delta I$, the power supplied to the circuit is

$$\delta W = (k_1 ab - k_2 b^2) L^2 \omega^2 \, . \, \delta I^2$$
$$= \frac{L}{C}(k_1 ab - k_2 b^2) \, . \, \delta I^2.$$

from which it follows that the negative resistance is

$$R - = \frac{L}{C}(k_1 ab - k_2 b^2) \quad . \; . \; . \; . \; . \; . \quad (7)$$

The required condition for the maintenance of oscillations is that this negative resistance shall exceed the actual resistance, R, *i.e.*, that

$$\frac{L}{C}(k_1 ab - k_2 b^2) > R \quad . \; . \; . \; . \; . \; . \; . \quad (6\text{B})$$

which is identical with equation (6).

Assuming that the necessary conditions are compiled with, any small oscillation that may be started by the closing of a switch or by any other means, will gradually increase in amplitude. The corresponding oscillation line will lengthen proportionally and in course of time will extend into regions where the values of k_1 and k_2 are no longer constant throughout the whole of the cycle, and the alternating component of the current from the valve will be no longer a sine wave. This effect will be particularly marked when the oscillatory current reaches such a value that the voltage at the positive electrode is reduced almost, or quite, to zero at the beginning of the cycle. In consequence of this irregularity the power supplied to the circuit from the valve will increase less rapidly than the square of the current in the main oscillatory circuit. Stable conditions where the power supply is equal to the power expenditure will thus be reached quickly and no further increase of the current will take place unless the resistance of the circuit is reduced.

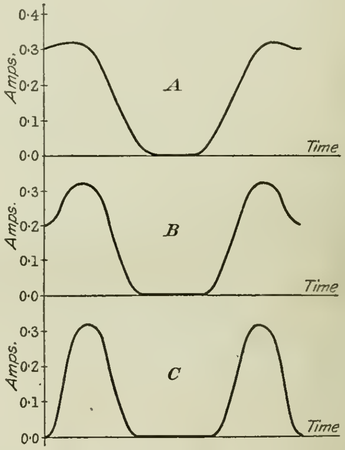

Fig. 13.

In Fig. 13 three cases have been taken. The circuit for which the curves are plotted consists of an inductance of 3,050 microhenries and a capacity of 3,000 cm., so giving a wave-length of about 6,000 metres. The connections to the valve are such that $b = 0{\cdot}26$, $a = 0{\cdot}04$, and the valve characteristics assumed are the same as those of Fig 10. The curve A has been drawn for a current of 3·7 amperes, which will reduce the voltage at the positive electrode to 700 volts at the beginning of the cycle. The power supplied to the circuit will be about 116 watts, and the current would be stable at this value if the resistance of the circuit was 11·8 ohms. In curve B a larger oscillatory current of 4·85 amperes is assumed, which would reduce the voltage at the positive electrode to 300 volts. A very marked kink is then appearing in the top of the wave of exciting current. The power supplied to the circuit will be about 137 watts, and the current would be stable at this value if the resistance of the circuit was 5·8 ohms. In curve C the oscillatory current has been taken as 5·7 amperes, which will just reduce the voltage at the posi-

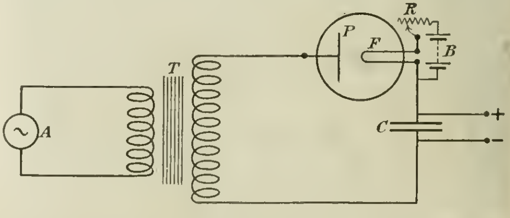

Fig. 14.

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*Paper read before the British Association at Bournemouth.

tive electrode to zero. Compared with the curve B the irregularity of the wave will be much greater, and the power supplied to the circuit will be reduced both actually and relatively, with the result that this current could only be maintained if the resistance was reduced to about three ohms. These curves show quite clearly why it is that with a valve generator the current increases but little when the resistance of the circuit is reduced, unless some alteration is made to the adjustments. They also illustrate a self-protecting property of the valve. If the load is taken off there is a a small increase in the current accompanied by a reduction of the main power taken from the supply. In curve A the mean current at the positive electrode is about 0·17 amperes, but in curve C it is only 0·12 amperes.

For the particular conditions in which the mid-point of the cycle of maximum amplitude is at the mid-point of the characteristics, the R.M.S. value of the exciting current from the valve is $\frac{I_e}{2\sqrt{2}}$, I_e being the saturation electron current; and the R.M.S. value of the voltage across the part Ob of the inductance is $\frac{V_0}{\sqrt{2}}$, V_0 being the steady voltage applied to the positive electrode.

The maximum power that can be obtained from the tube is then

$$\frac{I_e}{2\sqrt{2}} \cdot \frac{V_0}{\sqrt{2}} = \tfrac{1}{4} I_e V_0.$$

If I and V are the R.M.S. values of the alternating current and voltage in the oscillatory circuit, the stable maximum conditions are then approximately

$$I^2R = \tfrac{1}{4} I_e V_0.$$

But $I = \frac{V}{L\omega}$, and if the oscillation line just stops at the horizont axis, $bV = \frac{V_0}{\sqrt{2}}$

Hence
$$b^2 = 2\frac{V_0}{I}\frac{RC}{L} \quad . \quad . \qquad (8$$

This equation gives the suitable value for b, and the corresponding value of a for the maintenance of the oscillations follows from equation (6).

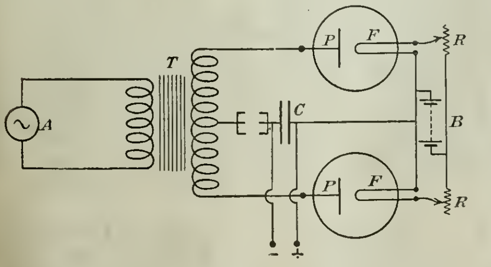

FIG. 15.

The average current taken from the supply is $\frac{1}{2} I_e$ at the steady voltage V_0. Hence the efficiency of the valve neglecting the power supply to the filament, is 50 per cent.

This, however, is by no means the highest possible efficiency Any arrangement of the valve and circuit that leads to an irregular wave of current giving a considerable power to the circuit but having at the same time a low arithmetic mean will give a much higher efficiency than 50 per cent. If a steady negative voltage is applied to the grid so that the midpoint of the cycle is towards the bottom of the characteristics, efficiencies up to as high as 75 per cent. can be obtained. A battery may be used for this purpose, but the circuit shown in Fig. 8 is preferable. Here the small rectified current from the grid passes through the resistance R_3 and so automatically maintains the grid at a negative voltage depending upon the amplitude of the oscillations.

This theory of the action of the circuits is applicable to any form of circuit. If, for example, a mutual coupling to the grid is used, the grid voltage can still be expressed as a fraction of the voltage across the main inductance. If M is the mutual inductance, $a = \frac{M}{L}$ and the condition for the building up of the oscillations is

$$Mbk_1 > RC + Lb^2k \quad . \quad . \quad . \quad . \quad . \qquad (9)$$

4. A SHORT DESCRIPTION OF CERTAIN VALVE TRANSMITTING SETS USED FOR W/T IN THE NAVAL SERVICE

Most of the valve-transmitting sets in the Naval Service have been designed to work as far as possible from the power supply of existing spark telegraphy sets. This power supply is in the form of a high voltage single-phase alternating current, of frequency from about 100 cycles per second upwards. To use this supply it is necessary to fit rectifiers which will convert the alternating supply into a direct current supply. The rectifiers used are two electrode valves differing from the three electrode valves only in that the grid electrode is omitted. Fig. 14 shows a simple method of connecting up a two-electrode valve for this purpose. During the half-cycles when the positive electrode P is positive to the filament, negative electrons are drawn from the filament. During the other half-cycles no reverse current can pass. Consequently there is a deficit of negative electrons on the plates of the condenser connected to the filament of the valve. The terminals of the condenser C can then be used as a direct-current supply. By increasing sufficiently the capacity of the condenser the uniformity of the direct-current supply can be increased to any desired extent. The numerical relationships of rectifiers of this type have been given recently by the author.*

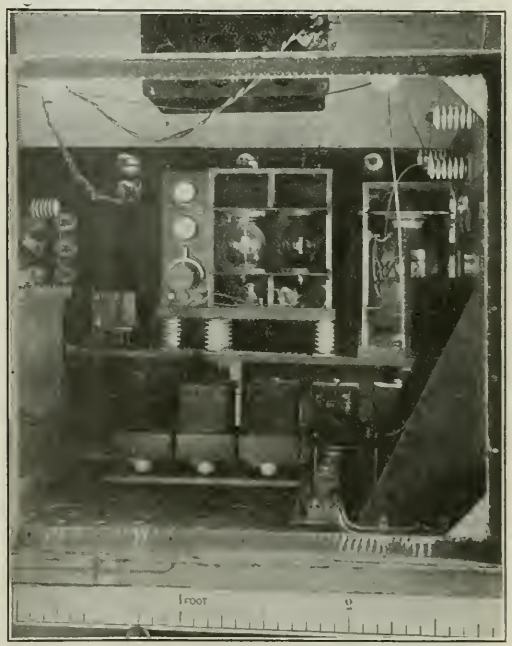

FIG. 16.

An improvement on the simple circuit of Fig. 14 involving the use of two valves, has generally been used. Fig. 15 shows such a typical circuit arrangement. With this system one valve is operative during each half-cycle and for a given uniformity of the direct current supply, the capacity required in the condenser C is much less. The facts that the mid-points of the secondary windings of the spark set transformers were already connected to earth, and that the whole secondary voltage was usually in excess of that required for the valves, were additional reasons for the adoption of the two-valve system.

For the oscillating circuit, two systems have been used; one in which the aerial has constituted the capacity in the circuit, and the other an arrangement of coupled circuits, in which the aerial circuit is separately tuned and is loosely coupled to an oscillating circuit connected to the valve.

When using the aerial as the capacity, the circuit arrangement is as shown in Fig. 8 with the addition of the necessary switch for the control of the oscillations in accordance with the Morse signal to be sent. This switch has to perform two functions, viz., to break the primary supply to the transformer and to throw the earth connection of the aerial coil over to the receiving instruments. Magnetically-operated switches have generally been used for this purpose which are controlled by the operator in the receiving compartment by a single Morse key of the ordinary type.

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* Paper read before the Physical Society of London, June 27th 191

Figs. 16 and 17 are photographs showing the general arrangement of one of the valve transmitting sets used in the Naval Service.

In the centre of Fig. 16 are the two rectifying valves with the controlling rheostat and instruments on the left; the whole unit being mounted on porcelain insulators. The alternating supply from the spark set comes in on the extreme left, where parts of the spark set actually appear in the photograph. Below the rectifier unit are the four condensers used for smoothing out the current from the rectifiers. The single oscillating valve is placed to the right of the rectifiers and appears on the extreme right of Fig. 16. Fig. 17 shows the additional apparatus required to couple the valve to the existing aerial circuit, together with a further view of the oscillating valve on the left. In the centre of Fig. 17 is the grid coupling coil. One part of this is connected in series between the aerial tuning inductance and earth. The upper part is connected to the grid, and in this set a variable condenser is used in parallel with this inductance in order to tune the grid circuit. The cylindrical object at the back of this condenser is the resistance R_3 of Fig. 8. The small magnetic switch in the front of Fig. 17 is the switch changing over the aerial connections from the earth connection to the receiving instruments in the interval between the Morse signals.

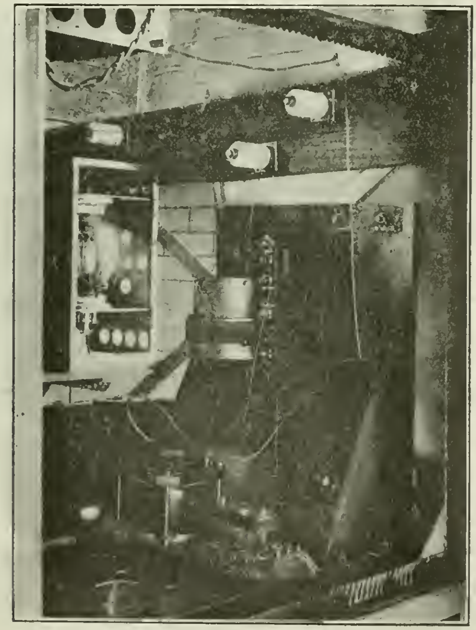


Fig. 17.

Fig. 18 shows the complete set of additional apparatus required for use with a much more powerful spark installation.

The complete rectifier unit is on the right, with the smoothing condensers below.

Three oscillating valves are used in parallel, the three filament regulators being situated immediately beneath them.

The grid coupling coil and grid circuit tuning condenser are in the centre on the left, and the R_3 resistance is in the left-hand top corner. At the bottom on the left is the alternator field regulator, and between it and the smoothing condensers are two transformers supplying the filament current for the valves.

In conclusion, the author would like to add a word of thanks to the staff of the W/T Department of H.M. Signal School, Portsmouth, for the assistance given in the preparation of this Paper.

The Limiting Voltage for Underground Cables.

By F. FERNIE.

The conclusions reached in Dr. Russell's 1907 I.E.E. Paper, "The Dielectric Strength of Insulating Materials," are commonly applied to impregnated paper cables, although it is stated in that Paper that they apply only to isotropic insulating materials; now the insulation of paper cables is essentially æolotropic. It is, therefore, not surprising to find that the breakdown law of paper cables does not obey the theory for isotropic materials, which makes a cable having a conductor of relatively small diameter have a lower breakdown value than one with a larger conductor, both with equal thicknesses of insulation. Dr. Russell himself quotes an experiment of Jona, illustrating this point, for which, however, he found an ingenious explanation. (Compare also experimental results of Dr. M. Klein, The Electrician, Dec. 26, 1913.) Impregnated paper, in fact, behaves in the same way as air, when (air) is tested between a wire stretched inside a cylinder and the cylinder. Air is found when tested in this way to have an apparently greater strength next to a wire of small diameter than next to one of a (relatively) larger diameter. Fig. 1 shows a curve of the average R.M.S. values of the breakdown voltage of a number of single cables plotted against sectional area of conductor, all the cables having the same thickness of insulation. These values were obtained with the voltage raised quickly. In Fig. 2 is plotted the "visual" or "corona" voltage of air on a wire stretched inside a cylinder (*see* The Electrician, Oct. 10, 1913). The similarity between the shape of the two curves is obvious and an analogous result to Fig. 1 is obtained with three-core cables.

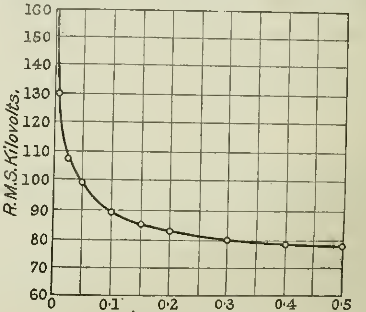


Fig. 1.—Breakdown of Single Cables.

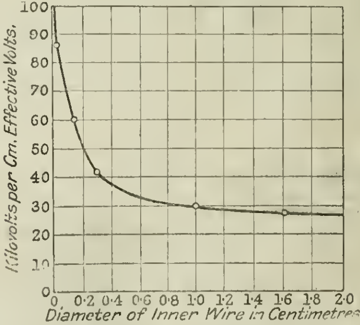


Fig. 2.—Corona Voltage of Air. Mean Results obtained by Ryan, Watson, Whitehead, Peek and Petersen.

There is an interesting theory to account for the behaviour of air in Peek's book, "Dielectric Phenomena"; it may also be that air, when subjected to an electric stress, becomes striated or æolotropic. Whatever may be the explanation of the behaviour of a paper cable, the conclusion that appears first to emerge is that very high voltages might be used for underground transmission, provided the conductor is made sufficiently small. Thus a cable made of a single No. 14 S.W.G. conductor with 0·5 in. of radial insulation might have a breakdown voltage of over 300 kv., and work at a pressure of 60 kv. to 100 kv. with a factor of safety against surges, &c., of three or more. Three such cables carrying 10 amperes and working at 100 kv. forming a three-phase circuit would carry between 1,300 kw. and 1,400 kw., with a power factor of 0·8. There would, of course, be a big drop in pressure in a long line. But whilst the cable considered above might withstand 300 kv. for a few minutes it would get so hot through energy losses in the dielectric if this pressure were maintained, as inevitably to break down. It is on account of the dielectric energy loss, which increases as the square of the voltage, that the limiting pressure for underground cables is not likely to be greater than 100 kv., and with cables as at present constructed is in the neighbourhood of 60 kv. This latter figure is a conservative estimate of the maximum value, and 100 kv. appears to be by no means out of the question with small conductors.

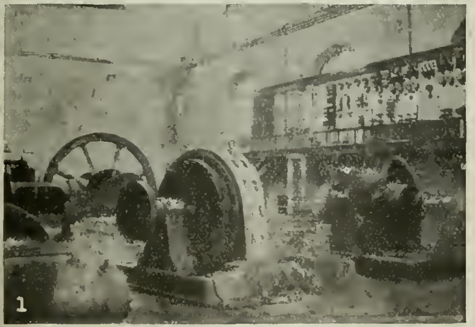
In The Electrician of April 4, 1913, is an account of the cables used for a 60-kv. single-phase transmission line between Dessau and Bitterfeld. Two single paper cables were used, each with a sectional area = 100 sq. mm. (0·155 sq. in.) and a radial thickness of insulation equal to 13 mm. (0·507 sq. in.). The frequency was 16·6. Each cable had an effective pressure of 30 kv. between conductor and lead. The loss in the dielectric was 0·23 kw. per kilometre: each cable being 1·3 km. long, the total loss was about 2 kw. The rise in temperature due to this loss was rather more than $\frac{1}{2}$°C. Also a test piece of the cable was subjected to a pressure of 55 kv. for one month, and the rise in temperature was only about 2°C. The temperature rise on this cable, due to the dielectric losses, seems very low, and encourages the belief that 100 kv. might be used.

Destruction by the Germans in Northern France.

The accompanying illustrations, which are reproduced from photographs by Major S. Utting, give some idea of the wanton destruction carried out systematically by the enemy on his retreat during our last offensive.

Figs. 1, 2 and 3 show the engine room of the well-known engineering firm, the Société Française de Constructions Mécaniques (Anciens Etablissements Cail), at Denain, about 5 miles from Valenciennes, which employed about 5,000 hands in pre-war days. The well-equipped shops were used by the enemy chiefly as an ordnance repair depot during his four years' occupation. Machines, tools and large stocks of materials were transported to Germany, which in the circumstances, may be excusable; but not so the deliberate wrecking of buildings and machinery which could not be easily removed. Charges were exploded in the windings of large electrical machines, under bedplates of engines, &c., and under the stanchions of the main buildings, &c. The travelling cranes in the various shops had one end on the ground, the main track having been removed on one side and the crane then set in motion.

Fig. 4 is a general view of the Forges de Denain et Anzin, a neighbouring steel works, having a pre-war output of 350,000 tons of steel per annum.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Figs. 1, 2, 3.—Power House, Cail. Fig. 4.—Forges de Denain et Anzin at Denain. Output 350,000 tons Steel per Annum.

The fine electric power house of the Mines d'Anzin presented even a worse spectacle than those shown, though this was, perhaps, largely due to artillery fire. In this case a 2,000 kw. alternator was uncoupled from the turbine and about to be slung for transportation to Germany when the Boche officer in charge fouled a stray Canadian shell. The Canadian advance at this period made the transportation impossible, so, as in the other cases, destruction was resorted to.

The Shipping, Engineering and Machinery Exhibition at Olympia.

(Concluded from p. 397.)

Second Notice.

It is indeed unfortunate that this, the first engineering exhibition in London since the outbreak of war, should have been marred from the attendance point of view by the railway strike. Those engineers living in London will find that a visit amply repays the trouble taken in getting there, and we hope that provincial engineers may yet be able to get to London before the exhibition closes on October 17th. On almost every stand something could be found worthy of mention, and had space permitted our descriptive list would have been considerably extended. Now that the strike has been settled we hope that the exhibitors and management will be rewarded by a large attendance.

Beckett, Laycock & Watkinson, Ltd. Stand 67.—This firm exhibit a series of their window fittings for motor cars, electric vehicles, boats, &c. The underlying principle of "Becklowatt" windows is a balance arrangement for taking the weight of the window. They are also showing their frictionless ball race runners for sliding doors, cupboards, laboratories, &c.

Allen West & Company, Ltd. Stand 76.—Here are to be seen a very representative range of drum-type A.C. and D.C. controllers, the fingers of which are of the mechanically hinged type, with compression springs, and fitted with heavy renewable contact tips. The D.C. patterns are fitted with suitable "blow-out" gear. The apparatus is well finished and liberally designed throughout, both mechanically and electrically. Another feature which attracted considerable attention was a large 36 in. circular lifting magnet hoisting scrap from a large water tank, the magnet being operated by a contactor controller and master switch.

Edison Accumulators, Ltd. Stand 78.—A complete house-lighting plant under working conditions is exhibited on this stand, the fact that a special accumulator room is not required for Edison batteries is made the most of: together with the additional advantage that the batteries do not depreciate when left, say, in a country house, during the winter. Demonstrations showing the construction of the battery are given at intervals.

Atlas Preservative Company, Ltd. Stand 104.—Striking evidence of the efficacy of Atlas "E" boiler preservative in preventing corrosion, grease and scale is shown by two boilers which are exhibited in such a way that the tubes can be withdrawn for examination. The difference between the boiler which has been treated with preservative compound and the one that has not been treated is very pronounced. They are also exhibiting a compact portable apparatus to enable engineers responsible for steam plant to test the boiler water, and determine with accuracy the proportions of soda or other re-agents to be used to counteract scale forming solids in the water.

British Electric Vehicles, Ltd. Stand 124a.—Standard patterns of B.E.V. electric industrial trucks are on view. We understand that they are manufactured in five different standard patterns and capacities, or will be made to suit special requirements if required. Particular care has been taken to produce a truck which could be operated without risk by unskilled workpeople, and one which would withstand rough usage and hard wear.

Alloy Welding Processes, Ltd. Stand 144.—Demonstrations are given with a single unit motor generator welding set, the generator of which is specially designed for welding purposes. This particular set has been designed for D.C. supply and for use in connection with tramways and light railways. The plant complete weighs but 32 cwt., and therefore is quite portable when mounted on a small truck. A semi-portable A.C. welding plant, consisting of a static transformer, special reactance coil and switchgear is also shown on the stand. Special demonstrations are made with "A.W.P." composite alloy electrodes for welding manganese and high carbon steels. These electrodes mark a new development in electric welding and are the result of five years' research and experiment. The results obtained so far with manganese and carbon steels are very encouraging and it is hoped to develop the process further with a view to its application to chrome, vanadium and other alloys.

Tok Manufacturing Company, Ltd. Stand 180.—The British-made rotary snap switches as manufactured by this firm are displayed and indicate that, given the support which this attempt to develop or recapture an industry formerly almost entirely American deserves, there is no justification for the use of foreign-made snap switches on heating and cooking apparatus, or in connection with the control of half-watt circuits. The switches are well made and finished, and are entirely manufactured in this country.

The Fuller Engineering Company. Stand 235.—The central station engineer will see much to interest him at this stand in the form of data sheets and diagrams demonstrating the economies to be obtained by the use of pulverised fuels.

Victory Dynamos & Motors, Ltd. Stand 278.—This firm are exhibiting two 40 h.p. shunt-wound motors coupled back to back and mounted on a bedplate and running under Hopkinson test conditions. Also two 20 h.p. shunt-wound motors under similar conditions.

Sparklets, Ltd. Stand 282.—The finish which this firm obtains on die-castings has long since established for them a sound reputation for this class of work and in passing engineers should take the opportunity of inspecting the specimen castings exhibited. The use of die-castings is open to considerable development with a view to obtaining rapid production and reducing works costs by eliminating drilling and machining operations and the consequent cost of special jigs.

The Electric Appliances Company, Ltd. Stand 12.—This stand exclusively displayed "Imperial" vacuum cleaners, which are claimed to be the smallest and most effective type of cleaner at present manufactured. They were certainly very effectively demonstrated by placing flour under a carpet and drawing it through the carpet by means of these cleaners. The machine is well finished and seems to be sufficiently substantial in design to withstand hard wear.

Roadcraft Engineering Company. Stand 16a.—This firm are the manufacturers of the T. W. electric truck, designed for the indoor transport of goods. Various sizes are made ranging up to 2 tons capacity, above which capacity it is not considered advisable to go because the cost of loading and unloading larger size trucks proves to be more costly than running extra journeys with a smaller truck. The main features of the design, after strength and travelling power over trackless floors and surfaces have been considered, are accessibility of parts and simplicity of operation. The motor, battery, controller or brakes can be dismantled in three minutes for the purpose of inspection or adjustment. The axles are made of nickel steel and the chassis and other component parts are made from steel or steel alloy. The truck can be turned in its own length and can be turned without backing. The battery is guaranteed for two years subject to periodical inspection by the makers being permitted during that time.

United Water Softeners, Ltd. Stand 51.—Here are displayed the latest types of water softening and exhaust steam-heating plant, together with labour-saving accessories. Two types of water softening plant are shown in operation :—

(*a*) A full size Lasses-Hjort water softening plant.
(*b*) A complete "Permatit" water softening plant.

Boulton & Paul, Ltd. Stand 57.—The main feature of interest is a particularly neat type of 1 kw. radiator cooled petrol-driven electric lighting set for country houses, &c.

The Power Plant Company, Ltd. Stand 68.—Those interested in gears always look with admiration at the products of this firm. The gears exhibited mainly apply to marine and to turbine work. In addition, there are a number of interesting photographs of typical gear units manufactured by this company.

Arthur Lyon & Wrench, Ltd. Stand 77.—A representative display of domestic electric lighting and heating appliances together with a Lyon-Brotherhood lighting set, comprising petrol engine, dynamo, switchboard and battery. In addition, the firm's standard types of D.C. motors and dynamos are also shown.

Igranic Electric Company, Ltd. Stand 92.—These specialists in electric control gear for all purposes are exhibiting a very wide range of their apparatus, amongst which the following attracted our attention :—A 59 h.p. control panel for machine tool control, arranged for individual motor drive under master push button control; a 15 h.p. "Conspede" pillar type motor control panel; a Telfer crane equipped with unit type electric lifting magnet. A machine for winding cores for electromagnets, and also a machine for testing coils in operation; a range of self-acting electric motor-starting rheostats for D.C. motors, and squirrel-cage and slip-ring induction motors.

The British Westinghouse Electric Manufacturing Company, Ltd. Stand 101.—This exhibit was confined to marine steam turbines consisting of a high-pressure turbine cylinder, a low-pressure turbine rotor, and a selection of nozzle boxes, blades, &c.

The Electric Suction Cleaner Company. Stand 139.—The various demonstrations of the "Premier" Portable Electric Cleaner, over 400,000 of which are stated to be in use, attracted a good deal of attention, despite the thin attendance caused by the strike. These machines are well finished and are guaraneted for 12 months. Special attention has been paid in design to obtaining a thoroughly efficient and reliable motor.

Fry's (London) Ltd. Stand 176.—The workshop superintendent or stores manager will find much to interest him here in the representative display of engineers' tools which are exhibited. The "Rededa" Ratchet Braces, provided with detachable handles to enable the brace to be fitted up with ease in cramped spaces. The brace can be operated with either the left or right hand, and the detachable lever acts at the same time as a spinner on the nut when getting up to the work. Machine tools of various types are also shown.

Petters, Ltd., & Vickers-Petters, Ltd. Stand 182.—This firm were exhibiting a 2½ H.P., a 5 H.P. and an 8 H.P. Petter Junior Engine suitable for agricultural machine driving or for couplings to dynamos, pumps, air compressors, &c. In each case the engine starts on petrol and runs on paraffin, giving low operating costs. Three models are made of each size—stationary, portable and semi-portable. In each case magneto ignition is employed. There were also exhibited an 18 H.P. Vickers-Petter semi-Diesel crude oil engine, and a 76 H.P. Vickers-Petter direct reversing marine crude oil engine. All these engines seem to be very well built, liberally designed and start very easily. The design has been simplified as far as possible with a view to permitting operation by unskilled labour.

Greenly's Ltd. Stand 204A.—The advertising pages of the various trade journals are decidedly improving, and the tendency to employ skilled assistance in the preparation of engineering publicity matter is rapidly growing. Those contemplating employing such assistance will be interested in seeing the various specimens of advertisements, leaflets, booklets and illustrations which are displayed on this stand. Messrs. Greenly's, Ltd., have evidently solved the problem of combining a knowledge of engineering with the technique of advertising.

G. D. Peters & Company, Ltd. Stand 217.—Frequent demonstrations are given of the Wilson Plastic Arc Welder, a very interesting system of arc welding developed in the U.S.A. during the war, where it was employed in making repairs to interned German liners. There is not space to give a detailed description of the operation of this system or the principles on which it is based, but we would certainly recommend anyone interested in electric welding to make a point of seeing a demonstration of this system. The method of operation is such that a constant temperature is ensured and the system can be applied to welding any metal in bulk.

Portable Electric Motors (1919), *Ltd.* Stand 286.—An interesting exhibit of small power portable motors, ranging from ⅛ H.P. to 6 H.P., and suitable for drilling, reaming, buffing, &c. They are very light in weight in proportion to the power developed, and will turn on either alternating or direct-current supply systems.

Greenwood & Batley. Stands 315 and 316.—The stands are devoted to an exhibit of a small De Laval steam turbine ship lighting set, which sets are made suitable for all classes of craft, from tugs to mammoth liners. It is claimed that they have a very low steam consumption combined with close speed regulation, and are easily erected or dismantled. An automatic lubricating system is fitted. The dynamo is driven through a ten to one gear.

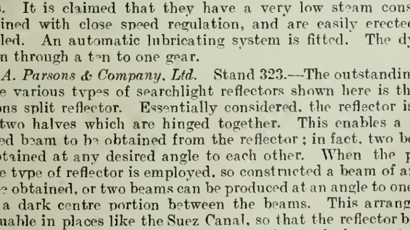
C. A. Parsons & Company, Ltd. Stand 323.—The outstanding feature of the various types of searchlight reflectors shown here is the special Parsons split reflector. Essentially considered, the reflector is divided into two halves which are hinged together. This enables a single or divided beam to be obtained from the reflector; in fact, two beams can be obtained at any desired angle to each other. When the parabola-ellipse type of reflector is employed, so constructed a beam of any width can be obtained, or two beams can be produced at an angle to one another with a dark centre portion between the beams. This arrangement is invaluable in places like the Suez Canal, so that the reflector beam does not dazzle the pilot on an approaching vessel, yet the buoys at the sides of the canal are illuminated.

Fyfe, Wilson & Company. Stand 82A.—This firm are exhibiting a standard range of petrol or paraffin engine generating sets, portable and stationary, suitable for country house lighting, arc welding, &c.

Heating and Cooking Exhibits

So far as electrical firms are concerned, those manufacturing heating and cooking appliances were certainly well to the fore, and this portion of the industry was well represented. Until the railway strike occurred the attendance was good, and it was noticeable what a considerable amount of interest this class of apparatus aroused.

Bastian Electric Company, Ltd. Stand 244.—A representative display of various types of Bastian electric fires fitted with the company's standard pattern of quartzalite glowers. All the frames of the fires are of the cast type and substantial, switches being mounted at the base and arranged to prevent abuse by the habit of switching with the feet. The terminals are also mounted at the base and enclosed with an effective housing to prevent accidental contact. A new type of heater for use in warming small spaces or boiling a kettle, &c., was noticed and is shown in the illustration. A 500 watts standard quartzalite element is mounted horizontally in an iron frame and within grooves fixed at the top of this iron frame is mounted a polished copper well-shaped reflector. The reflector has the effect of efficiently distributing the heat rising from the element.



New Type of Bastian 500 watt Heater.

We also noticed an American "Boss" oven fitted with Bastian quartzalite radiant elements. The oven has a sheet-metal frame, air-lagged, and the elements are mounted on the back and on the top. Heat control is provided for by means of two three-heat rotary type snap switches. The consumption of energy at high heat, all elements in circuit, is 4 kw.

We are given to understand that in place of silver soldering the element wire to the terminal connector, a process of arc welding is now employed and has been found to give better results. Another piece of apparatus to which we have not previously referred is the Bastian water heater. This essentially consists of a copper tank fitted with an adjustable ball-valve inlet water feed. Heating is obtained by means of an element mounted on a tray which slides in under the base of the tank. It is intended to be left continuously on circuit and will provide about 70 gallons of hot water each week. The loading of the element is 500 watts. The Bastian combined electric furnace and magnetic detector, which we recently described, is also exhibited.

Belling & Company. Stand 305.—One cannot help expressing pleasure at finding a series of table cooking accessories, manufactured in this country by a British firm, and which will compare with similar apparatus produced in America. The neatness of design and finish of these accessories is certainly to be commended. The majority of these pieces of apparatus have been described in these notes on previous occasions. Two pieces of apparatus have, however, just been shown at this exhibition—the "Sunflower Heater" and the "Dainty Fire." The first consists of a 500-watt radiant element mounted in a spun copper bowl reflector which is supported by a swivel mounting on a cast-iron base. The bowl, if desired, can be swung to a horizontal position when the heater can be used for boiling purposes. The Dainty Fire consumes 1 kw. and is also a radiant heater. The frame is rectangular in shape with cast front and an attachment is provided so that the heater can be placed in a horizontal position for use as a boiling plate. In addition to the articles mentioned there is a very good display of various patterns of Belling fires, cookers, grills, &c.

The Quain Electric Company, Ltd.—The active appearance of this stand immediately attracts attention. Kettles are a-boiling and steam is issuing forth from pails containing water, heated with immersion heaters. In addition a number of "Thermaglo" Electric Fires with radiant elements are in operation. The quartz type of immersion heater, previously described in these columns, has now been developed into a commercial pattern and is made in various sizes of which two are exhibited, one consuming 100 watts and suitable for heating small quantities of fluid, and the other consuming 1 kw. The element is contained in a quartz tube and the tube is protected by a nickel-plated heavy gauge wire guard. The element is of the radiant type and there is no danger of a "burn out" in the event of the heater being withdrawn from the fluid whilst on circuit. This was a very serious disadvantage with several types of pre-war immersion heaters.

The same type of element is fitted to a series of electric kettles of various capacities and supplied in polished copper or die-cast aluminium. The die-cast aluminium kettles particularly attracted our attention because of the way in which they have been so designed to facilitate cleaning. There are no sharp corners to accumulate dirt and grease. The fires are shown in various finishes, cast-iron matt black enamelled, cast-iron vitreous enamelled, and cast aluminium, the latter being a very attractive design. Further, the aluminium front does not make a rigid fire, but is light and therefore improves the fire where portability is a requisite factor in the choice. We understand that large export orders have been received for fires, immersion heaters and kettles, and that fires are being supplied for the Lyric Theatre and Strand Palace Hotel.

Falkirk Iron Company, Ltd. Stand 263.—The apparatus displayed on this stand is sufficient evidence that electric cooking has not only been applied to domestic purposes, but also on a large scale for canteen work. Here are to be seen two electrically heated roasting and baking ovens, mounted on legs to bring them to a convenient height, one oven being loaded to 5 kw., and the other to 6 kw. The latter is divided into two compartments and intended for pastry cooking. There are also shown a 5 kw. steaming oven, a carving table and bainmarie, and an electric range and boiling range. We intend to refer in more detail to some of these pieces of apparatus at a later date. A representative display of electric fires and table cooking appliances completes a very effective exhibit.

F. Husband, Ltd. Stand 268.—The main feature of this stand is the tiled pattern electric fire fitted with Woodhouse radiant elements. Two sizes are shown mounted in various coloured tiled frames: a three-bar fire consuming 2·4 kw. and provided with three-heat control, and a two-bar 1·6 kw. fire provided with two-heat control. A two-bar and a one-bar fire mounted in sheet metal frames are also shown.

Berry's Electric, Ltd. Stand 199.—Perhaps there is no other exhibit which so quickly attracts the eye of the passer-by than this stand, tastefully draped and furnished as a sitting room and containing a "Magicoal" electric fire. The resemblance of this fire to an ordinary coal fire is certainly very striking, and the illusory effect of a moving flame has been most successfully obtained. At the front of the illusory fire is mounted a radiant heater which can be utilised for toasting, boiling and simmering purposes. The cost will, to a certain extent, prevent the adoption of this fire at the moment on a large scale, but where expense is not a material item it certainly commends itself to consideration due to the fact that it so effectively satisfies the aesthetic desire for a flame fire.

Jackson Electric Stove Company, Ltd. Stand 180.—This exhibit reminds us of the development of the use of electrical cooking during war time in the Navy and comprises a complete line of such apparatus. Apparatus similar to that supplied to munition works for canteens, &c., is also displayed.

The Dutch Section.

This section of the exhibition comprises some 25 stands, occupying the centre portion of the hall and contained between specially designed walls. On the inner walls of this special section are displayed some very effective pictures of shipping, and the majority of the exhibits take the form of scale models of docks, ports, canals, ships, &c. The exhibit as a whole should give people who have not visited Holland a very clear idea of the shipping and distribution facilities which that country possesses. There are a number of representatives present to give information concerning the exhibits.

Official Visits and Lectures.

A number of official visits from engineering societies have been arranged, and of those which have not yet taken place there remain the following :—

Friday, October 10th.—Junior Institution of Engineers. Reception 4.15 p.m., tea 4.30. Lecture by Dr. H. S. Hele-Shaw at 7.30 p.m.

Tuesday, October 14th.—Institute of Marine Engineers. Tea at 6. Paper at 7.15, "Special Form of Ship's Keel, with Due Regard to Bilge and other Pipes," by E. F. Spanner.

Wireless Navigation for Aircraft.*

By Capt. J. ROBINSON.

1. The ordinary methods of navigation which are used for ships at sea are not sufficient for aircraft, as the conditions as regards drift are of an entirely different order. It is thus necessary to use some other means for determining position in the air. Drift is of a very large magnitude in the air, and by night or in fogs it is very often impossible to apply dead reckoning methods. The use of wireless bearings is the most hopeful method of progress, as bearings can be obtained with considerable accuracy.

The systems for determining bearings that were known at the beginning of the war were :—

(*a*) *The Single Coil Method.*—When such a coil is rotated about a vertical axis the intensity of the wireless signal varies from zero to maximum, being zero when the plane of the coil is at right angles to the direction of the incoming waves.

(*b*) *The Bellini-Tosi System.*—This system uses two fixed loop aerials at right angles to each other, the moving part being a small coil rotating between two coils at right angles which are in the circuits of the two fixed aerials.

(*c*) *The Tele-Funken Clock.*

2. There are two distinct methods of employing wireless bearings in order to determine position :—

(*a*) By the first method the machine transmits,and the direction-finding stations are on the ground. Each direction-finding station finds the bearing on the moving object and communicates its bearing to a central station. There the position of the moving object is worked out from the various bearings and re-transmitted to it.

(*b*) By the second method the moving object, either aircraft or ship, has its own direction finding apparatus, and finds bearings on fixed transmitting stations.

As regards aircraft, method (*a*) was used largely by the Germans. This method has considerable drawbacks; the first being that in case of war when the aircraft transmits to ask for its position—this is also disclosed to the enemy.

Secondly, only very few aircraft can be dealt with, as a considerable amount of transmission is required for a single aircraft to find its position. In consequence, it was decided to attempt to use method (*b*) in the British Air Service.

3. *Royal Air Force System.*—In attempting to apply direction-finding systems to aircraft it was found that considerable modifications to the known systems had to be applied. The single-coil and Bellini-Tosi systems are what are called minimum systems—*i.e.*, in order to determine the bearing, one finds the minimum by swinging the coil through this position until the signal is heard on both sides. On aircraft, as there is considerable extraneous noise, the region of this minimum is widened, and in consequence accuracy of the system diminishes. It is necessary to use a system where signals can be heard whilst the bearing is taken. The system devised is to use two coils at right angles which can be rotated together on a vertical axis. One coil alone is used first, and the system rotated to be somewhere near the maximum of this single coil. Then the second coil is introduced, and its effects added to or subtracted from those of the first coil. If the first coil is correctly on its maximum, then the second coil will be on its minimum, and thus there is no change of intensity on adding or subtracting the effects of this coil by a reversing switch. This method enables bearings to be taken whilst the signal is heard, and it is easy to see that it can be applied to any system which has hitherto been a minimum system. Having devised this system, there were other problems to be solved :—

(*a*) One was to obtain sufficient strength of signals. It was uncertain as to whether loops could be obtained of sufficient size to give loud enough signals to hear over the noise of the engine.

(*b*) *The Bellini-Tosi* system was considered to be too complicated, as at that time it was necessary to tune the two aerials to exactly the same frequency, and unless this system is very carefully installed fairly large errors are introduced.

4. It was hence decided to use the rotating-aerial system. This was done in two ways :—

(*a*) *The Wing Coil System.*—In this case the aerials are fixed rigidly to the aeroplane, which has to be rotated in order to determine the bearing. This system is particularly useful in the case of flying towards an objective where there is a wireless station. One particular example is where a wireless station exists at the aerodrome, and the machine can thus return home by merely heading to this wireless station.

(*b*) *The Rotating Coil System.*—In this case the rotating coils are placed in the fuselage and are rotated independently of the machine. This is particularly useful on the larger type of aeroplane, and enables position to be determined whenever a sufficient number of transmitting beacon stations can be heard.

5. Considerable difficulties had to be overcome to bring the R.A.F. system to a stage of perfection :—

(*a*) The extraneous noises on an aeroplane are considerable, but, besides, there is a far greater disturbing influence in the electrical disturbance due to the magneto. This produces considerable noise in the telephones, and cannot be overcome by amplification of signal strength. It is necessary to cut out this electrical disturbance. The cause of this disturbance was traced to the emission of very short waves by the magneto, the wave-length being of the order of from 5 to 30 metres. It is possible to use short wave stoppers to cut out these waves, but by far the most efficient method of eliminating this disturbance is to screen the whole magneto system.

(*b*) When using the fuselage coil system it was found that corrections had to be applied for the deviation produced by the metal work of the aircraft. These corrections can be determined by swinging the aircraft in a similar way to the swinging of a ship to adjust the compass

6. In addition to the preceding difficulties, there is another trouble in the variation of bearings produced by atmospheric influence. The extent of these variations is not large, possibly never more than about 3 deg. when using waves of 2,000 metres and upwards. The problem of this variation is one that should be investigated at an early date. The R.A.F. system of D.F., gives means for recording these variations very accurately. The sensitiveness of this system is under control, and depends on the ratio of the area turns of the two coils. It is possible to design coils so that the system is sensitive to ¼ deg. This is the case when the minimum coil has its area turns about eight times those of the maximum coil. With such a system it is easy to conceive an automatic arrangement so that the variations in bearings can be automatically recorded.

7. Excellent results have been obtained with the R.A.F. system of wireless navigation. A large number of flights have been made, and it has been found that the mean error of bearing is 1¾ deg. when using beacon stations whose distance varies from 20 to 500 miles. Under these circumstances, when three beacon stations are available, the mean error in determination of position was found to be 7 miles.

Flights have been made purely by wireless navigation. One particular flight was made from Biggin Hill to Paris and back from Paris to Brighton. In both of these flights the machine was above the clouds most of the time. Position was determined by wireless bearings, and the course was set or altered from these determinations. The navigator was in a position so that he could not look out of the aeroplane, and he was able to determine the force and direction of the wind and to forecast the time of arrival at his destination within two minutes.

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* Paper read before Section G of the British Association at Bournemouth.

Electricity Supply for Artisans' Dwellings.

By JAMES CLEARY.

The suggestions contained in the previous article published in The Electrician of August 8th appear to have been considered acceptable, judging from the appreciative comments, with perhaps one exception, the question of overhead v. underground cables, and the absence of criticism other than that from the confines of Bolt-court. Although it may not be possible to down the brace with one shot, the second barrel will easily account for this "grouse."

When lead-covered cables were advocated for this particular work, it was not suggested that overhead cables are unsuitable in every case, as most of the work done "for the duration" in fitting up camps, temporary hospitals, hutments, &c., was quite a success, and the conditions lent themselves admirably to this system. It is also acceptable, as often seen, in the case of a water-mill where current is generated for light only for the mill and adjacent miller's residence and workmen's cottages, in which cases the conductors are light in weight and comparatively short in length. Also in many cases on country estates where water-power is available and the requirements are confined to lighting a residence and outbuildings, the overhead cables need be of small section only; then, by taking advantage of the timber available on the spot, the whole environment lends itself admirably to this method. In the absence of water-power, the other conditions being equal, the installation of a small internal combustion engine-set will very well serve the same purpose. On the other hand, there are instances where the overhead method has proved anything but a success. Great discrimination is necessary when considering this question from the point of view of public supply. In a small compact village with little or no prospect of expansion a well-designed overhead system could be a success. But another village, straggling and with many intersecting roads a composite scheme might have many advantages. There are two instances not very far apart, where overhead schemes have been introduced, neither of which could be taken as a model for future schemes, but which on the other hand, can only continue by being remodelled on a composite plan.

In the first case a very picturesque old-time village of the straggling variety, where the connections have extended to its extremities, the demand has been such that the loss of potential occasioned is causing much inconvenience which in the circumstances is now difficult to overcome. A supplementary prime-mover would necessitate larger and heavier cables, which would in turn, require stronger and taller poles, and even then the line losses due to distance cannot be eliminated by any cheap method, overhead or other. The cable necessary to provide a remedy here is certainly a lead-covered cable of ample capacity laid underground. In the other case, a recent inspection revealed a state of things which, notwithstanding its humorous side, should in the name of efficiency be altered. This is an example of street lighting in the residential quarter of a well-known and historic town, consisting of the cheapest overhead cable system imaginable. One thing is quite evident, that in this case cheapness is not synonymous with economy, as the gas standard in every case has been ignored, and the thin end of a scaffold pole stuck near it in the pavement where a hole has been made to receive it. In some cases this was dispensed with in favour of an unpainted gibbet extending from the house to the edge of the pavement where the lamp is suspended. This example should be seen by every advocate of overhead wiring for all purposes. In some cases, having fallen down from its supports, the cable is within reach of schoolboys. Generally, it is supported on insulators of the simple order, but there are exceptions where it rests on the water-shoot. Some very pretty villas were negotiated by carrying over the roof, whilst at others attempts were made at concealment under the eaves; this was a delusion, however, as the spiders made it quite conspicuous by weaving webs like tennis-nets, which when covered with the morning dew did not add to the beauty of the carpet-bedding and the prim lawn in the garden. Perhaps the most curious thing seen was where the swallows in building their nests had enclosed the cables by building around them. Here again this attempt is at the end of its tether, and should never be repeated.

It is very doubtful whether overhead work can be recommended in any case where the supply is needed for hundreds of houses. In some cases the lay-out may be suitable for a composite scheme, but even then it must be approached with caution. Facilities must be given for other uses; this will necessitate cables of ample capacity which by a ring method can be accomplished with a minimum of copper, as the consumers who desire to use radiators or cooking devices can then benefit by any surplus available due to their neighbours using light only.

With regard to the criticism as seen through a "gas-mask," which obviously not only obstructs the view but limits the range, it should not be necessary to explain that the question —"Is all the air filtered that enters the room?"—like many of the others, is quite superfluous with reference to Brighton, as here it is usual to open the windows to admit pure air, and to use electricity to maintain it pure. The individual who scatters nails in the course of a motor car may be considered a benefactor by the man who repairs it, but it does not alter the fact that the whole operation is one of waste as regards time, material and opportunity, and if it should interfere with health it is the greatest waste of all. Whether a house requires redecorating oftener when gas is used as an illuminant can best be answered by those who have tried both electricity and gas rather than by one advocating the use of the latter only. If the economies mentioned in the previous article were beneath criticism it may be permissible to mention one other, much appreciated by the tenants—the saving of the rentals of the removed gas-fittings which is over £10 per annum.

This gas attack was quite unjustified as no mention of gas was made. Neither is it necessary, as electricity stands on an exalted plane by itself, and whether examined from the view point of health, economy or efficiency, it is the same result every time—the best. With regard to the personal question, *re* washing and changing clothes, this does not call for reply other than to state that this can easily be effected without donning "Memorandist's" (gas) mantle.

If the use of electricity is to be encouraged for all purposes in the artisans' dwellings of the future then it is necessary at the outset to remove all restrictions. The greatest of these is, perhaps, the need of the second meter and separate wiring. There is scarcely a supply undertaking that has not suffered through this cause. Then the question arises, if one meter can be dispensed with, why not both? There can be no difference of opinion with regard to the wisdom of removing the need for two meters, in the case of these small dwellings, both from the point of view of the capital outlay for the undertaking and the meter rents for the consumer. Add to this the saving to be effected in the installation it certainly seems that it is now opportune for a concentrated effort to be made by all concerned by which so much economy may be effected, and a permanent benefit obtained which will create more profitable work for the undertaking at a reduced cost to the consumer. If there are those who still persist in damming the stream of progress by adhering to the policy of two meters, and are not disposed to consider any alternative even to meet the case of the present house-building schemes, then in every such case the position is untenable. If, on the other hand, there is a real desire to eliminate the waste and loss of energy due to effete methods, they must be cut adrift without further delay. In advocating a remedy of this nature much opposition will be encountered, but so that this may be confined to as small an area as possible it should be clearly understood that what follows is intended to apply to new building schemes only. Most engineers are happy when there are prospects of lengthening the duration of the load. So happy, in fact, that in favourable cases special terms are conceded. These, as a rule, are a fixed price per kilowatt. The price must of necessity vary in different towns, and although it has been found expedient in almost every town to quote these special terms to an isolated power user, it is not usual to concede the same principle with the view of extending the use in private dwellings. In all probability £12 per kilowatt per annum would be tempting enough to make it worth while considering by most engineers. If this amount or less will suffice the rest is fairly easy. Once the price is fixed the consumer can use the current from the same wires for all purposes—lighting, ironing, cooking, heating or washing. It is only necessary to control the consumption of current. If the requirements in a house are for light only 200 watts may suffice; this would cost £2 10s per annum, which could be paid in advance monthly or quarterly, and this removes restriction No. 2—the need for a deposit. If additional light, with the use of a small iron be required, the allowance can be 400 watts at £5 per annum. A one-unit radiator and light could be used for £12 per annum, with facilities also for cooking, ironing, kettle boiling, &c. This seems so simple that it is a marvel that it has not become universal, instead of being restricted to a few experimental attempts.

What is necessary is a simple current controller which can take the place of two meters at the fifth of the cost of one. It should operate without the blinking effect, which is irritating; it should not only control the current consumption, but when it is put into action through overload it should automatically reduce consumption below the normal until the excess has been switched off.

This is all easily within the range of possibility, and if the only fault to be found is that the price per kilowatt named is too low or too high, that is easily adjusted. A scheme of 1,000 houses would effect a saving of about £4,000 for meters and all the incidental costs of reading and maintaining. Is there any evidence against it?

Starting of Asynchronous Motors by Means of Tertiary Eddy Currents.

By R. RÜDENBERG.

The first section of this Paper is devoted to a consideration of the usual methods of starting asynchronous motors and to questions connected with the design of the squirrel-cage type. There are also certain forms of construction on the market in which the motor is started automatically; here the starting resistance is gradually removed from the circuit either by an auxiliary motor, or by gearing connected to the main shaft. But the author considers these devices to be cumbrous, and thinks that it should be possible to construct asynchronous motors, which give a good torque at all speeds, and yet can be started without the necessity of any external mechanical agency and without the need of attention on the part of an attendant. Other starting devices are also mentioned. One consists in putting the starting resistance in the rotor, and cutting it out by centrifugal action. The increased resistance of the conductors at high temperatures has also been utilised, but this is not of much practical value. A more usual plan is to use two rotor windings, one of high and one of low resistance, the latter being cut out when the motor is at rest. The best suggestion of this nature is due to Boucherot, who imbeds the windings at different depths in the armature so that the resistance-winding possesses little induction and the short-circuit winding has high induction. But there is a considerable leakage between the windings, so that the characteristics of the motor are not particularly good. Similar results are produced by providing a massive iron rotor instead of building it up of different conductors. At full speed and low frequency the currents penetrate deep into the iron: at the start the high frequency causes the currents to flow only in a thin layer on the surface which has a high resistance. It is possible to solve the question of the distribution of these eddy currents. The slip of such an armature would be proportional to the square of the load if the permeability of the iron remained constant. Good results could be obtained if permeability and conductivity could be suitably chosen; unfortunately there is no suitable material of the kind that is required. Curves are given for a small motor of this kind; this shows that there is a considerable starting torque. For many purposes, *e.g.*, relays, this sort of rotor is quite suitable; but both slip and losses are very great and the teeth of the stator cause heavy pulsation losses.

It is now proposed to describe another method which uses the properties of the transformer with variable frequency, and let us suppose this to be inserted in the circuit of the rotor and not in that of the stator. The method is shown diagrammatically in Fig. 1. The secondary circuit of the motor is connected through a transformer with a tertiary circuit, in which a considerable resistance is inserted. When at rest, the rotor winding receives the full frequency of the network, so that the transformer produces a very small effect on the current. The resistance, which is not variable, produces almost exactly the same effect that it would do if it were directly connected to the slip-rings. It can, therefore, be of such a magnitude as to allow of the generation of a large starting moment. In the neighbourhood of synchronism, there is, however, a low frequency in the circuit of the rotor. The induction effect through the transformer is therefore lost, especially as the resistance is great in comparison to the self-induction. Under these conditions the only effect in the rotor circuit is that produced by the secondary conductor resistance, which is very small; so that the tertiary resistance can be regarded as being wholly without effect. The apparent ohmic resistance of this arrangement is, therefore, automatically dependent on the frequency of the slip. Let us consider Maxwell's formula for the apparent resistance, viz.:—

$$R_2 = r_2 + \frac{r_3(\omega M)^2}{r_3^2 + (\omega l_3)^2}$$

and construct the whole curve for the resistance of the rotor, and show how it varies with ω. This is shown in Fig. 2: we find over a

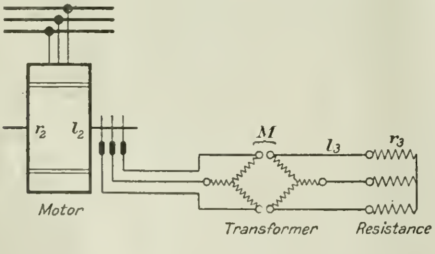

Fig. 1.—Connections of Proposed Arrangement.

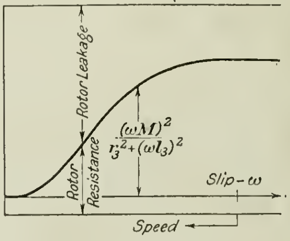

Fig. 2.—Relation Between Resistance and Slip.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," paper read before the Elektrotechnische Verein.

portion of the curve that the resistance varies more or less with the slip. Unfortunately there is a disadvantage attaching to this arrangement. Besides the resistance, the self-induction of the rotor circuit also varies considerably. When at rest this self-induction is quite small, seeing that the transformer can be so constructed as to have a low inductance and magnetising current. Let us suppose it to start and to have a low slip-frequency, under which conditions the induction coupling between the secondary and tertiary circuits will produce little effect. There is, however, the whole inductivity of the closed iron circuit of the transformer to be considered in its effects on the secondary circuit, seeing that the tertiary circuit does not react and weaken the field. From Maxwell's formula for the apparent induction, viz ,

$$L_2 = l_2 - \frac{l_3(\omega M)^2}{r_3^2 + (\omega l_3)^2},$$

we see that the rotor leakage can be represented in Fig. 2 by a similar curve with a different datum time. The effective rotor leakage is therefore very small at the start, but at full speed it is very considerable. The maximum torque will, however, be very small. Exactly similar effects are produced by inserting self-induction and resistance in parallel with the secondary circuit; this has been often suggested. Or the current may be controlled by iron starting resistances.

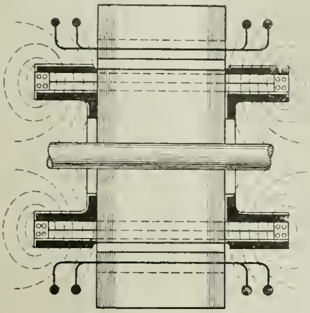

Fig. 3.—Proposed (Slip-ring) Form of Construction.

These plans, by which a transformer is inserted in the rotor circuit, has two disadvantages, viz., the great induction at starting, and the necessity for the employment of slip-rings. This latter difficulty can be avoided by using a transformer that rotates with the rotor; but this makes the motor more complicated. It is a better plan to abandon the use of a transformer altogether and to utilise the leakage field of the rotor, which exists in every motor and only acts harmfully by dissipating some of the work done by the transformer. As a matter of fact, at the start the leakage field is considerable and has a high frequency; it is, therefore, specially useful for producing induction effects. It is an extended flux, passing through air; it is, therefore, only necessary to expose broad masses of metal to its action in which the tertiary eddy currents can be formed. Fig. 3 gives an example, in which broad metallic rings are used, projecting at the sides; they can, indeed, be utilised for constructive purposes. It is still simpler to use the squirrel-cage form of construction, as shown in Fig. 4. On the left-hand side are seen the tertiary conductors, which fill out the whole of the slot, outside the secondary conductors, and on the right they are between the secondary conductors. The dependence of the active rotor resistance on the slip-frequency on this plan can be seen from the formula given above and follows a similar curve. The position of the curve can be made to depend on the choice of a suitable tertiary conductivity. If the tertiary conductivity is good the leakage field will be blown away too strongly at high frequency. With a low tertiary conductivity the formation of eddy currents at low frequency will be insufficient. The conditions are suitable for calculation in so far as the conditions of the leakage field are known; the problem is not very simple and yet it is soluble. It can be shown that the curve for the resistance most nearly approximates to a straight line, if the ohmic resistance of the paths of the tertiary currents is nearly equal to their induction resistance at the desired frequency. The leakage-voltage of rotors, constructed as shown in Figs 3 and 4, varies also with the frequency of the slip. It is therefore normal when the motor is running at full speed, but at the start it is markedly less.

Armatures, such as are shown in Fig. 3, have been frequently used. It is, therefore, reasonable to suppose that they will show this variable effective resistance. Measurements confirm this idea. A curve is given (not here reproduced) showing the results of tests on the rotor of an asynchronous motor of 1,200 kw., running at 1,500 revs. per min. The armature was removed from the stator, and supplied with polyphase current of variable frequency; the losses were measured by two watt-meters. The active effective rotor resistance, calculated from these results, is seen to vary in a marked way with the frequency. At 50 periods a second, the resistance is more than three times its value at 10 periods. Another curve is given for a 1,000-kw. machine, running at 1,500 revs per min.; and here again similar results were observed.

If we consider the usual squirrel-cage armature from this point of view it will be seen to be unsuitable for the production of strong eddy currents. The usual plan is to get a high starting moment by having a high maximum torque; this means a small leakage, especially in the rotor. Here we want exactly the opposite and to construct the rotors in such a way that eddy currents are formed as largely as possible. Drawings are given, showing suggestions for this purpose, and also the leakage that arises. The result of the reaction of the tertiary eddy currents on the secondary currents is that the current of each conductor, when the motor starts, is displaced outwards towards the mouth of the slot; consequently the current-density at this point rises, as also the effective resistance. If we desire to produce marked effects of this kind in this way, then the slots must be deep and narrow. If this is thought undesirable on mechnaical grounds, then another suggestion is made, also illustrated by similar drawings. Here layers of iron are imbedded in the copper conductors and these conduce to the sufficient formation of eddy currents, some with the ordinary form of slot. Owing to the concentration of the flux on this plan this may produce a specially good effect. The torque of the motor depends not only on the resistance but also on the leakage of the secondary winding. This leakage must, therefore, also be considered in judging of the suitability of any arrangement.

The author then proceeds to discuss suitable methods of construction and to give the results of tests on machines that have been made on these lines. But space cannot be found for the reproduction of this part of the Paper, which is partially concerned with theoretical considerations, arising out of the problem. Finally he compares the results given by his method with those shown by slip-ring and squirrel-cage motors. Curves show that the squirrel-cage machine has a very low starting moment with normal slip and high efficiency. The slip-ring method gives a good starting moment, but the controller must be worked by steps; the torque and current vary by jerks during the start, which are the more marked, the fewer the steps on the controller. The eddy current motor has a good starting torque, which during the period of starting does not fall below the normal value. It rises at high speeds to the value of maximum torque, and then the torque falls away in the neighbourhood of synchronism. This torque-curve appears to make the machine very suitable for many purposes. The starting current is certainly high, and the power-factor is rather lower than usual, especially in the case of low speeds and outputs. The high starting current ought not to be an objection in the case of large central stations, especially in industrial districts where strongly-built motors have to be used on heavy work. Even with slip-ring motors, it is possible to raise objections of a similar character. The eddy-current motor is considered likely to be suitable for many special cases, where the motor is required to start after the current has once been cut off. This is the case in textile, chemical and mining work, or in connection with centrifugal pumps and compressors It may also be used in the future for purposes of marine propulsion.

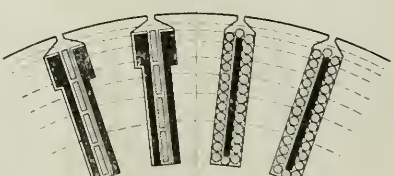

Fig. 4.—Proposed (Squirrel-Cage) Form of Construction.

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Our Future—and Canada.

"In no spirit of vainglory or of greed, but with full realisation of the solemn responsibility that the fact implies, and with recognition that international co-operation rather than international antagonism should be the future's watchword, every thoughtful American must perceive that as peace once more becomes established the United States will loom potentially if not actually the leading commercial nation of the world. . . . There remains of all the Great Powers only Great Britain to contend with the United States in fair and friendly rivalry for first place. Still, to rank below that great trading nation would be no disgrace, and enemy mischief makers will fail if they try to sow the seeds of national ill-will in business channels; but with our continental solidarity as against Great Britain's scattered empire, with our triumphant melting pot as against her millions of unassimilated population in India, and with our new merchant marine compelling enterprise by the fact of its existence, the elements in the case favour America." Thus wrote, on December 28, 1918, our esteemed and respected contemporary the "Electrical World," of New York. And this candid, dignified, fair-minded and eminently courteous statement is, we believe, in tune with the convictions of the great majority of thoughtful Americans.

What has Great Britain to say about it, and what is Great Britain going to do about it?

Every engineer and every other man of business who has Britain's welfare at heart, must face the position, must think, must speak and must act.

Are America's alleged advantages over Britain as real as they sound? The chief stress is laid upon America's "continental solidarity," as compared with Britain's "scattered empire." Yet this scattered empire, with its total area over four times that of the United States, contains two "bits," each larger than the United States. Australia is three per cent. larger and Canada is 20 per cent. larger.

The three and three-quarter millions of square miles of Canada and the three millions of Australia are not mere figures; they represent areas carrying a rich complement of resources of every kind; resources readily available, in a climate well suited to at least some sixty millions of our Empire's population.

We are confident that, in proper partnership with Canada, Australia and other dominions, Britain's great scattered empire has an assured world supremacy not only in commerce, but also in every other important line of progress.

At present Great Britain's relation towards these great partners falls short of "proper partnership," and immediate action is desirable. Canada is within sixteen hours by air and five days by water of London, and efforts ought first to be concentrated there. Again, Canada's practically unlimited water-power is being rapidly developed by the Canadian Government. There is thus immediate scope for the investment of large amounts of capital in every form of engineering industry. Business organisation in the Dominion is on the same up-to-date efficient lines as in the United States, and provided labour is procurable there is every facility for the rapid floating of new industries and for the distribution of products.

Can we do better than take our text again from the "Electrical World" of December 28, 1918? We read: "Canada can teach us much regarding the conservation of natural resources. Her water-power sites are not only surveyed; their economic features, capacities and in many instances costs of development are known as well. Moreover, in seeking to have these resources used the Dominion Government, while it affords reasonable protection to the public, at the same time offers suitable financial reward to private enterprise. *There is, however, little advantage for Canada to develop power which is transmitted to the United States.* . . ." But, later: "There are no indications that the Canadians object to *the joint development of the river* [the St. Lawrence, with its two million available horse-power] *by the Dominion and the United States.*" The italics are ours, for the point we wish to emphasise is this: That if Great Britain does not strenuously develop and cement her partnership with Canada the United States will cut her out—and that by means the most honourable and praiseworthy—in commercial ties and enterprise. Canada has developed along much the same lines as the United States, and it is useless for us to blink the fact that in some important respects in the world of commerce, construction and manufacture, Great Britain is behind the times in comparison with the States and with Canada. Not even the fact that this fact suffers great exaggeration can excuse us in neglecting it. It is of world importance to Great Britain and of national importance to Canada that there should be no possible question of outside partnership. It is useless to look to the politicians in this matter. The partnership is to be a business partnership. The influence of the politician will be important enough later. At present the chief aim of the politician should be to see that he does not hinder the work of the man of business. An unlimited supply of cheap power is the kind of foundation upon which a new nation might build up world supremacy. And it is an asset which can easily be made to ensure to an old-established and powerful nation like our own, not only the retention, but the continued enlargement of the supremacy already won.

It behoves the British and the Canadian Governments and peoples to get together vigorously on the development of what should be regarded as an imperial asset.

Review.

The Claims of Labour and of Capital. By W. R. Cooper, with a prefatory note by the Right Hon. G. H. Roberts, M.P. (London: Constable & Company.) Pp. iv.+84. 2s. 6d. net.

It would be impossible to find a more appropriate moment for calling attention to this important, interesting and well-devised book—at a time when the country's future so much depends on the relations between Capital and Labour.

Much has, of course, been written on the subject in one form or another, but here we have a dispassionate and unbiassed treatment on broad lines such as should serve a really useful end. The book is, perhaps, especially to be commended in that it lays stress on the absolute interdependence of Capital and Labour, and that a partnership between the two can only be carried on to advantage by a mutual cultivation of each other's confidence and interests.

Mr. Cooper considers (p. 14) that in the old days of small industrial firms "the link between Capital and Labour was much more human than it is to-day. Trade unions were not in existence, and the employers were known more or less personally to their men." This may be true to a great extent. Nevertheless, the reviewer has always felt that if, in piping days when Britain had practically a monopoly in many trades, some of our especially successful employers had been in closer touch and sympathy with those who had so greatly assisted them in amassing colossal fortunes—had, in fact, considered their well-being more by the introduction of co-operative principles, old age pensions, &c.—there would have been far less, if any, need for trade unions and similar organisations in the interests of the working man. Under such conditions, there would, at any rate, have been no opening for that highly harmful individual, the paid political agitator—the "skallywag" of labour—who, as a rule, has seldom done an honest day's work in his life.

This book is good reading in that it points to right-minded views as to the respective claims of Capital and Labour. It serves to show that, even apart from humanitarian considerations, it is, in the long run, in the best interests of the employer to provide so that those working for him are both well housed and well fed. On the other hand, it is also made clear that here it is not in the interests of the employee to begrudge his master any profit above a certain figure, if only because his own well being hinges on the prosperity of those he works for, the fact being that the public are never much disposed to subscribe capital to an individual concern in which the dividend is notably low. These, however, are only two out of many examples that could be quoted on each side by way of showing that the interests of Capital and Labour are really one. It is a vast pity that such truths have never been seriously appreciated. Their recognition would have saved the country as a whole from much trouble. Failure in this respect may be attributed in the first instance to the employers' over-concentration on speedy fortune making—together with lack of consideration for those helping him up the ladder of prosperity—and in the second instance to more or less excusable ignorance.

Mr. Cooper does well to draw attention to the different value of a given wage, owing to the difference in cost of living, in town and country. This, of course, at the same time, points to the desirability of works—preferably in healthy vicinities—being situated outside towns, though as near the coal pit as may be.

The book is also of use in showing (p. 20) that so far from the introduction of machinery being opposed to the working-man's interests, the actual effect is really the other way, in that by introducing machinery the output per head of the employees is raised, which consequently enables a higher wage to be paid. In illustration of this, Mr. Cooper quotes the Ford Motor Car Works, of America. This is an excellent example of the maximum use of machinery and automatic processes, and yet wages are said to run higher there than in other factories—notably so, indeed.

The present writer is in accord with the author in his desire to see payment by results brought into universal practice. Further, anything which tends to destroy—or even check—individual effort should at once be abandoned. The proposed minimum wage would certainly work in that direction, besides leading to all-round industrial bankruptcy.

Generally speaking, as the book tersely puts it, the only way in which Labour can receive more in wages is by *producing* more. Expressed in another way, it is, in reality, only by greater production per unit of capital and per unit of wage that higher wages can be obtained. It happens, too, that the only real solution of our present difficulties is vastly increased production. It is work alone that will achieve that cordial co-operation between employer and employee.

Mr. Cooper deals very fairly with the ethics of profit-sharing and co-partnership. Some people still argue that those who cannot afford to share losses must not expect to have a share in profits. That view, however, omits the fact that the labourer's arms and legs—aye and his health—represent capital with him. On the other hand, the labourer is sometimes disposed to take up the position that it is his efforts alone that produce wealth for his employers, leaving entirely out of account that important item, management, whilst also neglecting to recognise the part played, in turn—in the way of energy, foresight, &c.—by those controlling the business. Then again, those concerned with Labour seem often to even forget, judging by their arguments, that without the capitalist there would be no employment, so far as private enterprise is concerned. All this is very ably dealt with by the author.

Turning to the bigger, national, standpoint of the subject, as Mr. Cooper shows, the conscription of wealth will do the country no good, and only means "killing the goose that lays the golden eggs." It is the *production* of wealth that is alone of use.

A perusal of this volume should serve to indicate the necessity for Capital and Labour meeting one another with the fixed determination of arriving at friendly co-operation—in place of class conflicts—if only on the patriotic grounds of saving the country from an industrial and commercial ruin, such as at present looms before us. We must cease thinking in terms of a class and forthwith start thinking in terms of a nation. The immediate lesson, too, is surely as indirectly pointed to in Mr. Cooper's book—the general individual responsibility of working to render one's country once more prosperous.

Charles Bright.

How the Progress Department Assists.

I.—The Works Management.

By W. J. HISCOX.

In a great many concerns the Progress Department is a sort of "Ishmael"—with every man's hand against it—under the erroneous impression that it exists for the purpose of creating trouble. It is not recognised that the department, in exposing troubles, does so for the express purpose of eliminating the cause, and that, as a consequence, it is of the greatest assistance to every section in the factory. Not only is it of the utmost value to the management, but its value to the shop operators is no less marked, whilst the departmental foreman, as well as the technical and commercial departments can (if they will) derive considerable benefit from the same source.

The influence of the Progress Department permeates the whole factory, and the object of this series of articles is to demonstrate how (if instituted and conducted upon the right lines) the department cannot fail to justify its existence. No other department has such opportunities of exerting a beneficial influence, for it is in direct touch with everybody, from the works manager downwards. The trouble is that in so many concerns the department is not permitted to perform its legitimate functions, and as a consequence its value is not so apparent.

It is generally admitted that the Progress Department is of value to the management, for were it not so, the department would soon cease to exist. It is, however, on this count that it finds disfavour elsewhere, for it cannot be understood by the rank and file how anything calculated to assist the management can be of benefit to the workers. Nevertheless, the benefit derived by the factory as a whole depends upon the use made of the Progress Department by the management, for it is a fact that the greater the value to the management the greater the value also to the factory generally.

The department is instituted for the purpose of taking over the control and the responsibilities of delivery and output, thereby taking from the manager a mass of vexatious details which in the past has been the cause of much wasted time.

The fundamental principle of modern factory management is that the man who directs cannot handle detail, and therefore it is impossible for the manager to handle, in an efficient manner, the whole of the factors which contribute to the factory output.

The Progress Department takes this matter in hand, and, specialising in one direction, organises the resources of the factory in order to ensure that advantage is taken of everything calculated to facilitate progress and thereby improve delivery. The works manager, instead of endeavouring to conduct this business personally, is relieved by the head of his progress department, this individual assuming responsibility. The works manager issues his instructions, or demands information; the instructions are interpreted correctly and transmitted to the interested parties, whilst the demand for information is readily complied with.

The efficient works manager is conversant with every branch of the factory organisation, his knowledge being derived from the information at his disposal. The manager who counts is the manager who *knows*: the manager who can converse freely with his board of directors, customers or prospective customers, and the heads of the factory departments, as intelligently as though he had personally handled every detail. He does not have to send to the other end of the factory in order to get the information which will enable him to answer a question, for the information is already to hand, and has been considered and thoroughly digested before the question is asked. Thus it is that he is never at a loss, and not only that, but he knows what he is talking about, and succeeds in conveying that impression to his listener.

It is in this respect that he owes much to his Progress Department, which may in very truth be termed the "information bureau." The activities of this department extend throughout the factory, and it is safe to say that very little escapes its notice. The conditions prevailing in any department at any moment are commented upon, and plans to meet an emergency brought about by unforeseen circumstances are promptly put into commission. With the aid of an efficiently conducted Progress Department it is possible for the works manager (sitting in his own office) to be more conversant with what is happening in the shops than if he spent the whole of his time walking through the various departments.

And if it is true that the works manager is assisted in this direction it is equally true that much relief is afforded him in the matter of actual production. In the past he has had to devote a vast amount of time and energy in the endeavour to meet deliveries and to increase output; in the main with very unsatisfactory results. His method was to summon the various departmental heads to a conference, and there endeavour to elicit what was being done, what would be done, what ought to be done and why it was not being done. From personal experience the writer makes bold to declare that the manager very rarely gets the correct information on any count, which, after all, cannot be considered surprising. Each departmental head was bent upon making his own case good, and therefore set himself out to whitewash his own department.

If we take the counts in rotation, the works manager elicited the fact that every department was doing very well indeed, and in the future would do still better. In spite of this, whilst each foreman agreed with the manager on what ought to be done (this taking the factory as a whole) each one protested it was not the fault of his department that it was not being done. It was only when one foreman was singled out for close questioning that the manager began to understand that Jones could do better if Smith did not let him down so often. Smith says the real fault lies with Robinson, and that individual, feeling that everyone should have a turn, passes the blame on to Jones. Thus it is that everyone's time is wasted, and no satisfaction is achieved. The manager relieves his feelings by telling the respective foremen what he thinks of them, and there and then, acting upon the rose-coloured view expressed by the foremen with respect to the future, maps out another programme, which in its turn is mismanaged in exactly the same way as its predecessor.

Such a state of affairs cannot exist indefinitely, if progress is to be maintained, and so it is that the works manager has to descend into the arena and personally supervise the work of the foremen. This extra duty can only be undertaken at the expense of something else, and the result at the best is only of a temporary character. Overwork conduces to inefficiency, whether it be in the works manager or the office boy, and an inefficient manager must of necessity adversely affect the whole factory.

The only logical solution is to be found in the creation of the Progress Department, and the relief afforded the manager is soon apparent. The latter, secure in the knowledge that the delivery side of the business is in good hands, turns his attention to other matters which have an important bearing upon the organisation of the factory. In a short time the complaints of customers in respect to deliveries are noticeably less, and the output from the factory shows a progressive tendency. It is not suggested that all troubles cease as if by magic, and that every department performs what is expected of it without apparent effort. Foremen may still be summoned to conferences, but these conferences will be at longer intervals, and there will be no necessity for the manager to ask the foremen what is being done or what would be done. He will, on the contrary, be able to see at a glance exactly where the trouble is, and can, therefore, determine which department is at fault. Thus the matter can be adjusted without a lot of preliminary questioning, and this means time saved, and infinitely more satisfaction obtained.

Half an hour's study of the charts and tables prepared by the Progress Department will enable the works manager to grasp the whole situation, and to know exactly how he stands in regard to delivery and output. He notes that this line of manufacture is well up to schedule, and he therefore has no need to worry in that direction. A slump is apparent, however, in connection with that line, and the cause is traced to the machine shop. No need, therefore, to call to conference the heads of the foundry and fitting departments, for it would be only wasted time. The head of the machine shop is the man wanted, and he is called upon to furnish an explanation, and to state precisely what he proposes to do in order to retrieve the situation. This is usually forthcoming in a very short space of time, and the manager can then turn his attention to other business, secure in the knowledge that something has been accomplished.

This is a business-like proceeding, and should commend itself to any progressive works manager. There are still a few managers who consider it necessary to handle the whole business personally; who feel that their authority suffers if they depute anyone to take control of a certain section. These, however, are now a hopeless minority, for the Progress Department in practically every progressive engineering factory is daily becoming more important, and no one knows better than the works manager the infinite value of this department both to him personally and to the factory as a whole.

Correspondence.

PREDICTING MAGNETIC STORMS.

TO THE EDITOR OF THE ELECTRICIAN

SIR: I have been informed that I have wrongly attached significance to the declination of the planets in my letter in your issue of September 19 last, and I accept the correction. As the orbits of the planets or asteroids are all inclined to the ecliptic, it follows that at one opposition the sun, earth planet or other body may be more nearly in the same plane than at another opposition, and therefore more nearly in a direct line.

It was the importance of this variation to which I intended to refer, and which my too meagre knowledge of astronomical terms led me to wrongly express.—I am, &c.,

London, Oct. 6. C. ORME BASTIAN.

Penetration of Moisture in Insulating Materials.—A note on the above subject by Mr. C. J. Rottmann in the "Journal" of the Franklin Institute shows that many insulating materials are subject to slow penetration of moisture. In many samples investigated there was first a rapid ingress of water, then a long period during which there was practically no increase, and then finally a gradual increase once more.

Report of Electrical Inspector of Factories.

In our last issue (p. 400) we gave some extracts from the Report of the Chief Inspector of Factories for 1918, and we now give an abstract of the Report of Mr. G. S. Ram, M.I.E.E., H.M. Electrical Inspector of Factories.

Mr. Ram states that the outstanding feature as regards the use of electricity during the period of the war was the enormous increase that had taken place, due to the requirements of works engaged directly or indirectly on the output of munitions of war. In a recent return by the Ministry of Munitions in regard to 76 electricity undertakings which had added to their generating plant since 1914, the total amount of these additions was given as 969,500 kw. (1,300,000 h.p.), or an increase of 114 per cent. These figures, however, only represent a part of the increment, as many large works had added in even a greater proportion to their own generating plant and a number of new power-houses of considerable size had been erected in connection with new works. The greater portion of the new plant had no doubt been required for power purposes, but in certain districts principally in the Sheffield area, a large part had been utilised directly for electric furnaces. The extensions of public supply generating stations had been chiefly in the form of enlargement of existing works, although about 10 entirely new stations had been completed and put into use during the period under review. These stations are all equipped for extra high pressure, three-phase supply on modern lines. Three large generating stations and a number of sub-stations were also completed for the electrical working of sections of railways. Extensions of plant, having been under the control of the Ministry of Munitions, were permitted only where warranted by the importance of the load from a national point of view and even where carried out were in many instances not sufficient to keep pace with the demand of consumers for additional power. In other cases, where extensions were not permissible, the load had nevertheless increased, as in almost all parts of the country power was required for munition work of some kind, and many stations were consequently without any reserve of plant. In some cases, however, where the load was chiefly for lighting and domestic purposes, the demand actually fell off, due to lighting and heating restrictions. Much uncertainty exists as to the immediate prospects of development owing to the probability of the control of the whole of the electricity supply of the country being placed under a new Department in accordance with the scheme contained in the report of the Board of Trade Committee on Electric Power Supply. No doubt such a scheme may eventually lead to great economies in the matter of fuel, but it cannot be carried out all at once and extensions of many of the existing smaller stations will be imperative in the meantime, if developments in the use of electrical energy are not to be retarded. In connection with the building and equipment of some of the new stations and the extensions of the supply systems some very remarkable feats have been accomplished under most difficult conditions and it is to be hoped that the engineers concerned may now find time to put on record an adequate description of their achievements.

Considerable anxieties have been experienced by those responsible for running electrical stations owing to shortage of labour, many employees of all grades, including technical staff and chief engineers, having joined H.M. Forces early in the war. Although the public supply of electrical energy was a protected or a reserved occupation, employees were continually taken for the Army, so that in many cases much difficulty ensued necessitating a large amount of substitution. Women were widely brought in for such varied work as general labouring and cleaning, coal and ash handling, boiler cleaning, engine driving (assistants); while a more highly educated class were engaged in analysis of coal, switchboard attendance (usually under supervision) and as sub-station attendants, in some cases being in sole charge of the operation of the plant, including the running of motor generators or rotary converters. Where women have been engaged in this work they have been for the most part trained only at the stations where they were afterwards employed. As occupation as sub-station attendants seemed likely to lead to permanent work in the case of disabled men and as in any case the employment of women in the work could only be for the duration of the war, the Home Office latterly used every effort to get disabled men taken on for the work in preference to women and declined to grant exemption orders for women except where it was proved that suitable disabled men were unobtainable. Before the war few people would have thought it possible that women could have successfully undertaken the work of attendants in important sub-stations for converting from high tension three-phase supply to direct current for traction or general distribution and not many engineers would have cared to take the risk of making the experiment. Experience has, however, shown that the trial was justified, excellent reports of the capabilities and resourcefulness of the women having been received, naturally, however, with certain exceptions.

A number of new factories have been erected during the war by or under the control of H.M. Ministry of Munitions and many of them have been provided with their own electrical generating stations and sub-stations. These have been for the most part well designed and equipped with modern and up-to-date plant. New generating stations have also been erected by several private firms and many others have been extended. Generally, the new work has again been good. An important matter had, however, been overlooked in several instances. In stations intended to maintain a continuous supply, night and day and on Sundays, medium pressure three-phase switchboards have been so arranged as to make it impossible to carry out any work, *e.g.*, overhau of an oil switch, in safety. No isolating switches had been provided between the bus-bars and the oil switches and no divisions between the panels. This arrangement has been found on the main switchboards where the supply has been at medium pressure and in high pressure stations in regard to the medium pressure auxiliary switchboards. These switchboards controlling all the auxiliary plant in the station, *e.g.*, condenser pumps, feed pumps, mechanical stokers, &c., are just as important as regards maintenance of the supply as the main switchboards. In other cases both isolating switches and divisions were satisfactorily provided. In one large station for an electric railway, the matter had been dealt with in another way, the auxiliary switchboard being duplicated, so that either one could be completely shut down when necessary, every motor in the station having a cable from each switchboard with a change-over switch at the motor—an excellent arrangement although no doubt somewhat costly.

During the period under review, Mr. Ram visited a number of explosive works and filling fatcories. In general, the electrical work had been well done, special precautions being necessary on account of explosive risks or liability of damage to wiring and apparatus from acid fumes. "Danger" buildings had, where possible, been lighted entirely from outside, and motors and all switchgear, fuses, &c., being either in separate buildings or in rooms completely shut off. In some the lighting had been necessarily inside, special well-glass or bulkhead type of fittings being used. Motors, where inside, had been pipe-ventilated or provided with forced draught ventilation with spray washed air. The work was, however, much better done in some cases than in others and some otherwise good work was rendered dangerous by not being properly finished off. Thus pipe-ventilated motors were found with no pipes connected and even forced draught motors with no pipes on the outlet, in buildings with highly inflammable if not actually explosive material near by, where the effect of a burn-out of an armature would be to blow a torrent of sparks into the room. Slackness in maintenance was also sometimes noticed, well-glasses of lighting fittings having been broken and not replaced.

Amongst the heavier uses of electrical power several new steel rolling mills were put into commission. A rolling mill provides probably the most severe test of electrical machinery possible, and the fact that more mills are being equipped electrically is a sufficient proof that the method is reliable and has other advantages over steam power. The extremely heavy load being suddenly applied to the motor necessitates enormous mechanical strength in all parts. Motors of 5,000 h.p., giving 10,000 h.p. or 12,000 h.p. for short intervals on the peak, are in use. In some mills the handling of the steel, from taking the billets from the soaking pits to the rolls and passing them backwards and forwards through the mill and finally taking away, cutting up, and stacking the finished section is accomplished entirely by electrical power. Most of the mills are reversing, the motor having to start, come up to speed, slow down and reverse perhaps 10 times a minute. Some are not reversing, the motor driving the rolls constantly in the same direction, the steel billet passing one way above and the other way below the live or driven roll. Some have a direct drive, others are geared and some of the smaller ones are rope driven. In order to equalise the power taken from the supply source and prevent the enormous fluctuations, which would otherwise be experienced, full use is made of the storage of energy in flywheels. These are attached in the case of reversing mills to motor generator sets intervening between the source of supply and the mill motor, and in the case of non-reversing mills to the driving shaft of the rolls. The electrical control systems naturally appear somewhat complicated and are specially designed to reduce electrical losses to a minimum and are provided with various safeguards in case of accident. Other new heavy-duty motive power plants with intermittent loads include large hoists for dealing with loads of 40 or 50 tons, as for blast furnaces, fully loaded railway trucks being taken up and tipped directly into the furnaces.

Perhaps the most striking development in the direct use of electrical energy has been for furnace work, principally in steel manufacture, for the making of high-grade special steels and alloys. Several patterns of furnace are in use, all taking alternating current, single-phase, two-phase or three-phase. The sizes of the furnaces are mostly from half a ton to 10 tons capacity, although there are a few still larger. Carbon or graphite electrodes are used. In the smaller sizes they are arranged to be regulated by hand, and in the larger sizes during the first part of the process while the steel is being melted, after which the regulation is automatic. Success in their use depends very much in having skilled attendance, electrical as well as metallurgical, and some of the more important works have found that it pays them to employ an electrician in charge of each furnace. In many works, however, there is no such skilled electrical supervision. With most patterns of furnace the pressure used is about 90 volts for melting, being subsequently reduced to about 70 volts by means of selector switches connected in the primary side of the transformer windings. The current is very large, depending on the size of the furnace and the electrodes. The large currents required necessitate the provision of a transformer room as close as possible to the furnace. The main supply is, of course, at high tension, in many cases at 11,000 volts. Unfortunately the equipment of the transformer rooms in many instances had been carried out in a dangerous manner. In many cases the apparatus was badly arranged and the protection of the high tension conductors was totally inadequate, these being treated as of no more consequence than if at 100 volts. Similar furnaces are also being tried for brass making and casting, but direct heating by the arc appears to present some difficulties. Arc furnaces are also used in the manufacture of calcium carbide, phosphorus, carborundum, sulphate of lead, &c., some being on a large scale, others comparatively small. Electric resistance furnaces are also being tried for the making of crucible steel by heating the crucibles from the outside. Hardening furnaces, in which the current is passed through a bath of salts, are used for hardening tools. These are comparatively small, and the primary current supplied to the transformer may be only, say, 200 volts. Electric heating has also been developed in several new directions, among which may be mentioned that of cardboard box manufacture. Other new plants for the direct use of electrical energy include some for electrolytic manufacture of certain explosives, and of chlorine and oxygen and for the recovery of tin from scrap. At least one plant was installed for the manufacture of nitric acid by obtaining nitric oxide from the air by means of the electric arc. Several installations have been put up for depositing fumes and dust by means of high tension electrical discharge.

The use of electricity in welding has increased very much during the war. For resistance or contact welding single-phase alternating current from the supply circuit is transformed down to 2 or 3 volts by a transformer, generally contained in the base of the machine, the control being on the primary circuit. The contact or welding jaws, which form a part of the secondary circuit of the transformer, are insulated from the frame of the machine, which is earthed. There is, of course, no danger from handling the metal being welded at such a low pressure, but there is danger in case of a breakdown of the insulation of the transformer causing the welding jaws and the metal being welded to become charged at the pressure of the supply circuit, generally 200 to 400 volts and (as recorded in some previous reports) fatal accidents from electric shock have occurred in this way. This danger can be overcome by earthing one point of the secondary circuit. A number of welding machines were found in different works, notably for the welding of chains, where serious dangers existed through exposure of conductors, terminals, switches, &c., of the primary circuits. A considerable development has also taken place in electric arc welding, chiefly with metallic electrodes. Either direct or alternating current may be used. Although the pressure across the arc is only some 25 to 40 volts, the pressure of the circuit is generally from 90 to 110 volts in order to allow of a suitable steadying and regulating resistance in the circuit. Owing to the injurious effect of the rays from the arc upon the eyes a screen of darkened glass is always used, it being impossible to work without one. It is also necessary to protect the skin of the face, neck, arms, &c., both from the rays and from particles of hot metal. A point of some difficulty is that the glass has to be so dark that practically nothing but the arc and the hot metal immediately round it can be seen. In addition to reducing the luminous rays to an intensity which will not hurt the eyes, certain invisible rays both in the ultra-violet and infra-red must be cut out. Usually two coloured glasses, ruby and blue, are superimposed, or sometimes ruby and green with a third of neutral tint. Different workers favour different combinations, but the matter is one which appears to warrant further scientific research. A glass which will cut off the injurious rays and adequately reduce the intensity of the luminous rays, but which will nevertheless allow of the welder readily seeing his surroundings would be extremely useful, but owing to the contrast between the brightness of the arc and the general illumination of surrounding objects this does not appear to be within the range of possibility. In welding in a fixed position as in a workshop, a screen with darkened window is usually held in one hand by the worker, who manipulates the electrode with the other. As injury may be caused to the eyes by looking at the arc from some distance away, even for only a few seconds it is necessary also to surround the working places with opaque screens to prevent the rays reaching other persons in the vicinity or who may be passing. For working in confined spaces or in positions where the left hand may be required for use or for holding on by, a mask with a darkened window is sometimes used. A protective tunic with mask, completely screening the upper part of the body, devised by one firm provides that the welder can only see directly in front and he is consequently protected from the rays of any adjacent arcs which may be used by other welders. Such masks or helmets are ont, however, liked by the workmen, who prefer to use the hand screen whenever possible. With direct current the danger through electric shock is very slight and probably negligible, except perhaps as regards persons working on stagings or in confined spaces, and should therefore always be used where possible. With alternating current there are dangers which have to be guarded against, arising because it is in any case more dangerous than direct and also because a person holding a live conductor and getting a shock through his body will in general be unable to release himself. It is therefore very necessary that the electrode holder shall be so constructed that it shall be impossible for the worker to touch any live part with his hand whilst holding the handle. Mr. Ram reports that he has found in use many electrode holders which do not comply with this elementary requirement. Another important matter is that one pole of the circuit, that which is connected to the article to be welded, shall be efficiently earthed. There should, of course, be no switch or fuse in the earthed conductor. Except when the arc is actually maintained, the electrode is at the full pressure of the circuit. When the welding is done in a workshop the welder is usually close to the switch controlling the circuit and can readily cut off the pressure. In other cases he may be at a considerable distance from the switch and it may be inconvenient to get to it, and he may put the electrode and holder down or hang it up and it will remain live and a source of danger or he may be tempted to renew the electrode whilst it is live, a dangerous proceeding unless he is insulated from earth or wears insulating gloves. To get over this difficulty it has been suggested that there should be an auxiliary low voltage circuit in the flexible cable, with a push button thumb-switch in the handle of the electrode holder, arranged to operate a contactor switch at the fixed end ot the circuit. The electrode and holder would then normally be dead and would only be made live when actually put to use. One of the most important of the recent applications of arc welding is in shipbuilding for the welding of the plates.

Considerable study has been given to the question of lightning protection at many explosive works, and in some care had been taken to connect together all metal work within or about the buildings, with the idea of eliminating all possible points between which any spark discharge due to secondary effects of lightning could possibly occur. This precaution is probably very sound and might be more generally adopted.

Much consideration has been given during the last few years to the science of illumination and to the design of efficient fittings for distributing the light to the best advantage, the matter having been of special importance during the war owing to the large amount of overtime and night work resorted to in many works. For many years factory lighting by electricity was dependent upon the arc lamp for general illumination, with the attendant troubles of trimming, cleaning and the expense of carbons, and upon the carbon filament glow lamp of very low efficiency for localised lighting of individual machines, &c. The improvements which were effected some years ago in gas lighting would probably have led to gas largely superseding electricity for factory lighting had not the metallic filament glow lamp with its corresponding improvements been introduced just in time to re-establish the relative advantages of the latter. Recently the gas-filled or "half-watt" lamp has again doubled the efficiency, so that eight or ten times the light is obtained for the same consumption of electrical energy compared with the carbon filament lamp of ten or fifteen years ago. The half-watt lamps are made in sizes up to 1,000 c.p., so that it is now possible largely to dispense with localised lighting by providing a comparatively few of these lamps suitably placed. At the same time there have been useful developments in localised lighting. One which is particularly suitable for engineering machine shops provides for small ten-watt lamps, such as are used in motor-car head lights, in specially designed reflectors attached to fittings having universal joints so that the lamps may be put in any position. The pressure is only 10 or 12 volts, being reduced from the supply pressure by a small transformer for every ten or fifteen lamps. The wiring is concentric, the metal tubing of the fittings forming the return conductor and being earthed at the transformer. This construction, of course, greatly simplifies the mechanism of the universal joints. Besides being very robust and therefore suitable for machine shops, the advantages claimed are excellent lighting of the work, as much as 15 ft.-candles being obtained at 15 in. from the lamp, economy in the amount of electrical energy consumed, and particularly in regard to lamp renewals. A further advantage is no doubt in safety on account of the very low voltage. Some excellent examples of modern scientific lighting are to be seen in some of the new works.

Except as regards districts which have been supplied for many years with direct current, the development in the use of electrical power is mostly by alternating current, three-phase or two-phase, and which from the point of view of electric shock risk at low voltage is very much more dangerous if proper care is not taken. As distribution at high pressure is becoming more general in manufacturing districts, transforming sub-stations have often to be provided on the factory premises even for small consumers. At a number of new works using alternating current the work was excellent in every respect, but some new installations were defective and dangerous. In some cases otherwise good installations are spoiled by not being properly finished off. The most prevalent fault is that even though the conductors are well protected in screwed steel conduits throughout almost their entire length, the conduit is not taken right up to switch boxes or motor terminal boxes, so that loops of unprotected cable are left, often in positions where liable to damage—*e.g.*, on the floor at the motors. Several large manufacturers supply their motors without any terminal boxes, cable tail ends being brought through the casing for connecting up to the circuit, instead of providing terminal boxes with facilities for connecting up conduit, although they will supply them at an extra charge.

Mr. Ram thinks the proposal of the Institution of Electrical Engineers for the establishment of a national electrical proving house, under an independent authority (for testing all kinds of electrical apparatus to see that they come up to proper recognised standards and thereby eliminating much of the unsatisfactory class of goods now on the market) would be of great benefit to the industry and would no doubt materially assist in reducing the number of accidents due to faulty design and manufacture of apparatus.

Owing to the great expansion in the use of electrical energy during the period under review, it might have been expected that the number of electrical accidents would have increased. This, however, was not the case. The reduction in the number reported is so great that after making a liberal allowance for cases unreported owing to the stress of war conditions, it would appear to be a fact that the real number is considerably less than in the preceding period, and if the increase in the use of electrical energy is taken into consideration the proportion is very much reduced. On the other hand the number of fatal accidents has somewhat increased, 99 having been reported in the four years as against 70 in the previous like period, 1911-1914. Of the 99 fatalities, 14 occurred in electrical stations of public supply or traction undertakings, the remainder on ordinary factory premises. In addition, there were four fatalities indirectly due to electricity. One was caused through explosion of gas from a secondary battery by electric spark, one through failure of the current of a crane magnet allowing the load to fall on a man, one from burns where a girl got her dress set on fire by knocking the lead out of a terminal of a motor and the other from burns where a man short-circuited conductors with a benzine blow lamp. 95 out of the 99 fatalities occurred with alternating current; 19 being on systems of less than 250 volts, whilst 47 occurred on three-phase systems from 346 to 440 volts, but where the pressure to earth would not exceed about 250 volts, most of the systems having the neutral point earthed. Many of them occurred on lighting circuits taken from one phase and the neutral. In three or four cases only is it likely that the shock received from contact with two of the phase conductors, the accidents being nearly all due to contact with one conductor only, the current passing through the victim to earth. Three direct-current cases were on medium pressure traction systems having one pole earthed. In the case of the solitary low pressure direct-current accident death was probably due to the fall. In several of the cases where the accidents were due to absence of, or ineffective earthing, the actual pressure received may have been considerably less than the maximum voltage of the circuit. The importance of artificial respiration as a means of resuscitation in cases of apparent death from electric shock, although generally appreciated by electrical engineers for many years past, is not adequately realised by factory occupiers or even by many members of the medical profession. In 15 cases artificial respiration was carried on for an hour or longer, in some instances under medical supervision, in 10 cases for half and hour, in eight for 15 minutes, in two for 10 minutes, in one for 5 minutes. In four others no mention is made of the length of time, but the efforts at resuscitation were carried out "until the doctor arrived." In 10 cases artificial respiration was tried, but no mention is made of the duration of the effort. In 11 cases where a doctor was on the scene within a few minutes of the accident, practically no attempt was made to revive the patient. This indicates that the medical profession generally is woefully ignorant on the matter. Enlightened medical opinion is convinced of the efficacy of treatment by artificial respiration is well known, and Mr. Ram again repeats the opinion of Dr. Reg. Morton, that "death from electrical shock is only an apparent death at first, and whatever the conditions or severity of the accident, there is practically always a time, varying from a few moments upwards, during which it is possible to resuscitate the victim by artificial respiration if resorted to at once. Artificial respiration must be persevered with for at least two hours, or until the patient revives; in many cases it may be only a few minutes." It is, therefore, to be hoped that the "safety first" movement, which is now gaining ground, will lead to more general training of ambulance men at all classes of works in the methods of artificial respiration, so that victims of electrical shock may in more cases receive prompt and adequate treatment, and thus be given at least a chance of recovery.

The 1919 Leipzig Fair.

The annual Industrial Fair, which is held in Leipzig in September, affords an excellent opportunity of studying German industrial conditions and of gauging the capacity of Germans to re-establish their export trade, their ability to purchase commodities from the United States, &c. Consequently, the report of a competent observer on the recent Fair which we have just received, should be of interest to our readers.

We learn that about 10,000 firms (mostly German) exhibited, and there was a record attendance of about 118,000 people, or 20 per cent. more than in any previous year. Some 7,000 foreign buyers were also present. The general impression gathered from conversation with representative exhibitors was that nearly all branches of German industry are on the verge of bankruptcy, due principally to the shortage of coal, and secondly to the loss of export trade. In order to assist in forcing a wedge into foreign markets, German manufacturers have now concentrated on new mechanical devices and novelties, which were much in evidence at the Fair. Most of the German representatives inclined to the opinion that they would recover their export trade through American and neutral buyers.

The most important exhibits were those of the technical section, including all types of new machine tools, mechanical and electrical devices. In this branch of industry, the Germans are in a position to fill orders quickly, and in many cases there are large stocks on hand, due partly to the fact that they had not been short of iron ore and coal during the war to the same extent as industries relying on foreign raw materials, and partly to the fact that there was little home demand to be met. The mechanical engineering industry depends upon foreign trade for its stability, and is concentrating as much as possible on fine mechanical precision machinery and articles. The accuracy of the work done, as exemplified by the machinery exhibited and the finish of the machines themselves, left nothing to be desired, except that every effort was made to avoid the use of brass. Delivery of machine tools from stock can, therefore, in most cases be obtained; the prices are approximately 200 to 400 per cent. above the pre-war basis. The German firm arranges all the necessary export regulations and shipping, leaving the import side to the importer. Cash must be deposited in the German bank on receipt of invoice that the goods are ready to be despatched, or (in some cases) when they have already been forwarded. It is reported that much specialised new machinery was on view, and in many cases the Germans are only too willing to sell the covering patents to foreign manufacturers.

Second only to the engineering exhibits were those of the toy trade. There was a larger and more representative exhibit of toys than in any other year. It was stated on all sides that the factories were at a standstill, and the greatest efforts were about to be made to re-establish the German toy export trade, by offering to foreign buyers the best made articles at the lowest possible prices. The toys were good and can be exported at less than pre-war prices, due to the rate of exchange.

There was one rather fine exhibition of aluminium kitchen utensils, &c. The head of the exhibiting firm stated that, due to the coal shortage in Germany, there were now not more than 400 tons per month of raw aluminium blocks produced out of a possible total output of 4,000 tons. Among the building trade (construction material) exhibits were many machines used in the manufacture of substitute materials from various factory waste products. Various clay and natural cement substitutes were offered in lieu of Portland cement which requires about half its weight in coal for its manufacture. Much artificial marble (from gypsum) was also seen.

One of the most striking features of the Fair was the large number of foreign purchases, mostly Dutch, Scandinavian and Swiss, although there were a considerable number of Americans present. These foreigners were there to buy German goods, and on all sides one heard from the Germans that in most cases it was only the lack of coal or raw materials which prevented much greater sales. At present, labour is being paid from 200 to 300 per cent. more than pre-war rates for an eight-hour day, against a 10-hour day in the past, in return for which labour does about two-thirds as much work. The conclusions of our correspondent are that the whole Fair showed the desire of the German nation to work and recover itself, but everywhere one was struck with the hopeless dependency of Germany on foreign raw materials and increased coal output. In fact, with the German glass, pottery, textile, leather, toy and many other industries closed down, or operating at 5 or 10 per cent. of their normal output, due to inability to purchase raw materials at the present value of the mark, the Fair gave direct evidence of Germany being at present in a very difficult position.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

118,595 Domestic Engineering Co. Battery charge indicating devices. (30 7 17.)
121,744 Monard. Apparatus for electrically controlling railway signals. (20/12 17.)
124,416 Murray. Processes of electric welding. (22 3/18.)
131,322 Gaothofs. Sparking plugs for internal combustion engines. (29 8 18.)
131,344 Cooper & Griffiths. Electrically heated apparatus for evolving gases from liquids. (4/5/18.)
131,361 Forest. Radio signalling system. (16/6, 17.)

Comprises the combination with an antenna-earth system including an inductance and a capacity in series of an audion containing a hot and a plurality of cold electrodes, a conductive connection between said hot electrodes and one side of said capacity, a conductive connection between one cold electrode and the other side of said capacity and a circuit between another cold electrode and said hot electrode inductively associated with said inductance of said antenna-earth system.

131,362 Latour. Audion or lamp relay or amplifying apparatus. (23/10 16.) (Divided application on 15,543 17. Addition to 5,363 17.)
131,372 Sarron & Simon. Electro converter furnaces, and process of treatment for the manufacture of steels thereby. (27 5/18.)
131,377 Wordingham. Systems for distributing electric energy. (31 5/18.)
131,392 Rota & Binetti. Apparatus for the concentration of electric waves in a single direction or upon a fixed point. (18 6 18.) (Addition to 11,658 17.)
131,395 Languepin. Electrodes for electric arc welding. (31 10, 17.) (Divided application on 15,888 17.)
131,405 Lester. Apparatus for measuring and indicating an electricity supply. (24 5 18.)
131,410 Marks. (Splitdorf Electrical Co.) Electric circuit controlling devices. (16/7, 18.)
131,412 Christian. Relay for electric circuits. (26 7 18.)
131,426 Western Electric Co. (Western Electric Co.) High-frequency electric signalling. (16 8, 18.)

An electrical signalling system in which signals are transmitted by a high frequency carrier wave modulated in accordance with said signals and are at the receiving station re-inforced by being combined with locally generated oscillations of the frequency of said carrier wave, and wherein the means for producing said carrier wave at said transmitting station and the means for producing said locally generated oscillations at said receiving station are both controlled by control oscillations produced at said transmitting station and transmitted to said receiving station with said carrier wave.

131,429 O'Leary. Electric motors. (16 8 18.)
131,455 Jascowitz & Rosenbaum. Cleaning metals by electrolysis. (22 8 18.)
131,465 Hayward. Commutators for use on internal combustion engines. (26 8 18.)
131,487 Christian. Automatic or semi-automatic exchange telephone systems. (17/9 18.)
131,490 B. T.-H. Co. & Hastings. Electro-magnetic switches. (23 9 18.)
131,491 B. T.-H. Co. (G. E. Co.) X-ray apparatus. (24 9 18.)
131,499 B. T.-H. Co. (G. E. Co.) Means for controlling alternating electric currents. (10 10/18.)

1919 Specifications.

121,118 Cave. Alkaline electric accumulators. (28 11 17.)
123,727 Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij. Thermic telephones or like electrical apparatus provided with heating conductors. (15 2 18.)
127,234 Akt. Ges. Brown, Boveri & Co. High voltage windings embedded in grooves or slots. (24 5/18.)
131,543 Sykes Interlocking Signal Co. & Tarrant. Railway electric track-circuit systems. (3 2/1919.)
131,549 Holt & Brolt, Ltd. Self-regulating dynamo-electric machines. (20 2 19.)
131,533 B. T.-H. Co. (G. E. Co.) Wireless signalling systems. (6 3/19.)
131,561 Jackson, Mellersh-. (Taylor.) Radio-telegraphic transmission systems. (8, 4 19.)

131,574 Goldstone & Lightfoot. Electrical replaceable fuses. (26/5/19.) (Addition to 121,651.)

131,624 Evershed & Vignoles & Evershed. Field magnets for magneto-electric machines. (29 5/18.)

131,625 Plaisant. Electromagnetic devices. (29 5/19.)

131,635 Schneider et Cie. Electrical apparatus for indicating and repeating movements at a distance. (13 2 18.)

131,639 Latour. Use of audion or lamp relay amplifying apparatus in telephony. (30 6 17.) (Addition to 5,363 17.)

131,668 Edison Swan Electric Co. & Hiatt. Valves of wireless transmission systems. (24 7 18.)

131,670 Rabinovitch & Cosmo Lamp Works. Manufacture of electric valve tubes for use in wireless telegraphy and the like. (24 7 18.)

131,680 Bloxam. Valves for generating electric oscillations amplifying electric currents or rectifying electric currents. (31 7 18.)

131,697 Latour. Apparatus for rectifying alternating current. (14 8 17.)

131,699 Benard-Barbier & Turenne & Granat. Electric controlling device operable at a distance for the laying of artillery, projectors, range-finding apparatus, and other similar apparatus. (15/8 18.)

131,702 Electrolytic Zinc Co. of Australasia Proprietary, Ltd. Treatment of zinc solution, preparatory to the recovery of zinc by electro deposition. (17/8/17.)

131,704 Latour. Telephone repeaters or relays. (18 8 17.)

131,707 Taylor. Automatic telephone systems. (21 8 18.)

131,716 Automatic Telephone Mfg. Co. & Savin. Selecting switches such as are used in automatic telephone systems. (24 8 18.)

131,725 Ferranti De. Electric transformers. (27 8 18.)

131,732 Lyster Russ & Newton & Wright. Electric switches. (28/8 18.)

131,765 Clarke & Hart Accumulator Co. Electric accumulators or secondary batteries. (20 9 18.)

131,767 B.T.-H. Co. Electric furnaces. (20/9 18.)

131,782 Majima. Electric cell plates. (22·10/18.)

131,817 Johnson. Electric batteries. (7 1·19.)

131,825 Ivamy. Dynamo-electric machines and the like. (5/2, 19.)

131,826 Fuller Accumulator Co. & Jones. Electric storage batteries or electric accumulators. (6·2 19.)

131,832 Crompton & Co. & Burge. Self-starting synchronous motors. (24/2/19.)

131,839 Bundy & Bev. Thermal-electric switches. (3 3/19.)

131,856 Newland. Carbon holder and feedkng mechanism for arc lamps particularly for use with cinematograph projectors. (23 4/19.)

APPLICATIONS FOR PATENTS.

Note.—*Nomes within parentheses are those of communicators of inventions.*

August 26, 1919.

20,892 Cubitt. Switches.

20,901 Findlay. Safety circuit-breaker for overhead tramway wires.

20,902 Brantom & Bitton. Eliminator of atmospheric discharge, &c., for wireless telegraphy.

20,912 Cooper. Implement for use with automatic disc telephones.

20,920 Duggan & Gardiner. Storage batteries.

20,946 Leede. Switch.

20, 60 Western Electric Co. & Deakin. Telephone exchange systems.

20,986 Kenmington. Electric ignition for engines.

August 27, 1919.

20,994 Lawton. Electric furnaces.

20,995 Cunliffe. Hand-operated controllers for electric motors.

21,025 Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij. Telephone switchboard and plug fittings. (27/8/18, Germany.)

21,037 Hall & Tnankelin. Arc lamps for photography, &c.

21,049 Foro. Electric Kettles, &c.

21,067 Splitdorf Electrical Co. Operating mechanism for electric generators or magnetos. (16/1 15, U.S.)

21,070 Western Electric Co. Electric telegraph systems.

21,089 Clifford. Dynamo-electric machines.

August 28, 1919.

21,104 Irwin & Rushton. Automatic excitation regulator for electric machines.

21,113 Halpin. Connectors for wires and electrical conductors.

21,120 Villiers Engineering Co. & Pountney. Flywheel magneto devices.

21,124 Wood. Re-magnetising magnetos.

21,151 Ryan. Wireless telegraphy, &c.

21,159 Western Electric Co. Electric telegraph systems.

21,168 Runbaken. Accumulators.

21,179 Bolis. Magnetos. (17 9 18, Italy.)

21,189 Powell & Smith. Electrically controlling throttle, &c., of engines.

21,190 Arioli. Magnetos. (29 8, 18, Italy.)

21,199 Beeton. Apparatus for converting heat into electrical energy.

21,219 Arosio. Casings for storage batteries. (28 8, 18, Italy.)

August 29, 1919.

21,235 Lane. Device for reducing effect of vagrant and interfering waves on wireless telegraph receivers.

21,258 Johnson. Galvanometers, &c.

21,272 Standard Motor Co. & Maudslay. Electric cable mountings for use on motor vehicles, &c.

21,293 B.T.-H. Co. (G.E. Co.) Regulating systems.

August 30, 1919.

21,322 Cooper. Dynamo-electric machines.

21,327 Sanders & Preston. Electric lamp-holders, &c.

21,334 Royston. (Federal Storage Battery Co.) Storage batteries.

21,342 Heyen. Electric arc furnaces.

21,363 Elion. Locking device for switches of magnetos.

21,373 Beiley. Fixation of atmospheric nitrogen.

21,392 McKenzie, Holland & Westinghouse Power Signal Co. Traffic controlling systems. (4 3 18, U.S.)

September 1, 1909.

21,399 Taylor. Obtaining alternating currents of any frequency from three-phase systems of any other frequency.

21,410 Woodburn. Manufacture of tubular articles by electric welding.

21,415 Western Electric Co. Signalling systems.

21,441 B.T.-H. Co. (G.E. Co.) Wire making machines.

21,446 Berry. Electric fuses, heating elements, &c.

21,447 Norsk Hydro-Elektrisk Kvaelstofaktieselskab. Production of liquid ammonia. (13 9 18, Norway.)

21,448 Craufurd & Doughty & Wylie. Detecting distant ships whereon electric machinery is running.

21,460 Neate. Electric terminal.

September 2, 1919.

21,497 Kidner. Varying current through magnets or solenoids in automatic musical instruments, &c.

21,503 F[illegible] Pa[illegible]lin & McL[illegible]. Telemotor apparatus.

21,514 Western Electric Co. Signalling systems.

21,515 Automatic Telephone Mfg. Co. (Automatic Electric Co.) Automatic switching mechanism.

21,522 Hunter. Electric signalling for railways.

21,548 Bjerregaard. Automatic time switches &c. for electrical circuits. (13/7/17 Denmark.)

21,568 Scintilla. Magneto-electric ignition machines. (2 [illegible] 18, Switzerland.)

21,579 Birkett. Ship's telegraphs, &c.

21,582 De Luca. Electric furnaces.

21,583 Frister Akt. Ges. R. Electric water heaters. (9 9 16, Germany.)

21,585 Schneider. Electrodes and accumulators.

21,586 Schlegel. Miners' electric lamps. (9 11 18, Germany.)

Commercial Topics.

Reduction in Lamp Prices.

The Electric Lamp Manufacturers' Association of Great Britain announce that "considerable reductions" have been made in the prices of the half-watt type (gas-filled) electric lamps. The announcement will be read with pleasure by all associated with the electrical industry, and particularly by electric light consumers who are beginning to feel the effects of the continual increases in the charges for electric current. The reduction in prices, which has been made by the ten firms who are members of the Association, should therefore have a beneficial effect upon the supply industry, and also assist in the development of the export trade to Australia, India, South Africa and elsewhere.

* * * *

Profiteering Act Orders.

The Board of Trade have made some orders under sec. 1 of the Profiteering Act, 1919, and others are said to be in contemplation. In the schedule to the first Order "all building materials" were specified as coming within the Act, and among the articles mentioned are "electric cable, fittings, plant and meters," plant, tools and tackle required for the construction of buildings and public works, &c. It is stated that the articles specifically mentioned in the schedule are given as examples of the class of articles to which the Order applies, and any other article within the class is within the Order.

Like a good many recent documents emanating from the Board of Trade, we think that the first Order is somewhat ambiguous and we question very much whether it can be said that "electric cable fittings, plant and meters" come under the heading "All Building Materials"; certainly meters do not, and it is only under exceptional circumstances that electric cable can be so included.

* * * *

British Trade with Australia.

In a report by H.M. Senior Trade Commissioner in Australia it is stated that "with the reorganisation of works and factories that has taken place in the United Kingdom, and the anticipated commercial reorganisation overseas, the United Kingdom should recover all the lost ground and increase its share of the import trade of Australia."

It appears probable that American competition will be felt more particularly in hardware, machinery, motor cars and specialities of various kinds. On the whole, British business methods are preferred, and on the resumption of normal conditions the bulk trade should revert to the United Kingdom.

Japan has rendered useful service to Australia by supplying quantities of goods which were difficult or impossible to obtain elsewhere during the war. It is, therefore, with regret that it has to be recorded that in a great many instances the goods supplied were of most inferior quality, and frequently not up to samples submitted, whilst the methods of trading adopted were often unsatisfactory. Reference is also made to the copying of British and other trade marks and brands. This has been done in such an open manner that one is led to the conclusion that those guilty of such practices must often be unaware of the significance of their actions.

Although the underlying sentiment of Australia is British, yet there is, or was, states the report, a widely expressed feeling that the British were ultra-conservative. The control of the non-ferrous metal industry, prior to the war, by Germany was pointed to as an instance of want of enterprise on the part of the United Kingdom, whilst the alleged refusal of the United Kingdom manufacturer to make trifling alterations in his products, or generally to adapt himself to the special needs of Australia, was given as proof of conservatism and lack of enterprise. The best remedy would be an increase in excellence, where possible, of United Kingdom goods, and particularly a general improvement in methods of sale and distribution. The report emphasises the necessity for greater attention to commercial organisation. The point of view taken is that the prosperity of the United Kingdom manufacturer is the basis of the prosperity of United Kingdom trade, and that the essential functions of the merchant can be readily adapted to changing conditions. The tendency in the other competing manufacturing countries has been towards developing and strengthening the manufacturers' commercial organisation, and at the same time to build up a merchant distributing system to compete with the British. With the closer settlement and development of overseas countries, the growth of the aggressive competition of foreign manufacturers, and increased competition amongst United Kingdom merchants, the tendency of the latter was to introduce unnecessary competition between the British manufacturers, and in many cases to lend their systems of distribution to foreign goods which competed with those of United Kingdom manufacture.

If a proper balance is established between the brains and organising ability put into the manufacturing side and that put into the commercial side of every manufacturing concern, most, if not all, of the criticisms levelled against the United Kingdom manufacturer will automatically disappear. The establishment of branch factories in Australia is being considered by a number of British manufacturers, partly on its own merits and partly owing to the protective tariff. Provided that unnecessary competition is not introduced, it may be said that branch factories of United Kingdom manufacturers would be welcomed in Australia. Land is easily obtainable, but buildings are costly. The local market is extremely limited owing to the scanty population but skilled and unskilled labour is scarce and costly.

Electricity Supply.

Islington (London) Borough Council has made a further increase of 20 per cent. in the charges for electrical energy.

The cotton mill scale of charges for electric current has been increased from 20 to 30 per cent. over pre-war rates by the Stalybridge, Hyde, &c., Tramways and Electricity Board.

Blackburn Council have confirmed an agreement for the supply of electricity to the Little Harwood Commercial Mill Company. This is one of a number of Blackburn sheds run by electric power.

Surbiton Council will oppose the application of Callender's Cable and Construction Company, owners of the local electricity works, for authority to increase the charge for electric current from 8d. to 9d. per unit.

As the result of a report by Mr. R. Blackmore, the Colne and Nelson Councils will enter into an agreement for the supply of current by Nelson to Colne Corporation, the terms and conditions to be agreed upon by the parties.

The outside market tenants at Burnley have asked that their stalls be lighted by electricity instead of gas, but the Markets Committee, in view of the high prices of materials, do not consider the time opportune for the change.

As there are many prospective consumers of electrical energy who cannot be supplied at present, Dewsbury Electricity Committee recommend that sanction be applied for a loan of £83,000 for extensions of plant at the electricity works. The matter has, however, been postponed for a short time by the Council.

The Charing Cross, West-End & City Electricity Supply Company, Ltd., recently applied to the Board of Trade for power to increase the charge for electric current from 5d. to 8d. per unit in the City of London, but the Board has only allowed an increase of 1d. per unit.

Coventry City Council has adopted a recommendation to obtain sanction to a loan of £40,000 for the extension of mains, &c. The charges for electric current for lighting have been increased by 66⅔ per cent. over pre-war rates and the hire of motors by 50 per cent.

Liverpool has agreed to increase the charges for electric current, except to consumers with special agreements, and the Tramways and Electric Power and Lighting Committee has been instructed before entering into future special agreements, to have due regard to the average cost of production.

The imperative need for making provision to meet large forthcoming demands for current is reported by the Rochdale Electricity Committee. The whole of the bulk supply to be provided by the Lancashire Electric Power Company is already absorbed, and the company is to be asked for terms for a further supply of approximately 5,000 kw.

Oswaldtwistle Urban Council recently wrote to the Ministry of Health intimating that it was desired to obtain powers to supply electricity, but current in bulk would be purchased from an adjoining town. The Ministry intimate that they are not prepared to entertain applications for provisional orders, pending the decision of Parliament on the Electricity (Supply) Bill.

Considerable extensions at the Bolton Electricity works are necessary owing to the demand for current for lighting and power. The present capacity is 16,000 kw., and plant of a further 8,000 kw. is to be added. The extension scheme, which involves an outlay of £150,000, has been generally approved by the Ministry of Health, but formal sanction to the loan is withheld until estimates based on provisionally accepted tenders have been submitted.

Kettering Urban Council has applied for sanction to a loan of £38,000 for extensions of the electric supply undertaking, including £18,000 for plant, £2,900 for foundations, &c., £1,000 for switchgear and cables, £2,500 for cooling tower, £5,000 for Stirling boiler, £1,950 for chain-grate stokers, £1,390 for an economiser, and £2,000 for contingencies. During the year ended August there were 49 new applications for current, bringing the total number of consumers to 1,053.

In view of the termination of the Railway Strike the Lighting, Heating and Power (Emergency) Order, 1919, prohibiting display lighting, has been revoked. It is, however, considered necessary to maintain for a short time the restrictions imposed by the Coal and Fuel (Emergency) Order, 1919, limiting deliveries of coal to 1 cwt. The Gas and Coal (Emergency) Order, 1919, which prescribes a maximum calorific value of 425 B.T.U. gross, and provides for the diminution of pressure in case of necessity, will also remain in operation.

West Ham Electric Light Committee is considering the tenders recently received for the supply and erection of additional generating plant. The proposed extensions include a 10,000-kw. turbo-alternator and two water-tube boilers, addition of circulating water system, foundations, switchgear, &c., and also mains, transformers and services. The Corporation decided to proceed with the scheme on the advice of the electrical engineer and manager (Mr. F. W. Purse), who had previously considered the possibility of obtaining a supply in bulk.

Increased charges for electricity have been adopted at Accrington. For lighting there is a flat rate of 7d. per unit, with a minimum of 5s. per quarter during the summer and 10s. during the winter; for heating and domestic purposes through separate meter, 2½d. per unit; the rateable value basis is 15 per cent., with 2d. per unit, and for power there is a sliding scale ranging from 4d. per unit for first 100 units to 1¼d. per unit over 6,600 units per quarter. The proposal to erect a steel smoke-stack at the electricity works has been vetoed by the owner and lessees of the estate.

Beckenham Urban Council has decided to install a 1,000-kw. Ljungstrom turbine set at an estimated cost of £16,500 and application has been made for sanction to borrow this sum, together with £2,500 for mains, and £4,000 for services and £2,000 for meters. The Council has taken this step because Sir John Snell had advised them that it would be cheaper to put in a steam turbine than take a supply of current in bulk. The present works cost, allowing for increase in coal, &c., is £15,186. If they took a bulk supply on the terms offered by the West Kent Electric Power Company the figure would be £14,457; but if they put in the steam turbine the figure would be reduced to £11,645.

Stepney Borough Council recently applied to the London County Council for sanction to borrow £21,212 for the electric supply department, but the County Council is prepared to sanction the borrowing of only £18,462 (repayable as to £3,712 within 60 years, £8,750 within 12 years and as to £6,000 within 10 years). The borrowing of £2,750, the cost of services laid between April 1, 1916, and March 31, 1919, and the cost of meters, &c. provided between those dates was disallowed. It has therefore been decided to take up a loan of £18,462 at 5¼ per cent., and the balance (£2,750) of the sum originally applied for will be paid out of the revenues of the electricity supply undertaking.

Mr. J. H. Rider, of Messrs. Preece, Cardew, Snell & Rider, who has reported to Wrexham Corporation on the present position of the electric-supply works, thinks that the existing power station, with its low-tension system of generation and small uneconomical engines, is entirely out of date and wasteful. The site is not suitable for a modern station owing to the fact that all coal had to be carted. The boiler-house arrangements could not be permanently improved without entire reconstruction. It would be advisable to make a canvass and estimate of the potential power requirements, within a 4 or 5 mile radius, in order to ascertain whether a new power station would be justified or not. The installation at Gresford Colliery could relieve the present tax on the capacity of the works by helping to supply the Garden City, but the manager was unable to agree to the proposal unless the Corporation were prepared to supply the whole of the existing colliery load in the event of a breakdown of the colliery plant. As the present Corporation plant is already overloaded, the Council is not in a position to comply with the condition. The existing plant is inadequate and more or less obsolete, thus costing considerably more for generating than a modern plant. The heavy cost of generation is partly due to the great increase in the price of coal and labour; but Mr. Rider considers that the engineer (Mr. Pickavence) is doing remarkably well with the plant and staff at his disposal.

The Council has increased the flat rate charge per unit to 7½d. net, and other rates in proportion. Quotations are to be obtained for water softeners and an automatic stoker.

Miscellaneous.

The following heading has been deleted from the schedule to the Proclamation of May 10, 1917, in regard to Prohibition and Restriction of Exports: (A) Telegraphs and telephones, wireless, and instruments and material for wireless telegraphic and telephonic apparatus, including valves.

Application has been made by the British Electrical Development Association for a licence to permit the registration of the Association with limited liability, but without the addition of the word "limited" to its name. Objections to the companies' Department of the Board of Trade by Nov. 1.

The Court of Arbitration has concluded the hearing of the case between the National Transport Workers' Federation and the owners of the tramway and omnibus undertakings as to the claims of the men for an increase of 12s. per week on existing rates in the case of employees of 18 years of age and over and 6s. in the case of those under 18 years. On Saturday evidence was submitted for the London bus companies, and on Wednesday the award of the Court was issued and grants 4s. a week to employees of 18 years and over and 2s. to workers under 18 years.

Some curious evidence was given at an Inquest, which was held at Runcorn on Tuesday, upon a man named David H. Howard, who was drowned in the Manchester Ship Canal. When passengers were landing from the Transporter Bridge at Runcorn on Saturday, the bridge suddenly receded one yard, and Howard stepped over the end, falling between the car and the roadway into the Canal. Mr. Wood, engineer to Widnes Corporation, said he had found cobwebs on the collector pulley and the driver's cabin. He believed these were saturated with moisture from fog, and that a certain amount of electric current leaked along them to the car switch, causing a momentary and mysterious movement of the car. It was stated that experts would be consulted to solve the mystery.

In a review of the Birmingham Industrial Situation caused by the railway strike the "Birmingham Post" pays a high tribute to the service rendered by the excellent supply of electricity by the Corporation. All the big metal-rolling mills are operated electrically and take current from the Corporation mains. The millowners, foundries and factories had raw materials to carry on, and as there was a sufficient supply of electric current the amount of unemployment was almost negligible. The vast electrification of industry in Birmingham proved a tremendous asset in all directions. Motor and cycle firms, machinists and general engineers, ironfounders, lamp manufacturers, stampers and piercers, wire workers, bedstead makers, the gun trade, electro-platers, jewellers and a great many other Birmingham industries were well off for motive power. The leather trades were hardly affected by the strike, except as regards the clearance of manufactured goods. Lamp manufacutrers also, now at the height of their season, had power and raw material, so that, generally speaking, manufacturers were hardly affected.

Electric Traction.

Ilford Council will order two electric vehicles from Edison Accumulators, Ltd., at £3,208, subject to a guarantee as to early delivery.

As the parcels department of the Accrington tramways is being carried on at a loss the charges have been increased by the Tramways Committee.

In the Manchester Corporation Bill for 1920 power will be sought to construct four tramway terminals, some new lines and also to double existing lines.

Sunderland Council are recommended to approve of a scheme for relieving the congestion of tramway traffic in the centre of the town, and probably the extension of the system to Whitburn, about a mile beyond the present tramway terminus.

There is a proposal to connect up the electric tramways of Leeds and Dewsbury, but representatives of the latter Council complain that the conditions imposed by the Leeds Tramways Committee make it difficult to proceed with the scheme.

The accounts of the Birkenhead tramways department for the year ended March 31, 1919, show revenue £114,974 (compared with £97,838 last year), and working expenses £69,249 (£53,815). Interest required £19,049 (£16,492) and sinking fund £10,138 (the same as last year), and net profit was £16,500 (£17,372). Revenue was 22·44d. (19·25d.) and working expenses, including power were 13·51d. (10·39d. per car mile. Passengers carried were 23,942,837 (20,538,476) and car miles run 1,229,610 (1,219,250).

St. Helens Corporation took over the local tramways on the 1st inst., and they are now run as a municipal undertaking. At last week's Council meeting Coun. Rudd said that the track and equipment would cost the Council £73,000, and the cars £24,000, but they would be forced to spend £17,000 on new cars. In addition to that they would have to take into early consideration the reconstruction of a great part of the track, so that ultimately it was probable the capital expended would be about £200,000.

The accounts of the Bradford tramways department for the year ended March 31, 1919, show revenue £494,245 (£402,181), and expenditure £375,074 (£314,998). Interest required £31,292 (£29,345) and sinking fund £27,054 (£26,462), and the net profit was £60,826 (£31,376), of which £60,820 has been transferred to depreciation &c., account. Working expenses, including power, but excluding parcels, rail-less traction and Bowling Hill and motor garage departments, were 16·542d. (12·322d.) per car-mile, and total revenue was 22·257d. (15·892d.). Passengers carried were 76,419,459 (84,129,252) and car-miles run 5,269,834 (5,905,356). The revenue on the rail-less trolley system (17 vehicles owned) was £15,121 (£12,249)=10·549d. (7·934d.) per car-mile, and the working expenses were 17,157 (£12,761)=11·97d. (8·266d.).

On Tuesday the London County Council had under consideration important reports from the Highways Committee dealing with a number of schemes for linking up the present tramway termini and extending the system. On the tramway question the Committee recommended :—(*a*) That the Government be asked to set up forthwith an independent body to consider the full scheme of tramway development projected by the Council, and to hear any objections that may be raised to such scheme by the local authorities, &c. (*b*) That it be referred to the Parliamentary Committee to take the necessary steps to obtain the suspension of the Standing Orders of Parliament so as to provide in respect of tramway schemes to be introduced in the session of 1920 that the Council shall be enabled to place such schemes before Parliament for consideration, notwithstanding the fact that it may not have secured all the requisite consents of the local and road authorities under standing orders to the introduction of the necessary Bill. (*c*) That the Minister of Transport be asked to receive a deputation from the County Council in support of the proposals contained in the foregoing resolutions.

With regard to auxiliary omnibus services the Committee recommended : "That notice be given of the intention of the Council to consider at its meeting on Oct. 21 a proposal that it shall take the necessary measures for promoting in the session of Parliament of 1920 legislation to enable the Council to own omnibuses, and to run in, and in the vicinity of, the County of London auxiliary omnibus services for the linking up of tramway dead-ends and for other specific purposes.

The Committee also presented a lengthy report on the removal of certain financial burdens of the tramways, the rating of tracks, repayment of loans, &c. The Committee reported that "after careful consideration of the whole question of loan repayment we do not think that any departure should be made at present from the existing practice." As to the maintenance of tramway tracks and street improvements it was recommended that : (*a*) that application be made to Parliament in the session of 1920 for the Council to be relieved of liability for the maintenance of the surface of the roadway in thoroughfares in which tramways are worked or may hereafter be worked, with the exception of any rails or other works which may be used for the purpose of the tramways ; (*b*) that the resolutions of July, 1909, with reference to the incidence of the cost of street improvements along tramway routes be rescinded so that no part of the cost of street improvements be charged to the tramways account except in the case of improvements which are solely and specifically required for working the tramways system.

The reports and recommendations were adopted except that relating to the cost of street improvements, which was referred back. Supplemental estimates were approved for the construction of Lee-green to Eltham route (£11,462) and the line from High-street, Wandsworth, to East Hill (£5,520).

Imperial and Foreign Notes.

Efforts are being made to develop the resources, to improve agriculture and to introduce new industries into British Honduras. A company was recently formed with a capital of £10,000 in order to assist the movement, and licences have been granted by the Government for the installation of electric supply and ice-making plants at Belize, the capital.

The import duty on complete parts of certain articles specified in item 447 of the Canadian Customs Tariff is 12½ per cent. under the British Preferential Tariff, and 17½ per cent. under the Intermediate and General Tariffs. The following have been added to the schedule of complete parts admissible under item 447 : Ball and roller bearings ; cable sets for magnetos, with terminals ; fans for radiators ; headlights for tractors ; magnetos ; radiators ; springs, brass valves, &c.

The Lake Huron Steel Corporation proposes to erect extensive works at Goderich, Ontario, and a sum of $2,000,000 will be spent on electric steel plant during the next 12 months. Six Héroult electric furnaces will be installed. A blowing mill, rod mill and bar mill will be built for the production of high-grade steel billets, rods, bars, and ferro-alloys. The company will require about 14,000 h.p. of electrical energy during the initial operations, and that this will be increased to 20,000 h.p. which will be obtained from the Hydro-Electric Power Commission.

According to the "Industrial Australian and Mining Standard," the Australian Electric Steel Company, Ltd., which was established 2½ years ago in Sydney, has demonstrated its ability to manufacture the highest grades of cast steel. The present capacity of the plant is 200 tons per annum, but the company will shortly erect a similar plant some 7 miles from Perth, which will be supplied with power from the electric power station of the Government. To protect this industry, a demand is being made that chrome, manganese and other alloy steel castings and locomotive wheels should be placed under the same classification as carbon steel castings, on which the import duty is 30 per cent. and 35 per cent. respectively, under the preferential and general tariffs.

With the progress of hydro-electric power development in the province of Quebec, many manufacturing and industrial plants have been established at various points. Electric power has been developed to the extent of over 200,000 h.p. at Shawinigan Falls, 130,000 h.p. at Grand Mere, 100,000 h.p. at La Tuque and 100,000 h.p. at Three Rivers, while it is anticipated that there will be a total development at various points of 830,000 h.p. The power from Shawinigan Falls is used for the production of paper pulp, calcium carbide, carbon electrodes, acetone, acetic acid, magnesium, aluminium and ferro-alloys ; and at the other centres the power is used chiefly for the production of lumber, pulp and paper. There is practically an unlimited supply of power available for development in the province, and, although United States interests are prominent, British manufacturers of mill machinery and electrical plant might also find it possible to secure profitable orders.

The Hydro-Electric Power Commission of Ontario is carrying out an important engineering project at Niagara Falls practically without the use of steam. In order to get water to the new power house which will be erected above Queenston, the commission will utilise 4¼ miles of the Welland River, causing this sluggish stream to flow backward, and to take water from the Niagara River instead of emptying into it above the Falls. Connecting with the Welland River is a power canal, stretching from Queenston and encircling the city of Niagara Falls, Ont., which will be 8¼ miles long when completed. The original survey for the Niagara development was made in 1914, and the construction work begun in May, 1917. The commission expects to have the new plant in working order in 1922. The undertaking will cost approximately $27,000,000. A steam dredge is gnawing away operating on the Welland River, and its attendant tugs are the only pieces of equipment, together with six or seven switch engines, are the only apparatus in use on the development which require steam in their operation. Even the drills employed on the rock deposits of the canal right of way are operated by air, electrically compressed. A mile or two inland a huge clamshell swung from an aerial cableway, drops into the river and then emerges, bringing with it generous bites from the river bottom, which are deposited on the river bank at the foot of the tower from where the operator directs the activities of the clamshell. On the canal proper, the huge electric shovels, electric trains and gangs of men present a striking picture. The electric shovels pick up from 8 to 10 tons of material, lift it 70 ft. into the air and deposit it into waiting cars, all within the short space of 40 seconds. Trains hauled by electric locomotives convey the mud and clay to the dump at St. David's. The boulders and rock from the canal are borne away to the stone crusher on the cliff above Queenston, and converted into material for roadways, &c. The stone crusher has a capacity of 4,000 cubic yds. The rocks from the excavations are cast into a trough opening into gigantic steel jaws which grind and break the largest pieces into smaller bits that are carried away on a belt conveyor. A series of crushers reduce the rocks to a form where they may be utilised for building purposes. There are 55 miles of electric railway, which tap five trunk lines. On this railway the commission has in operation more electric locomotives than any railway system in Canada. At present 2,000 men are employed on the big job. The commission maintains its own telephone system on the development, and it has connections throughout the province. Garages, machine shops and office buildings line the right of way. By establishing its power house at Queenston the commission is enabled to take advantage of the full drop of both Niagara Falls and the Gorge, a total drop of 305 ft., affording 100 per cent. more electric power from the same amount of water. Electric generating units of 55,000 h.p. will be installed in the power house, to produce electrical energy for distribution throughout the Province of Ontario.

It is announced that a concession for the construction of a tramway system in Canton has been granted to a syndicate composed of two British subjects and one Chinese.

A projected tramway between Vise and Vivegnis, the terminus of the Liege tramways, will give a shorter and more efficient means of communication between Brussels and Germany. The tramway company will also build other tramways and supply electrical energy for power and lighting in the district.

The French Department of the Posts and Telegraphs now permits the transmission of telegrams under pre-war conditions, and the authorised code languages and telegraphic addresses are allowed, provided the country to which they are addressed will accept them. Senders of code telegrams must prove their identity if they are unknown to the telegraphic authorities.

The Danish Government recently announced the removal of the prohibition of the exportation of chrome ore, copper ore and pyrites, electric cables, ferrochrome, ferromanganese, ferromolybdenum, ferronickel, ferrosilicon, ferrotungsten, ferrovanadium, iron ore, pig iron, iron unwrought and partly prepared. iron and steel wire, lead compounds, magnesium and its compounds, manganese, nickel ore and compounds, strontium and compounds. The permission of the Ministry of Justice need no longer be obtained for exporting lamps and lamp-shades and electrical goods.

In regard to the position of the Mexican Tramways, the chairman of the bondholders' committee denies the statement that a contract for the resumption of construction had been entered into, but in view of the fact that, owing to the unsettled conditions in Mexico and to the financial position of the company, an arrangement has been made with the Mexican Government by which the time limit for the completion of the line to Puebla has been extended for an additional term of 6½ years. The properties of the tramways company were taken over by the Mexican Government several years ago and operated by them until May last, when they were handed back to the company, which is now operating them.

Tenders Invited and Accepted.

Blackpool Corporation invite tenders by Oct. 20 for 2,000 tons of steel tramway rails.

Glasgow Parish Council require tenders by Oct. 24 for 12 months' supply of electric lamps and fittings, bell furnishings, &c. Forms of tender from the Inspector and Clerk, 266, George-street, Glasgow.

Edinburgh Corporation require tenders by Oct. 13 for the electric lighting installations in dwelling houses under the Gorgie housing scheme. Specifications from the City Electrical Engineer.

The Commissioners of H.M. Works invite tenders by 11 a.m. Oct. 13 for the purchase of old electrical accessories. Forms of tender, &c., from the Controller of Supplies, King Charles-street, S.W. 1.

Manchester Tramways Committee require tenders by 10 a.m. Oct. 14 for the supply of steel girder tram-rails. Specifications, &c., from Mr. J. M. McElroy, general manager.

The Deputy Postmaster-General, Brisbane (Queensland) will receive tenders until noon Oct. 22 for supply of paper-insulated, lead-covered, steel-armoured cable (schedule 475) for the Australian Commonwealth, Postmaster-General's Department.

Johannesburg (Transvaal) Council require tenders by noon Nov. 24 for the supply of tramcar spares (contract No. 531), and by noon Dec. 1 for the supply, &c., of a 500-kw. converter, or, alternatively, a 750 kw. converter, and spare parts (specification No. 114).

Bristol Docks Committee require tenders by 10 a.m. Oct. 20 for the construction, maintenance, &c., of six electrically-driven lifts and two electrically-driven mutton hoists, at the New Cold Stores, Royal Edward Dock, Avonmouth. Specifications from the Engineer, Avonmouth Dock.

Tenders are required by Jan. 20 for the supply, &c., to the Australian Commonwealth Postmaster-General's Department, State of Victoria, of Automatic Telephone Switchboards at Collingwood, as per schedule 1,583. Tender forms, &c., from the High Commissioner, Room 406, Australia House, Strand, London, W.C.

The following tenders were accepted by the British Government Departments during August :—

War Office.—Waygood-Otis, Ltd., maintenance of lifts in London district. *India Office.*—Tudor Accumulator Company, accumulators; Lancashire Dynamo & Motor Company, alternator; Lawrence Scott & Company, armatures; Babcock & Wilcox, boilers; Pirelli General Cable Works, Callender's Cable & Construction Company, British Insulated & Helsby Cables, W. T. Henley's Telegraph Works Company, W. T. Glover & Company, Johnson & Phillips, Siemens Bros. & Company, Union Cable Company and Macintosh Cable Company, cables; Chloride Electrical Storage Company, cells; General Electric Company, lamps; Evershed & Vignoles, meggers; British Westinghouse Electric & Mfg. Company (*now* Metropolitan-Vickers Electrical Company), motors; Marconi Wireless Telegraph Company, receiving sets and radio stores; Chance Bros., searchlights; T. Cooke & Sons, stress recorders; Elliott's Metal Company, T. Bolton & Sons, F. Smith & Company, R. Johnson & Nephew, Shropshire Iron Company and British Insulated & Helsby Cables Company, wires. *Post Office.*—British Insulated & Helsby Cables, supply and drawing in of cables (Glasgow-Dumbarton); W. T. Henley's Telegraph Works Company, ditto (Sevenoaks-Tunbridge Wells); British Insulated & Helsby Cables, ditto (Glasgow-Coatbridge); Johnson & Phillips, ditto (Rawtenstall-Bacup); Siemens Brothers & Company, telephone exchange equipment (West Bromwich); Peel-Conner Telephone Works, ditto (Clerkenwell); Automatic Telephone Mfg. Company and Phœnix Telephone & Electric Works, protective apparatus; British L. M. Ericsson Mfg. Company, Phœnix Telephone & Electric Works, Sterling Telephone & Electric Company and Western Electric Company, telephone apparatus; Bullers Limited. w.i. brackets; British Insulated & Helsby Cables, Johnson & Phillips and New Gutta Percha Company, telegraph and telephone cable; Fuller's United Electric Works and Hart Accumulator Company, secondary cells; Phœnix Telephone & Electric Works and Western Electric Company, telephone cords; Walkers, Parker & Company, earth plates; C. M. Powell Brothers, jointing sleeves; Bullers Ltd., pole steps; E. & J. Richardson. cable suspenders; British Thomson-Houston Company, amplifying valves; British Insulated & Helsby Cables, insulated bronze wire; Whitecross Company, steel wire. *Crown Agents for the Colonies.*—Siemens Bros. & Company, cables, &c.; Hooper's Telegraph & India Rubber Works, river cable; Bullers Limited, insulators and spindles; British Thomson-Houston Company, motor-generators, &c.; British Switchgear, Ltd., switchboards; Siemens Bros. & Company, telephone line material; Shropshire Iron Company & Elliott's Metal Company, copper wire; R. Johnson & Nephew. g.i. line wire. *H.M. Office of Works.*—Premier Accumulator Company, storage battery, &c.; Ferguson, Pailin, Ltd., switches, &c.

Appointments Vacant and Filled.

A lecturer is required in the electrotechnics dept. of the Borough Polytechnic Institute. Salary £300, rising to £400 per annum. Applications to the Principal, Borough-road, London, S.E., 1, by Oct. 13.

A lecturer is required for the electrotechnics department of the South African School of Mines and Technology, Johannesburg. Salary £450, rising to £550. Applications to Messrs. Chalmers, Guthrie & Company, Ltd., 9, Idol-lane, London. E.C.3, by Oct. 20.

A professor of physics is also required for the South African School of Mines and Technology, Johannesburg (Transvaal). Salary £800, rising to £1,000. Applications to Messrs. Chalmers, Guthrie & Company, Ltd., 9, Idol-lane, London, E.C.3, by Oct. 10.

Sunderland Education Committee invite applications for the position of assistant in the electrical engineering department of the Technical College. Commencing salary £250–£10–£350. Applications to the Chief Education Officer, Mr. H. Reed, 15, John-street, Sunderland, by Oct. 13.

Applications are invited by the London County Council for the position of charge shift engineer at the Greenwich generating station. Salary £250–£10–£300 a year. plus war bonus of 20 per cent., plus £90. Applications to the Clerk of the London County Council, Spring Gardens, S.W.1, by 4 p.m. Oct. 20.

Applications are invited for the position of lecturer in electrical engineering at the University of Cape Town. Commencing salary £350, rising after three years' service by annual increments of £25 to £450, plus war bonus. Applications to the Secretary, High Commissioner for the Union of South Africa, 32, Victoria-street. S.W., by Nov. 30.

Shanghai Municipal Council require a boiler-house chemist, a second assistant mains engineer, and an assistant draughtsman. Salary. 350 taels per month in each case. An assistant secretary is also required for the electricity department of the Shanghai Municipal Council. Salary 400 taels per month. Applications to Messrs. Preece, Cardew, Snell & Rider, consulting engineers, 8, Queen Anne's-gate, London, S.W. 1.

Mr. R. W. Grubb has been appointed borough electrical engineer at Dewsbury in succession to Mr. R. H. Campion at a commencing salary of £450 per annum.

Bexley Urban Council has promoted Mr. J. Makin from the position of assistant electrical engineer to that of chief electrical engineer and manager of the electric supply and tramways department at a commencing salary of £550 per annum. Mr. Makin will take up his duties on the 1st prox., when Mr. Stokes will leave for Plymouth.

Business Items.

The General Electric Company, Ltd., has issued an artistic folder which gives the reduced prices of Osram G.E.C. lamps, Atmos type.

The Electrical Apparatus Company are erecting a new factory on land adjoining the New House Park Estate, near St. Albans.

The address of the Manchester office of Messrs. Babcock & Wilcox, Ltd., is now Victoria-buildings, 230, Deansgate (telephone, City 3112; telegraphic address, Babcock Manchester).

Messrs. Mansell & Ogan, Ltd., 15-17, Cecil-court, Charing Cross-road, W.C. 2, have issued a price list of the half-watt flood lanterns for stage lighting, arc lamps, plugs and sockets, "Cecil" dimmers, &c., supplied by them.

We have received from the Tubular Woven Fabric Company, of Pawtucket, R.I., a sample of a product called "Duracord," which appears to be a good quality portable extension cord for drills or portable tools, or wherever heavy duty extension lamps, &c., are required.

The Bastian Electric Heating Company, Ltd., 185, Wardour-street, London, W. 1, has issued a leaflet giving illustrated particulars of the Bastian hot water tank. The company will be glad to send copies to those of our readers interested in water heating, especially in connection with new housing schemes.

Companies' Reports, &c.

The Submarine Cables' Trust notify that on and after the 15th inst. the coupon due on that date will be paid by Messrs. Glyn, Mills & Company, 67, Lombard-street, E.C.3.

The directors of the Kaministiquia Power Company have declared a dividend of $2 per share (or at rate of 8 per cent. perannum) on the common stock in respect of quarter ending Sept. 30.

The directors of the Cuba Submarine Telegraph Company, Ltd., bave declared an interim dividend on the ordinary shares for the six months ended June 30 last at the rate of 5 per cent. per annum, tax free.

The directors of the Bombay Electric Supply & Tramways Company have declared an interim dividend for the half-year to June 30 last on the ordinary shares at the rate of 14 per cent. per annum.

At a meeting of the Northampton Electric Light & Power Company on the 6th inst., it was decided to increase the capital to £250,000 by the creation of 50,000 additional "B" shares of £1 each ranking pari passu with the existing preference shares.

The following companies were Struck off the Register of Joint Stock Companies on Oct. 3: Alpha Electrical Company, East London Electrical Company, G.O. Accumulator, South American Railless Traction Company.

The French Thomson-Houston Company proposes to increase the capital from 120,000,000fc. to 200,000,000fc. by the issue of 160,000 new shares of 500fc. each, of which 140,000 shares are to be offered to the present shareholders, whilst 20,000 sbares are to be taken up by the General Electric Company of New York.

The report of J. Stone & Company, Ltd., for the year 1918 states that there is a credit balance, after necessary allowances for depreciation, &c., of £90,189, which with £116,702 brought forward, makes £206,891. The directors propose to pay a dividend of 10 per cent. per annum and a bonus of 1s. per share on the ordinary shares, and to carry forward £131,861.

At the meeting of Hudson's Consolidated, Ltd., on the 2nd inst., the chairman, Mr. C. Howard Tripp, stated that the exploitation of the company's wireless telegraphy patents had been retarded during the war, but since peace had been declared they had secured the services of an expert lately in the employ of a Government Department, and under his guidance the board hoped that the first apparatus would be completed in about two months' time. They had very high hopes of the value of the invention. It was generally known that "wireless" to-day could be tapped by instruments which were correspondingly tuned, and there was no secrecy possible under such a system. The directors were assured by their advisers that when the company's secret system was perfected the machine could not be tapped, and if that proved to be correct it would be a very valuable asset.

Sir Charles Ellis, who presided over the ordinary general meeting of John Brown & Company, Ltd., explained the arrangements made for strengthening the position of the company, and said considerable interests had been purchased in the Carnforth Iron and the Cravens Wagon Companies. It was quite impossible to expect that a company like Carnforth's, which was a pure armaments business, could carry on under the different circumstances. There was a very large plant of modern and valuable machinery, and they asked themselves what was the best purpose to which it could be adapted. It was felt it was perhaps most suitable in connection with their electrical installations. The directors accordingly made arrangements that they join forces with very large electric machinery producers, and form themselves into the English Electric Company. The English Electric Company was a purely British concern. There had been rather too much Hun about the names of electric companies, so that John Brown's were determined to make theirs a British concern. He was asked by telegram when he was in Paris if he would be chairman, and consented, and he had the support on the board of Mr. Bernard Firth and Mr. John Sampson.

At the recent meeting of J. Lysaght, Ltd., the chairman outlined the company's Australian policy. It had been the policy of the Australian Government to develop its own iron industry, and to assist local enterprise by helping to make such undertakings successful. The war strengthened this policy, and as a consequence the company commenced the erection of their own works at Newcastle, N.S.W., for sheet-rolling and galvanising. At the point where the Government left off the company began, as they had reached an agreement whereby the Government would supply their requirements in the way of steel bars, and undertook that they would not themselves go into the manufacture of sheet iron. With the aid of the bonus received from the Australian Government, the benefit of the tariff, the advantage as regards freights and the use of the experience of the company's staff in its home works in laying out and equipping the new undertaking, they felt confident that the policy of local manufacture would prove a great success. The dislocation of business produced by the war of course can only be set right by degrees, but he was glad to report that in every department at home and abroad work was being resumed on normal lines. The output was being gradually increased, and he hoped that within a few months all the manufacturing departments would be at full work. Half the population of Great Britain was supported by its export trade, and unless our productions could be manufactured in this country at costs which would enable them to compete with the United States and other countries in the markets of the world our trade could not be held.

New Companies.

AMALGAMATED ELECTRIC WORKS, LTD. (159,136).—Private company, reg. Sept. 26, capital £5,000 in £1 shares, to carry on the business of electrical and general engineers and contractors, manufacturers of and dealers in electrical apparatus, wires and cables, &c. Secretary, A. S. Richards, Reg. Office: 44, Leadenhall-street, E.C.

BALLYMORE ELECTRIC LIGHTING & TOWN IMPROVEMENT COMPANY, LTD. (4,794)—Private company. Reg. in Dublin Sept. 26. Capital £3,000 in £1 shares. To carry on the business indicated by the title. First directors are P. O'Hart, W. J. Lipsett, J. Hannon, P. E. Durcan, W. Kane, J. Cawley, J. Healy, A. Rogers, A. McCabe and F. McDonagh. Sec.: P. E. Durcan. Reg. office: The Market House, Market-street, Ballymote.

BELL BATTERY COMPANY, LTD. (159,253).—Private company. Reg. Oct. 3, capital £15,000 in 9,000 preference shares of £1 each and 60,000 ordinary shares of 2s. each, to carry on the business of wet and dry electric cells, electricians, manufacturers of and dealers in electric appliances and apparatus, &c. Directors: M. Edenborough, O. W. Seligman and L. Cornelis. Reg. Office: 52, New Broad-street, E.C. 2.

BROWNING & LAMBERT, LTD. (159,255).—Private company. Reg. Oct. 2, capital £3,000 in £1 shares, to carry on the business of motor electrical, and mechanical engineers, engineers, &c. First directors are Miss M. H. Browning and Miss B. M. Lambert, 23, Torlingham-gardens, Folkestone (both permanent, subject to holding 300 shares each). Reg. Office: 28-29, St. Swithin's-lane, E.C.

H. CLARKE & COMPANY (MANCHESTER), LTD. (159,067).—Private company, reg. Sept. 24, capital £25,000 in £1 shares, to take over the business of a manufacturer of and dealer in insulating materials and screws and general engineers' sundriesman carried on as "H. Clarke & Company" at Old Trafford, Manchester. Reg. Office: 22, Cooper-street, Manchester.

JOBSON & BECKWITH, LTD. (159,154).—Private company, reg. Sept. 26, capital £1,000 in £1 shares, to carry on the business of mechanical, electrical and water supply engineers, manufacturers of machinery, &c. Reg. Office: 30, Norfolk-street, Strand, W.C. 2.

Prices of Metals, Chemicals, &c.

Tuesday, Oct. 7.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£111 0 0	£1 0 0	—
Electrolytic bars ...	,,	£120 0 0	—	£1 0 0
H.C. wire basis......	per lb.	1s. 3$\frac{15}{16}$d.	—	—
Sheet	,,	1s. 3$\frac{5}{8}$d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 7$\frac{15}{16}$d.	—	$\frac{1}{4}$d.
Brass 60/40—				
Rod, basis	,,	0s. 11d.	—	—
Sheet, basis	,,	1s. 2$\frac{3}{8}$d.	—	—
Wire, basis	,,	1s. 2$\frac{1}{4}$d.	—	—
Pig Iron—				
Cleveland Warrant	per ton	Nominal	—	—
Galvanised steel wire, basis	,,	£32 10 0	—	£1 0 0
Lead Pig—				
English	,,	26 15 0	—	—
Foreign or colonial	,,	25 17 6	5s. 0d.	—
Tin—Ingot	,,	282 0 0	£4 10 0	—
Wire, basis	per lb.	0 3 6	1$\frac{7}{8}$d.	—

Salammoniac.—Per cwt. 80s. and 75s.
Sulphur (Flowers).—Per ton £21.
,, (Roll Brimstone).—Per ton £21.
Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £41.
Boric Acid (Crystals).—Per ton, £72.
Carbon Bisulphide.—Per ton £55.
Sodium Bichromate.—Per lb. 11d.
Sodium Chlorate.—Per lb. 6d.

Shellac.—475s. December delivery 445s.
Rubber.—Para fine, 2s. 6d.; plantation 1st. latex 2s. 2$\frac{1}{4}$d. lb.

Thirty-Seven Years Ago.

From The Electrician, Oct. 7, 1882.]

Egypt.—Telegrams for all parts of Egypt are now accepted, and the restrictions as regards messages in cypher have been removed

Electric Light in London.—Messrs. B. Verity & Sons' establishment in King-street, Covent Garden, W.C., is now lighted by the Edison system, 60 lamps being in use. Messrs. Verity are large makers of gas and electric light fittings, electroliers, &c.

A Telephone Line without Insulators.—The Evansville (Ind.) Telephone Exchange Company work 400 miles of line without insulators of any kind, the wires being simply attached to the poles. It is even stated that the line has been found to work better than one on insulators.

Fatal Accident.—The "Standard's" New York correspondent, telegraphing on Wednesday last, says: "A workman who was repairing a lofty Brush light here received the electric current which was supplying 40 lights. It passed through the man, who fell dead, the body dangling among the telegraph wires below. The hands were seared, and the face bore the expression of intense agony."

THE ELECTRICIAN:

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ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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Notes.

The Miners and Nationalisation.

MR. LLOYD GEORGE's straight talk with the deputation from the miners last week will afford some relief to the public. Much has been made of the idea that the Government pledged themselves to carry out whatever measures might be recommended by a majority of the Coal Commission, even if that majority were merely one or two. Mr. LLOYD GEORGE stated very clearly the impossibility of any Government binding itself to accept the finding of any Commission, particularly such a body as the Coal Commission, which contained only three independent members apart from the chairman, and the proceedings of which were marked by the extraordinary incident of two of the members giving evidence and then sitting to determine the value of this evidence. The improbability of the State being able to manage the complicated coal industry in anything like an efficient manner, and in a way which would produce coal more cheaply, was clearly brought out in the discussion. Moreover, the theory that the men would not strike against the State owing to the fact that the question of private profit would no longer arise, has been rudely disturbed during the last week or two. Any such idea, we feel, is merely an ideal which would not be fulfilled. From later utterances, it does not seem as if the Miners' Federation will accept the decision as final, and we fear that there is every prospect of difficulties in the near future which may be very serious for the industries of this country. We only hope that the rank and file will not be lead into any extreme course. Those who are leading them, although they disclaimed any idea of threatening the Government, do not appear to be entirely sincere in their expressions. Obviously, they desire as much control as possible. Nominally, it is not absolute control that they wish, though this is by no means clear from the reading of the report. The scheme suggested by the Government would give the miners a very effective voice, not merely on pit committees, but also on boards of directors. Short of absolute control, the terms proposed give as much as can reasonably be expected. Moreover, the scheme would undoubtedly lead to higher efficiency in the utilisation of the coal as far as possible, owing to the nationalisation of minerals. Yet Mr. SMILLIE stated that the Federation would prefer that the conditions should remain as they are rather than accept such a scheme. In the face of this refusal, we think the conclusion drawn by Mr. LLOYD GEORGE is a very natural one—that the miners fear lest the adoption of the scheme might be so successful that nationalisation would no longer be desired. The only official utterance we regret is that the issue is apparently to be made political, which means that it is to be decided by the electors, most of whom know nothing of the subject.

Supply Companies and Future Finance.

THE Electricity Supply Bill as it now stands is likely to have a very prejudicial influence in one important direction, namely, the raising of further capital by electric supply companies. The mere fact that the possible compulsory purchase of their generating stations will henceforth always be hanging over their heads, like a sword of Damocles, is of itself a deterrent to investors embarking further on electric supply shares. But when, in addition to this element of uncertainty as to whether, or when, any purchase is likely to take place, the terms of purchase themselves are so unsatisfactory, the best of companies can hardly expect other than the cold shoulder when they come to the public for further capital. This is a position which will have to be faced, and the whole question looks as though it would be one of the very early problems which the Electricity Commissioners will be called upon to solve. Every extension of electric supply, in fact, every new consumer means additional capital expenditure, and the money must come from somewhere; otherwise the operations of a very large number of companies must dwindle rather than enlarge, and the very object of the Bill be, in a large measure, defeated. The situation might, of course, be eased if there could be some early pronouncement as to there being no likelihood of certain undertakings being affected for a considerable number of years. Possibly that would partially meet some of the cases. Further, if the purchase clause were adjusted on a more equitable basis, the whole complexion would be brighter. One would be happier as to this prospect if concrete realisation followed more often the dulcet pronouncements of our statesmen. It was only the other day that the PRIME MINISTER gave utterance to some very winning words that might well allay any fears of injustice being done when the Government are the purchasers or when they compel purchase. We commend the following words to the notice of the HOME SECRETARY, apropos of the Purchase Clause under the new Bill: "A man's property," said the PRIME MINISTER, at the Mansion House, "whatever form it takes, whether it takes the form of land, or buildings, or labour, if the community needs it, it must pay a fair price for it." A part of the "property" of electricity supply companies, and an indispensable asset, was their power of getting new capital. They are practically robbed of this by the Purchase Clause, as we have indicated above—that is, unless the HOME SECRETARY takes this precept to heart and arranges some more equitable basis.

Electrical Schools in New York.

AN account is given in the "Electrical World" of some measures taken to improve the position of schools for electrical workers in the United States. The scheme presents some features of interest, and is proposed as the result of an industrial education survey covering the printing, inside electrical work, carpentry and machinists' trade. It is interesting to note that the findings of the Committee were approved by the Conference Committee appointed by the Electrical Contractors' Association and the Independent Electrical Workers' Union. It is remarked that the workers' effectiveness in the electrical industry "depends on knowledge rather than skill," by which we presume it is meant to imply that in this field there is much that cannot be "picked up," but requires systematic instruction. The number of these wishing to take courses in electricity is rapidly increasing, and the present facilities are quite inadequate. Some 1,300 men out of a total of 6,815 electrical workers have registered for evening classes. It is recommended that two trade schools should be established, and the equipment at present used in three-day vocational schools and evening trade schools consolidated therein. This centralisation of apparatus will doubtless be an advantage, as there is often a tendency, in scattered night classes, for appliances to be inadequate. A feature is the proposed special instruction for travellers in "trade extension" classes. The unions require all travellers to attend evening classes of this nature, and the employers' committee will urge the members of its association to send their apprentices to part-time trade extension classes, with pay. All this implies a keen recognition both by workers and employers of the need for education in electrical work, and we wish we could believe that there was a similar keenness to be found in all the leading manufacturing cities in this country. The contention that electrical work demands special educational measures as compared with other trades is justified, as workers have here to deal with abstract phenomena which are not easily grasped. It is common knowledge that many of those filling subordinate positions in the electrical industry receive very little instruction of this type, and that the proportion who attend classes is not as large as might be desired.

* * *

I.M.E.A. Annual Convention.—The 1920 Convention of the I.M.E.A. will be held at Bradford during the week commencing June 20.

North-East Coast Institution of Engineers and Shipbuilders.—The annual general meeting of this Association will be held on Friday October 24th, when Mr. A. Ernest Doxford will deliver his presidential address.

Batti-Wallahs' Society.—The opening lunch of the Winter season will take place at the Holborn Restaurant on Monday next, Oct. 20, when Mr. Hugo Hirst will be the Society's guest. After the luncheon Mr. Hirst will give a short address.

I.E.E. Wiring Rules.—A few alterations to the 17th edition of the I.E.E. Wiring Rules, which were published in 1916, have been issued. The alterations, which are in the form of a fly leaf, and can be obtained gratis from the Institution, deal, generally speaking, with minor points. Rules 68 and 69, however, have been cancelled, and a new rule has been substituted, specifying conditions under which lead-covered unarmoured conductors should be employed. The table giving particulars of conductors has also been modified so as to bring it into line with the latest figures published by the British Engineering Standards Association.

Association of Mining Electrical Engineers.—The 11th annual general meeting of this Association, which was postponed from the 10th and 11th inst., is to be held at Edinburgh on the 24th and 25th inst. The ordinary general meeting of the London branch is posponed until the 29th inst.

Electrical Trades Benevolent Institution.—The annual festival dinner, which has been for the last five years in abeyance, will be held this year on Nov. 12 at the Imperial Restaurant (Oddenino's), Regent Street. Mr. H. J. Cash, president of the Electrical Contractors' Association, will be in the chair. It is hoped that members of the electrical industry will support him with their presence and their contributions, and if they are unable to come to the dinner that they will assist by sending contributions to one of the Committee or to the President of the Festival at Caxton House, Westminster. The secretary, Mr. F. B. O. Hawes, 18 & 21, Park Mansions, Vauxhall Park, S.W., will be pleased to receive contributions for the Institution at any time.

Grants for Research.—The British Association has addressed the following resolution to the Prime Minister and the Treasury:

> The British Association for the Advancement of Science, in reviewing the results of scientific methods applied to military and other practical arts, recognises that the successful issue of the war has sprung from the efforts of scientific men concentrated on those problems, and, with the conviction that the well-being and security of the nation is dependent on the continuous study of such matters, would urge on his Majesty's Government the necessity for apportioning an adequate sum from that allocated to home administration and the upkeep of the fighting forces, for the purpose of a definitely organised scheme of research, as, for example, on problems connected with health, food, and commerce, on explosives, on chemical warfare and on physical and engineering problems bearing on military work.

Similar resolutions have been forwarded to the First Lord of the Admiralty, the Secretary for War, the President of the Board of Trade and the Ministers of Health and Food.

The Shortage of Platinum.—A recent contribution by Mr. J. M. Hall, of the U.S.A. Geological Survey, describes in detail the various efforts that have been made to use substitutes for platinum during the war. Many uses of platinum are met by alloys containing more or less iridium, &c., and in other cases, again, tungsten and nickel-chrome alloys will answer. There are, however, instances, both in electrical and chemical work, where pure platinum is necessary. As is well known Russia has been in the past almost the sole source of platinum, producing over 90 per cent. of the world's production, but at present the industry is entirely disorganised. The most hopeful sources are Columbia, which has large reserves, and Alaska, where the production is increasing.

Industrial League and Council.—The second lecture of the series arranged by the Industrial League and Council (incorporating the Industrial Reconstruction Council and the Industrial League) will be held in the Council Chamber of the Guildhall on Tuesday, October 21st. The chair will be taken by the Right Hon. J. H. Thomas, M.P., and a lecture will be delivered by Mr. E. J. P. Benn on "Should Wages be Lowered?" Applications for tickets should be made to the Secretary, Industrial League and Council, 66, Victoria-street, S.W.1.

The annual dinner of the Industrial League will take place at the Connaught Rooms, at 7 p.m. on October 22nd, 1919. The Right Hon. G. H. Roberts, M.P., President of the Industrial League, will preside, and Lieut.-Col. John Ward, C.B., C.M.G., will be the principal guest. Since the last annual meeting the Industrial League has made considerable headway, and recently amalgamated with the Industrial Reconstruction Council, of which the Right Hon. J. H. Whitley, P.C., M.P., is President. A large number of employers from all parts of the kingdom are bringing workmen, shop stewards, foremen and managers to the dinner, and a record gathering is anticipated.

Electric Shock.—The war has led to additional information on electric shock, as on other subjects. Dr. S. Jellinek, in "Elektrotechnik und Maschinenbau," remarks that the shocks resulting from contact with the electrified wire fences used during the war (usually fed with a pressure of 1,000 volts), varied much in severity. One most important factor was undoubtedly the "state of preparedness" of the victim. Experience showed that a shock which was likely to prove fatal if received unexpectedly was harmless when anticipated. Experiments on animals have confirmed this impression and were also instrumental in showing that the physiological effects of shocks administered with direct and indirect current are distinctly different. It is also remarked that a close resemblance to death after shock should not be accepted too readily as proof. Persons apparently dead have not infrequently recovered when artificial respiration was applied. It is best to give the victim every benefit of the doubt.

Practical Daylight Measurements in Factories. In a Paper under the above title Messrs. E. G. Perrot and F. C. Vogan describe in the "Transactions" of the American Illuminating Engineering Society some tests of the admission of daylight into factories. In particular they have sought to verify the use of the "daylight-factor," indicating the degree of access of daylight for a given interior, as developed in England for work on this class. In view of the difficulty in applying practically theoretical researches on the inevitably changeable and fluctuating daylight we have always considered the idea of relating interior illumination to the total unrestricted illumination out of doors a happy one. We notice that the authors find, not unnaturally, that the "daylight factor" is not exactly constant for some types of interiors and for sunny days and blue sky. Nevertheless the daylight factor is probably a good average criterion of admission of daylight, and it must be remembered that in this country blue skies are unfortunately the exception, and not the rule.

The Sun as a Magnet.—An instance of the far-extending range of modern speculation on physical subjects is afforded by a paper read at the British Association meeting at Bournemouth by Sir Joseph Larmor, who discusses the circumstances under which a rotating body, such as the sun, could become a magnet. There possibilities were indicated: (1) Surface phenomena on the sun suggest the existence of a residual internal circulation, inducing an electric field acting on the moving matter and possibly creating an electric current flowing through a conducting path round the solar axis; this would produce a magnetic effect. (2) Conceivably the force of gravitation, or centrifugal force, can excite electrical polarisation, which, by rotation, produces magnetic polarisation. (3) Crystals possess permanent intrinsic electric polarisation, and one of the size of the earth would presumably produce an enormous electrical field; such a crystalline body moving with high speed through the ether might be expected to produce a magnetic field. It is easy, however, to adduce evidence against (2) and (3). The extraordinary feature of the earth's magnetic field is its great and rapid changes. Yet the absolute fixity of length of the astronomical day indicates extreme stability of the earth as regards material structure. But conceivably considerations of the type (1), which appear reasonable for the case of the sun, would account for magnetic change, gradual or sudden, on the earth.

International Electrotechnical Commission.—As previously reported, the fourth Plenary Meeting of the International Electrotechnical Commission will be held in London at the Institution of Civil Engineers, on October 20th to 24th. Eighteen foreign countries will be represented at this meeting by some 35 delegates. This is the first Plenary Meeting since the outbreak of the war, and is also the first to be held in London since 1906. The meeting will be officially opened on Monday, when an address will be given by the president, Mr. Maurice Leblanc.

The activities of the Commission were inevitably largely suspended on account of the war, and at the forthcoming meeting its future policy will be considered. Whilst this Plenary Meeting will be principally concerned with the future work of the Commission, one technical point of importance will come up for final ratification. The Special Committee (International) is recommending that 40°C. be adopted for the reference cooling air temperature for the rating of electrical machinery, this being in agreement with the existing British, American, Italian and French National Standardisation Rules. At a meeting of the British National Committee, held on the 13th October, Sir Richard Glazebrook, C.B., President of the British National Committee, and Mr. Roger T. Smith, President of the I.E.E., were nominated to be the British Members of the Council of the I.E.C.

With regard to the future, proposals have been received that the I.E.C. revise the list of Terms and Definitions which were prepared prior to the war, and issue them as soon as possible. It will also be proposed that terms and definitions for automatic telephones be considered internationally.

The delegates appointed by the British National Committee to represent them when the question of nomenclature comes up for discussion are: Dr. Alex. Russell, Mr. A. P. Trotter, Sir William Slingo, Major K. Edgecumbe and Mr. E. B. Vignoles.

Symbols.—A proposal will be brought forward that the I.E.C. should prepare an international list of graphical symbols. The British Committee have already prepared a list of nearly 200, and these, together with the list of symbols published by the Italians, would form a suitable basis for the work. The delegates appointed by the British Committee are as follows: Dr. Alex. Russell (Chairman of British Sub-Committee on Symbols), Mr. A. R. Everest, Capt. J. Slee, R.N., and Mr. A. J. Stubbs.

Nomenclature of Prime Movers.—Prior to the outbreak of war a Special Committee of the I.E.C. commenced the preparation of a report on the nomenclature of steam turbines for electrical plant, and it will be proposed that this work be continued. The following British delegates have been appointed to deal with this subject: Capt. H. Riall Sankey (Chairman of British Sub-Committee on Prime Movers for Electrical Plant), Prof. Gerald Stoney, Mr. F. Samuels and Mr. P. V. Hunter.

Screw Lamp Caps and Lamp Holders.—The proposal received from the French Committee that standards for screw lamp caps and sockets be prepared will be discussed. It is understood that the British Committee are in favour of this proposal and have nominated the following delegates to deal with this question: Mr. C. H. Wordingham (Chairman of British Sub-Committee on Electrical Accessories), Mr. F. M. Chapman, Mr. S. W. Attwell, Mr. S. H. Callow and Mr. J. E. Edgecumbe.

Standard Pressures for Distribution and Insulators.—This question having been raised by some of the foreign Committees the following delegates have been appointed, and instructed by the British National Committee in regard to this: Sir Richard Glazebrook, C.B. (Chairman of British National Committee), Mr. C. P. Sparks (Vice-Chairman of British National Committee), Mr. A. R. Everest (British Delegate to Special Committee on Rating), Mr. C. H. Wordingham (Chairman of British Sub-Committee on Electric Control Gear), and Mr. W. B. Woodhouse (Chairman British Sub-Committee on Overhead Transmission Line Material).

Standard of Resistance for Aluminium.—It was agreed to co-operate in the preparation of an International Standard of Resistance for Aluminium. It will be recalled that the standard of resistance for copper was internationally agreed and the value issued by the I.E.C. in 1914.

Personal.

On the 10th inst. the Right Hon. A. J. Balfour was elected Chancellor of Cambridge University, in succession to the late Lord Raleigh.

Dr. G. O. Arnold, Dean of the Faculty of Metallurgy and Professor of Metallurgy at SHEFFIELD UNIVERSITY since 1899 has tendered his resignation owing to ill-health.

Arrangements for the Week.

FRIDAY, Oct. 17th (to day).

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W.1. Lecturette on "The Manufacture of Collapsible Metallic Tubes," by Mr. E. R. Sharpe.

MONDAY, Oct. 20th.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At Storey's-gate, London, S.W. Meeting of Graduates. Paper on "Production," by Mr. C. H. Adams.

TUESDAY, Oct. 21st

INDUSTRIAL LEAGUE AND COUNCIL.

4.30 p.m. In the Council Chamber, Guildhall, London, E.C. Lecture on "Should Wages be Lowered?" by Mr. E. J. P. Benn.

FRIDAY Oct 24th

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Papers to be read on "The Effect of Pressure and Temperature on a Meter for Measuring the Rate of Flow of a Gas," by Dr. N. W. McLachlan: "A Cheap and Simple Micro-Balance," by Mr. J. H. Shaxby, B.Sc., and "The Resolution of a Curve into a Number of Exponentials," by Mr. J. W. T. Walsh, M.A.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Address by the President.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W.1. Lecture on "Fire Prevention and Protection in Factories and Workshops," by Capt. Stanley W. Thorpe.

SATURDAY, Oct 25th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At the Grand Hotel, Colmore-row, Birmingham. Ninth Annual Ladies' Night.

Electric Furnaces in Metallurgy.

The Greaves-Etchells Furnace.

The object which the inventors of the Greaves-Etchells furnace had in view was the design of a furnace in which the intense concentration of heat around the arcs would be avoided. Such concentration leads to destruction of the refractory lining near the arcs. It also seemed desirable to secure a steady working load consistent with a reasonably high power factor.

Better distribution of heat can be secured by resistance methods. Consequently the method adopted has been that of generating some of the heat in the lining of the furnace itself.

Mechanically the furnace does not differ greatly in design from other types of furnaces at present on the market, although there are many detailed features which the inventors have altered and improved upon in the light of their own experience.

Electrically, the furnace differs from others in the method of making electrical connections, and of grouping the transformer windings. The inventors early came to the conclusion that electrode furnaces in which each electrode was independently regulatable were most desirable in maintaining a good load factor. The furnace was therefore designed with a hearth connection, which would act as an opposite terminal to each electrode entering the upper portion of the furnace, so that an arc can be maintained on one electrode only quite independent of whether the other suspended electrodes are in connection with the bath.

In making an electrical connection with the hearth, it was not desirable to offer a hearth of very low resistance to the electric current, first because the refractory materials employed in the hearth of the furnace would have to have their refractive qualities very much impaired in order to give them the necessary electrical conductivity, and secondly, because if the hearth, while being constructed as an electrical conductor, could be made to offer an appreciable resistance to the passage of an electric current it would exercise a beneficial damping effect against short circuit loads.

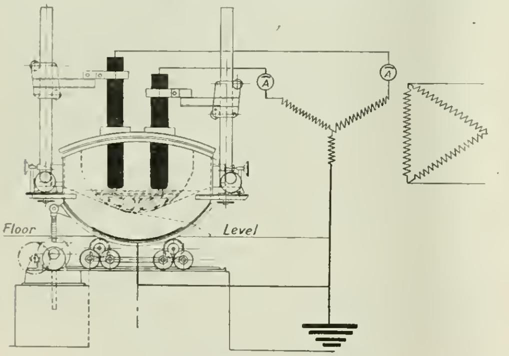

Fig. 1.—Arrangement of a 12-ton Furnace.

The fact that resistance was introduced into the hearth of the furnace made it quite impossible to provide a good electrical system by making an electrical connection to the hearth, which was merely a neutral conductor. The fact that the hearth itself was to absorb energy in the form of C^2R, made it necessary to design an electrical system which would supply and maintain a definite electrical potential between the metallic charge in the furnace and the hearth electrode connection.

The furnace body, therefore, consists of a steel shell with suitable copper connections in the bottom, which are connected to one definite pole of a "star" group of transformer secondary windings. The liquid metal in the furnace is partially insulated electrically from all portions of the furnace shell, so that the current which is connected to the bath by the suspended upper electrodes has to pass through the lining of the furnace to reach the bottom electrode connection. The lining of the furnace is made at least 2 ft. thick, and as this consists of highly refractory material, such as dolomite, considerable electrical resistance is thereby interposed to the passage of the current, but not so much as is interposed by the gap of an electric arc.

The other two poles of the "Y" group of transformer secondary windings are connected to the upper electrodes of the furnace. The bottom electrode of the furnace is maintained at earth potential, so that both the metal in the furnace and the star point of the transformer group are both maintained above earth potential. It will be seen that any short circuit current passing between two upper electrodes of the furnace or passing from one upper electrode through the metallic charge and the furnace lining to the bottom electrode must always pass through two transformer secondary windings, which are in series with each other, and which have a difference of 120 deg. phase angle between them. This in itself lowers the power factor at the moment of short circuit, and thus helps to steady the electrical load on the furnace.

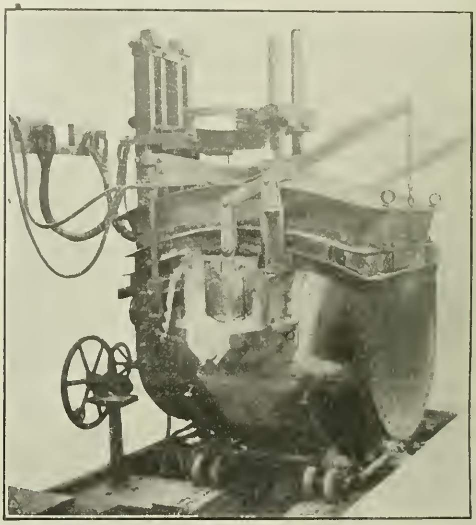

Fig. 2.—10-cwt. Furnace.

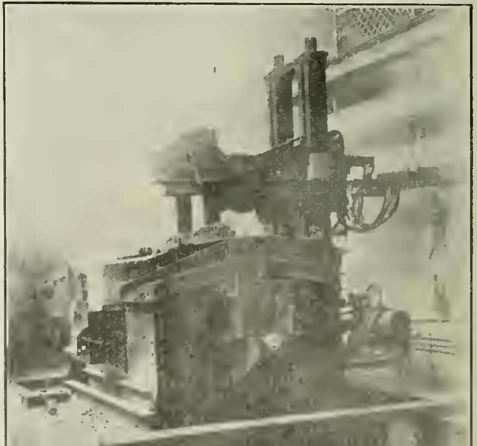

Fig. 3.—3-ton Greaves-Etchells Furnace.

A brief reference to Fig. 1 will show, however, that a lagging power factor is obtained on one half of the system, and a leading power factor is obtained on the other half of the "Y" so that, providing each half of the system is evenly balanced, the over-all power factor is as near unity as is practically possible.

The connection between the hearth of the furnace and the bottom electrode connection embodies no troublesome contrivances such as water-cooled studs, but a very efficient connection is obtained by cementing the hearth of the furnace to a large copper plate over the steel plate in the furnace bottom.

The effect of generating heat in the hearth of the furnace causes a circulation of the metal which more rapidly absorbs and distributes to all parts of the bath the heat generated in the arcs.

The furnace is designed with two upper electrodes up to 5 tons capacity; furnaces up to 15 tons have four upper electrodes. Larger furnaces can be fitted with six and even eight upper electrodes.

The furnace body is rectangular in shape, and is lined with the usual furnace materials, consisting of magnesite and dolomite, rammed with tar for the hearth, and silica brick or special fireclay bricks for the roof.

The electrical system comprises three transformer windings, or in the case of larger furnaces, multiples of the same, the primaries of which are delta-connected, and the secondaries star-connected, as shown in Fig. 1. Tappings on the primary windings give various voltages on the secondary side. With multiples of two and more groups of windings, it will readily be seen that many variations can be obtained in the amount of current which is allowed to pass through the furnace hearth. By a selection of phase connections, identical windings in each group can be put in parallel, in series, in opposition, of at various phase angles, and thus the current through the furnace hearth can be reduced to zero, or several times as much current can be passed as passes through one upper electrode of the furnace.

In order to balance the lower voltage drop across the hearth of the furnace against the higher voltage drop on the electric arcs, a method of transformer grouping is adopted which is new. The voltage of the transformer leg connected to the hearth of the furnace has to be reduced in relation to that of the other two secondary windings, but certain definite laws have been established by which this can be accurately calculated to give a balance between the primary supply phases both in power and power factor. More than this, the net-work of transformer grouping is such that even when one half of the secondary system is open-circuited the load on all three primary phases is maintained to a very appreciable extent.

It is true that the loads are not balanced under these conditions, but it is not possible, as in other types of furnaces, to have one primary phase taking no load at all, while the other two phases are heavily overloaded. Short circuits on the secondary side, therefore, divide the overload automatically on the phases of the primary supply. The more even distribution of heat in the furnace itself is stated to result in easier manipulation during the working of a charge, better control of chemical composition owing to the ready manner in which cold alloy additions dissolve in the liquid charge, instead of lying sluggishly on the bottom of the bath, and longer life for the lining of the furnace, owing to more uniform wear upon the refractories constituting it.

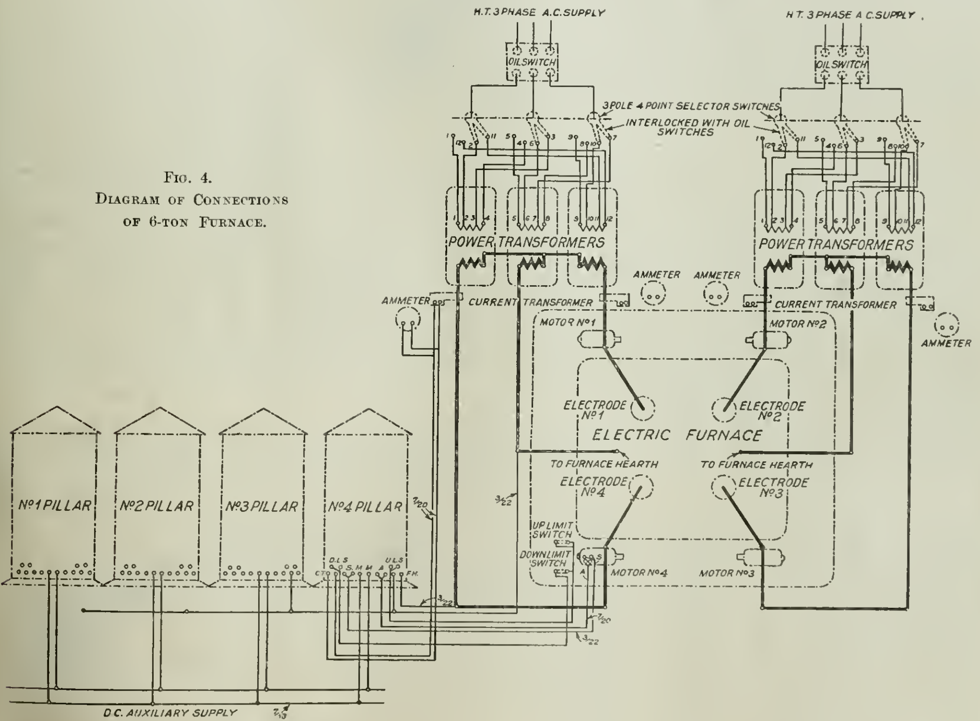

Fig. 4.
Diagram of Connections of 6-ton Furnace.

The system has been adopted for two-phase alternating-current supply, and the basic principles with which the inventors started out can to a large extent be applied in both single-phase and direct-current furnaces.

Types of Furnaces.

The Greaves-Etchells electric furnaces are made in the following standard sizes:—10 cwt., 1 ton, 2 tons, 3 tons, 5 tons, 7½ tons, 10 tons, 15 tons and 30 tons.

The 10-cwt. furnace is a very handy type of furnace, which was designed specially for the tool steel manufacturers of the Sheffield district. It consists of a rectangular steel tank 5 ft. square with a dished bottom mounted on rockers. The tank is tilted over by means of a screwed shaft operated so as to command a view of the teeming spout of the furnace. The furnace is fitted with a teeming spout at the front and a slagging spout at the back, each spout opening being covered by a sliding door. The furnace carries a very thick lining, the bottom being about 2 ft. thick and the side walls about 15 in. thick in dolomite up to the top of the banks, and having 9 in. thickness of brickwork above the banks.

The roof is built of standard bricks and is 9 in. thick. Two graphite electrodes, each 4 in. in diameter pass vertically through the roof. Each electrode is carried in an electrode holder at the end of a jib arm, and the carriage is made to travel up and down a mast fixed to the side of the furnace. The adjustment of the electrodes is made by hand gearing. The general appearance of the furnace is shown in the photograph, Fig. 2.

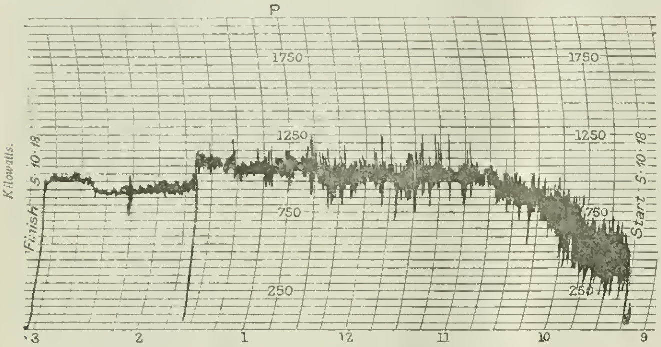

Fig. 5.

This furnace is equipped with three transformers totalling 260 k.v.a. It can melt 10 cwt. of steel scrap in 1 hour, and as many as eight heats have been obtained from this size of furnace in the ordinary working day from 6 a.m. to 6 p.m. The question of output depends entirely upon the organisation of the melting shop, but the makers usually estimate on this furnace turning out four heats daily and eight in 24 hours.

When the steel is melted only, the consumption of power is very low, but when the first slag is removed and a finishing stage is applied, the average consumption of energy overall is in the region of 900 kw.-hrs. per ton of steel produced. This small furnace possesses all the refining possibilities of the larger electric furnaces, and it is possible to imitate the composition of the purest crucible and Swedish Bessemer steels obtainable. The furnace has also been largely used for high speed steel. During the war when the situation in regard to high speed steel became acute, this type of furnace was installed in many works to supplement the efforts of the crucible steel manufacturers. Not only did this furnace make high speed steel from the usual good quality materials used in the crucible, but it was found possible to refine the waste metal which was caused through crucibles breaking out and allowing their contents to fall through the coke in the furnace.

The electric furnace also refined any class of high speed steel scrap which was procurable, and thus supplemented to a great extent the supply of raw materials available for making high speed steel. The electric high speed steel thus necessarily produced found great favour with those firms who were able to manufacture it to the expert degree necessary. It should, of course, be remembered that where the operator of the electric furnace does not attain expertness the resulting product is not only bad but very bad.

The 2-ton and 3-ton furnaces are slightly different in size to each other, but follow the same general characteristics. The general arrangement of the furnace body is similar to the 10-cwt. size, but a charging door is incorporated in one side of the furnace casing. Each furnace is equipped with two upper electrodes, each electrode being operated by motor-driven gear, the motor of which may be controlled by means of a hand control or automatic control The tilting gear is also electrically operated. Each furnace is provided with three transformers, the total k.v.a. for the 2-ton furnace being 650 k.v.a. and for the 3-ton furnace 800 k.v.a.

For the 20-cwt. furnace the average power consumption is 850 kw.-hrs. per ton of steel teemed, and for the 3-ton furnace 800 kw.-hrs. per ton. Figures are available, however, from certain very well managed melting shops, in which the consumption of power has been reduced to an average of 700 kw.-hrs. per ton on the 3-ton size of furnace. The electrodes may be either amorphous carbon or graphite electrodes of equivalent conducting capacity.

The general appearance of these furnaces is shown in Fig. 3.

The 5-ton furnace is also a two-electrode furnace, and this is the maximum size which the makers recommend should be equipped with only two upper electrodes. Where larger furnaces are equipped with only two electrodes, the makers contend that the distribution of heat cannot be sufficiently uniform, and this results in very irregular wear of the lining and roof of the furnace.

A very successful size of furnace, which has been installed in England and in the U.S.A., and of which large numbers are on order for other foreign countries, is the $7\frac{1}{2}$-ton furnace. This furnace is equipped with four electrodes, and the transformer groupings are arranged as if two 3-ton furnaces were joined into one body. The method of grouping is shown in Fig. 4.

This furnace is usually equipped with 1,500 k.v.a. capacity transformers.

The upper electrodes are each of 14 in. diameter amorphous carbon, or of 8 in. graphite The heating is stated to be very uniform indeed, and the electrical loading of the furnace is almost perfect. Each pair of electrodes is switched up separately, so that one half of the furnace works quite independently of the other half. The furnace body is of ample capacity and has carried up to 9 tons of metal successfully. The power consumption on this size of furnace is very low, averaging about 700 kw.-hrs. per ton and coming down as low as 650 kw.-hrs. per ton for the double process of melting and refining.

Furnaces up to 15 tons capacity are built on the same lines with increased dimensions, and the makers state that they have designs for 20-ton and 30-ton furnace which can deal with this weight of cold metal in one charge.

The electrical load of the Greaves-Etchells type of furnace is remarkably uniform compared with other types of furnace operating in this country and the U.S.A. In Figs. 5 and 6 are shown two typical diagrams from the recorder of a $7\frac{1}{2}$-ton furnace operating in this country. In these curves it will be noticed that no slagging off has been undertaken, although there is a fairly long period during the end of each heat where the metal has been kept in a molten condition while certain refining operations and the addition of alloys and pig-iron is made.

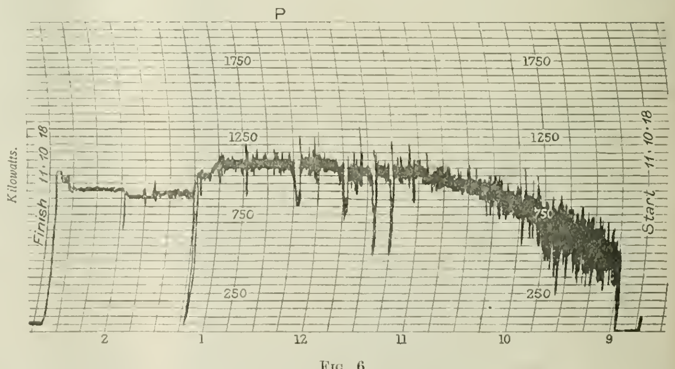

Fig. 6.

Institution of Electrical Engineers. North-Western Students' Centre.—The date of the first meeting has been provisionally fixed for Tuesday, Nov. 18, at 7.30 p.m., when Mr. A. J. Robertson, chairman of the Centre, will give an address. Subsequent meetings will take place fortnightly on Tuesday evenings. The Committee are endeavouring to find a convenient meeting place and an appeal is made to members of the Centre to introduce others with a view to securing an extended membership. Forms of application for student membership will be forwarded on request.

Inter-Imperial Communication Through Cable, Wireless and Air.[*]

By Sir CHARLES BRIGHT, F.R.S.E.

Just 21 years ago the author contributed a Paper to the Bristol Meeting of the British Association. It was read to Section G and was devoted to making the loudest possible appeal for an "All British Pacific Cable," in the face of much prevailing opposition from interested parties. Two years later that cable was duly laid, despite supposed technical objections, and has proved its value ever since. Without it we should have often fared comparatively badly over the war, and the line is now also in a thoroughly sound position financially.

Cable Congestion.

War wastage, the banning of private codes, general increase of traffic,[†] partly owing to absence of mails and voluminous Government messages,[‡] were all responsible for an appalling congestion in the world's cable traffic, the result being several days'—sometimes even weeks'—delay in the transit of messages on most of the more important trunk lines.[§] Though things are now somewhat easier with the withdrawal of the censorship and the renewal of private codes, the ultimate delivery of cablegrams is still a very slow business. Since the Marconi transatlantic Wireless Service was re-established, a few months ago, some measure of relief has been felt in that quarter. Unfortunately, however, it is at present only capable of dealing with a small proportion of the ordinary prevailing cable traffic.

Under the present shortage of labour and materials there seems little prospect of the various inoperative cables being again "put through" for several months to come. But even when that state of things has been reached, are our telegraphic links going to be once more free from congestion? It may be doubted, if only because the war has inspired a vastly increased taste—let alone political necessity—for inter-communication between the various widely scattered members of the Empire. The latter is obviously a matter of general congratulation, but it is also a feature which demands special provision.

Increased Communication for Increased Production.

Yet above all it is owing to the desire—aye, necessity—for increased production that we especially need not only to make good our weakened condition in the matter of communication, but to greatly improve on it.

Transatlantic Telegraphy.

The Atlantic cable situation may now be turned to.

Within 4 hours of the declaration of war we cut Germany off from cable communication with the United States by severing her two Atlantic lines *via* the Azores. One of these was handed over to the French, but the other was eventually turned to account for our own purposes by the route of the cable being diverted to Halifax as well as to Penzance. That was when we were more than half-way through hostilities, and since then the connection has only been partially operative.

About a year before the cessation of hostilities the United States Government, which had previously assumed control of their land lines, proceeded to take over the administration of all the remaining transatlantic cables. That this could have been possible must seem strange to those at all familiar with the history of transatlantic cables, *i.e.*, that every one of these was made and laid by British hands and that the majority had been formerly worked by pioneer British companies, the Anglo-American Telegraph Company and the Direct United States Cable Company. As a matter of fact, such a step only became possible through our previous Government's ineptitude, allusion to which must now be made. In the year 1911, the Western Union Telegraph Company, which—in addition to the four cables of another American Company, the Commercial Cable Company—had owned more than one transatlantic line, sought to take over, on a 99 years' lease, the five British cables. Appreciating the undesirability of this step from a British standpoint,[*] the author did his utmost to prevent the deal going through. He delivered an Address to the London Chamber of Commerce on "The Atlantic Cable Position and its Moral,"[†] wherein he pointed to our weakened position in the event of a subsequent misunderstanding such as may always arise in national matters between the best of friends.[‡] The Postmaster-General of that time was thereupon urged to withhold the transfer of landing by which alone the said British cables could pass under the control of a great American organisation. The deal was, however, allowed to go through within but a few weeks.

It is true that a material time after the Armistice the United States Government abandoned control of the transatlantic cables, along with that of all the other American telegraphic systems. But the position has never been at all satisfactory from a British standpoint ever since the aforesaid absorption, for naturally an American company is primarily concerned with the interests of its own country rather than with those of another, and the very idea of Canada learning British news and views through American sources is surely not very satisfactory for trade reasons amongst others.

The All Red Cable Route.

From what has been said it will be recognised that the long-standing national need for a modern high-speed British transatlantic line has now become more than ever accentuated. The author has for long advocated it, but it also formed one of the Imperial War Cabinet's recommendations. Further, it has been urged by each of the Dominion Governments as well as by the Empire Press Union and the principal Chambers of Commerce. Though it is true that H.M. Post Office are now working what was once a German Atlantic cable, this line has been for long periods out of operation, and is, at its best, an ancient and poor working affair for sole reliance in emergency, besides being an unsatisfactory direct connection with the Imperial Pacific line.

Pacific Cable Duplication.

But from the Australasian standpoint it would be worse than futile to provide a new link without duplicating the deepest section of the All British Pacific Cable, seeing that the latter is now greatly over-congested with traffic. The section referred to runs into a depth of some 5 miles, and, though the line as a whole has been remarkably fortunate so far, it is asking too much to rely on a cable under such conditions after 17 years' uninterrupted service. It is this section, that being the thin neck of the bottle, so to speak, keeps the speed so low on the whole system, but by means of the duplication here urged a greatly improved position would accrue. The rest of the line would also require to be dealt with similarly in due course; and to effect really satisfactory communication between the Mother Country and Australasia, the Pacific Cable Board should be enabled to work direct from London to Melbourne, *via* (1) the above suggested All British Atlantic Cable, (2) a new independent (underground) land line connection between Halifax or Montreal and Vancouver and (3) the duplicated Pacific Cable

"Variety of routes and variety of strings" should be our maxim (for security) in this matter of Inter-Imperial communication, and another greatly needed connection is a cable between Barbados and Bathurst. Had such a line existed during the war it would have relieved the ordinary "Eastern" route of a great deal of its congestion. A further cable between Bathurst and Gibraltar would also serve to complete a fresh "All British" link with the Cape.

The eventual realisation of these connections—together with the active development of wireless links—would do much for improving the political and trade relations of the Empire. No effort should, indeed, be spared to advance by telegraphic connection towards that elimination of time and space such as tends more than anything else to promote the family feeling and the family fortunes of our great British Commonwealth.

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[*] Paper read before Section F of the British Association at Bournemouth.

The term "communication" is here used in what is thought to be its more legitimate sense, the writer considering that railways and shipping are more correctly described as "transport."

[†] In the case of the "Eastern" system, the traffic was more than doubled during the war.

[‡] Out of the 7½ million words sent over the "All British" Pacific cable last year, one-third were Government messages.

[§] Soon after the outbreak of hostilities the Atlantic cable congestion was so great that a large proportion of the Service messages had to be "mailed" across the Atlantic, and, later on, many for headquarters in Paris were despatched by boat and train.

[*] Apart from ordinary peace-time trade considerations, too great stress can scarcely be laid on the national importance of cable control preceding, as well as during, warfare.

[†] London Chamber of Commerce Tract, November 11, 1911.

[‡] As a matter of fact, such a misunderstanding very nearly did arise over the cotton contraband controversy.

American Activity.

Whilst we have *talked* of "All British" cables for many years, our American cousins have, of late, shown a strong inclination not only to talk "All America" but to establish links going by that name.* Their ultimate aim is apparently to embrace the whole of the North, Central and South American Continent—telegraphically speaking—with a view to vast development in American trade generally as well as for fostering friendly relations between the republics here involved. The United States Government has lately taken active interest in this matter, and is evidently fully alive to the strategic and commercial importance of American owned and American controlled cables run on a low rate basis.

British Imperial Links.

If, then, we are not only to keep pace with the tendency of the age, but also to meet our greatest of all needs—a vast increase in production—it clearly behoves us, as a country, to do all that is reasonably possible towards developing Inter-Imperial telegraphic communication on a broad and economic basis, and in general national interests—not merely for overcoming the existing telegraphic congestion, but quite equally for high political, defence and trade reasons.

Subventions.

As previously indicated, none of the proposed lines could be proceeded with at present, if only owing to the number of existing cables that now need repair; but as it took many years' activity to secure eventual realisation of the "All British" Pacific Cable, it is clearly desirable to speak in advance if one wants to get anything done—and to do so on every possible occasion.

In addition to the labour and cost of material difficulties, there is also a marked shortage of telegraph ships; and as this is due to contractor-owned vessels being lost in carrying out the nation's war needs, it would seem that the Government might suitably come to the rescue with some German prize ships or else in the form of a subsidy to submarine cable contractors.

Wireless Telegraphy.

A word now in reference to "Wireless."

There is to-day little to choose between the working speed obtainable through a cable and that, under the same conditions, by "wireless" of a correspondingly up-to-date character. Even now, however, the cable appears, for one reason or another, to be most favoured for extended commercial purposes.†

But so far reaching and important have been the technical developments of this ("wireless") method of communication‡ since hostilities commenced that it behoves us to endeavour to turn it to something like the same account between distant lands as has already been done for marine purposes.

The author would like to see (1) the All British Wireless Chain put into effect without much further delay, (2) every Inter-Imperial cable connection supplemented by "wireless," and (3) a highly-developed wireless news service established for the prompt and synchronous dissemination of news betwixt all branches of the Empire, this being a field for which "wireless" is especially well adapted.

It has to be remembered that "wireless" can in some instances be satisfactorily used and maintained where the same does not apply with a cable. Moreover, wireless stations can often be more speedily established than a cable could be made and laid.

Message Rationing.

Owing, however, to the vastly increased call for Inter-Imperial communication that may reasonably be expected, it is conceivable that the increased facilities by cable and wireless might yet not be sufficient to cope with requirements.

For this reason, as well as on general utilisation grounds, the author especially advocates the application of a system of message rationing, by means of which each word in a message is turned to the fullest possible account—if possible, of a more scientific and efficient order than any existing code. If Government offices were to give heed to this suggestion, they could, without textual alteration, reduce the length of their service messages by at least 50 per cent.

Ciphers and codes generally are, of course, to a considerable extent employed for the purposes of secrecy; but their adoption for economic purposes is now recognised to be far greater—not only economic to the user, but also in the sense of overcoming congestion on the line.

Tariff.

We now come to that disagreeable subject "Tariff"! The author has always argued that a great national and Imperial benefit would be conferred—largely in the interests of trade—if a really low flat rate, common to the whole Empire, came into force on any All Red cable and wireless system. This would surely be recognised as a legitimate form of preference in the interests of Inter-Imperial commerce, and as helping towards a still closer understanding and union between the various sections of the Empire.

A sort of Inter-Allies Customs Union might also be applied for the purposes of telegraphic rates, as an intermediate preference with those who have fought with us over the war.

But it must not be forgotten that an essential accompaniment to a low telegraph tariff is many more communicating strings; otherwise, the congested condition would only become worse congested. On the other hand, it is also only by great developments—of one sort and another—in our means of communication that an increased, as well as cheaper, telegraphic output can be secured.

The Press Aspect.

With the prevailing high rates, accompanied by the still existing congestion, it is impossible for the Press of the Empire to do a tithe of what it might do in the service of the nation and Empire, either in a political or trade sense. At present, the newspapers have to do all their condensing at the transmitting end, resulting very often in unfortunate misunderstandings of a highly important nature—political and otherwise. All condensing should, of course, if possible, be done by the newspaper on its reception, in accordance with individual requirements.

Existing Organisation.

By far the greater proportion of the cable doing service at the bottom of the sea is the result of British private enterprise, to whom much credit is due for the excellence of the service provided.

The projectors of the original lines stood in the position of commercial pioneers, and their successors have upheld a great tradition. It remains to be said that the companies concerned have, quite rightly, already benefited by rich returns, besides obtaining handsome subsidies from the State.*

On the other hand, those acting on behalf of the State appear to have greatly lacked in securing an adequate return in the nation's interests when drawing up agreements with the companies. So far, landing rights seem to be the only ordinary lever for negotiation and but little advantage has been taken even of this lever on behalf of the country. Moreover, it is fairly clear that an altogether insufficiently wide Imperial view of telegraphic communication has, as yet, been taken by the responsible Government officials. It is, indeed, a question whether, for instance, successive Postmasters-General have not been too closely confining their ambitions to questions of departmental profit and loss, instead of making a wide and deep study of the national service that can be rendered by the Post Office in the matter of commerce, trade, &c.

(*To be concluded.*)

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* The very first cable expedition, of which the author was a member (in 1882-3), had for its object the laying of cables which connected up the North and South American Republics, and this system of cables was subsequently termed the "All America" cable system. Our American cousins continue, so far, to allow us to make and lay their cables.

† Cable working methods have throughout been developing, though not much heard of outside. The Brown drum relay, the Muirhead gold wire relay and the Heurtley and Dixon magnifiers have all done much to increase the efficiency of the cable within the last 15 years. More recent inventions are the water jet relay or "magnifier," due to Mr. Axel Orling, and the rectifying relay of Mr. E. Raymond-Barker, partly associated with the researches in inverse currents of the late Mr. John Gott. These are likely to achieve at least equally good results. Then, again, Dr. H. W. Malcolm has, of late years, developed an entirely new theory of submarine telegraphy, which points to the attainment of far higher working speeds.

‡ Special mention may be made of the thermionic oscillation valve, largely originating from the work of Dr. J. A. Fleming, F.R.S., as scientific adviser to the Marconi Company, in addition to that of Dr. Lee de Forest.

* Over the war, too, these corporations have—unlike the railway companies—been very considerable profiteers, and, that being so, an actual reduction in the rates to meet war conditions might have been expected. This, however, would certainly have brought about a still greater traffic congestion. In any case, normally speaking, our railway companies—probably thanks to competition very largely—have always evinced more enterprise in various senses, though far less favourably situated than the said (British) cable working companies. On the other hand, what is known as the "All America" cable system, though for the most part constituting a monopoly, made large reductions in their tariff early in the war—partly also with a view to the subsequent development of trade.

The Wave-lengths Radiated from Oscillating Valve Circuits.

By S. R. HUMBY, M.A., and B. F. J. SCHONLAND, B.A.

The research described below was carried out during the winter of 1917-1918. Circumstances prevented any resumption of the inquiry, and the publication of the results obtained until the present time. While some of the points brought out have more recently been demonstrated in publications by various authors, it is hoped that the following account is still not without value.

Four problems were studied :

(1) What relation do the wave-lengths radiated from a simple oscillating valve circuit (Fig. 1) bear to the separate wave-lengths of the grid and plate circuits ?

(2) What is the nature of the oscillation, and what are its determining conditions when in such a circuit the " reactance " is reversed ?

(3) What is the phase relation between currents and potential differences in grid and plate circuits ?

(4) How is case (1) affected when an aerial and earth are attached, either directly to grid or plate coil or with a loading inductance in series with the aerial ? The latter is sometimes termed the " Anode Tap " connection in continuous wave transmission.

It was felt that the above points had important practical applications.

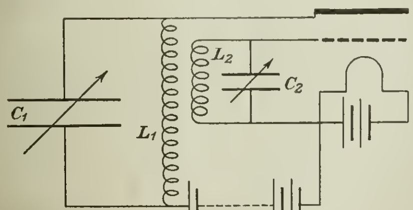

Fig. 1.

(1) and (2). Two coupled circuits $C_1L_1(\lambda_1)$, $C_2L_2(\lambda_2)$ should, when oscillatory currents are set up in one of them, give rise to two frequencies of oscillation such that, if λ and λ_1 are the corresponding wave-lengths,

$$\lambda', \lambda' = \left[\frac{\lambda_1^2+\lambda_2^2 \pm [(\lambda_1^2-\lambda_2^2)+4K^2\lambda_1^2\lambda_2^2]^{\frac{1}{2}}}{2}\right]^{\frac{1}{2}} \quad . \quad . \quad (A)$$

(*See* Eccles, Handbook of ω/T, page 91.)

In Fig. 1 $\lambda_1=60\sqrt{L_1(C_1+C')}$

$\lambda_2=60\sqrt{L_2(C_2+C'')}$,

where C' represents the self capacity of coil L_1, together with capacity of leads, plate of valve, &c., and similarly for C''.

Experiment showed that C' and C'' could be ignored provided C_1 and C_2 were not less than 0·0003 microfarad.

L_1 and L_2 were found

(*a*) by calculation based on the dimensions of the coils ;

(*b*) by measuring the wave-lengths obtained with known capacities.

K was then measured for a number of positions of the two coils.

It was thus possible to calculate λ and λ'. When the valve was generating oscillations the radiated wave-lengths were measured by means of a separate and specially calibrated valve wave-meter which was capable of reading wave-lengths correct to within five or ten metres.

The calculation of λ and λ' can be confirmed, or even dispensed with, by simply disconnecting the filament battery in Fig. 1, and putting a shunted buzzer across the grid and filament. The wave-lengths λ and λ' could be measured directly in this way on the wave-meter described.

A preliminary investigation showed, as is well known, that only one wave-length, with its harmonics, is radiated from such a circuit as in Fig. 1. Search with a special test coil in either the grid or the plate circuit failed to show the existence of any form of oscillation other than that giving the above single wave-length, and certain of its harmonics. On reversing the reactance, however, the wave-length radiated altered considerably.

Considering case (1) above, the normal connection of the coils is such that a rise of plate current will induce into the grid coil a current which would tend to make the grid potential positive with reference to the filament. K in this case is negative. In case (2), when the reactance is " reversed " K is positive.

On setting the valve to generate oscillations in the circuit shown in Fig. 1 it was found that :—

For case (1), *K negative, the wave-length radiated is λ, the longer of the two given by equation A above.*

For case (2), *K positive, the wave-length radiated is λ', the shorter of the two given by equation* (A).

In case (1) no trace of wave-length λ' could be found.

In case (2) no trace of wave-length λ.

Some experimental results are attached :—

λ_1	λ_2	K	λ calculated.	λ radiated.	λ' calculated.	λ' found.
Metres.	Metres.		Metres.	Metres.	Metres.	Metres.
1,010	1,135	0·50	1,317	1,305	756	750
1,010	1,135	0·23	1,201	1,200	924	920
1,010	1,135	0·087	1,145	1,155	992	975
1,010	1,135	0·03	1,133	1,135	997	†
1,620	980	Not measured.	1,700*	1,700	800*	790
1,580	1,760		1,820*	1,820	1,460*	1,460

With reference to the conditions governing oscillation with reactance " reversed," these are similar to those determining the normal case (1) viz. : degree of coupling and closeness of tuning between λ grid and λ plate. For given values of the latter, however, the coupling must be tighter than for the normal case, or with a given degree of coupling λ_1 and λ_2 must be nearer together, if oscillation is to take place. In the ordinary case (1) of oscillation, the radiated wave-length is always greater than the greater of the two circuit wave-lengths λ_1 and λ_2.

In case (2) it is always less than the smaller of λ_1 and λ_2. Moreover, the nearer λ_1 and λ_2 are together, the further will these radiated wave-lengths be from λ_1 and λ_2 respectively. These statements are obvious from the numerical results given above, and can easily be shown from equation (A). The change of wave-length with coupling in the two cases is of practical value in assembling valve circuits. The results given above hold also for circuits where C_1 or $C_2=0$, as investigated by Vallauri and others.

(3) A detailed theoretical examination of these results is not attempted, although we were led to the conclusion that the phase difference between the oscillatory currents in the grid and plate circuits can be either 0° or 180°, but cannot have values differing sensibly from these.

The two are in phase in the usual case and in opposite phases when the reactance is reversed. An interesting analogy published in The Electrician for July 28th, 1917, may help. A system of masses L_1, L_2, and springs C_1 C_2 has four methods of vibration (*see* Fig. 2).

(1) L_1C_1 oscillating alone.

(2) L_2C_2 oscillating alone.

(3) A slow (long wave-length), oscillation in which the motion of the two masses is in phase. This corresponds to K negative.

(4) A more rapid oscillation in which the two masses are

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* These were not calculated, but found by the buzzer method described above. † No oscillation.

at a given instant moving in opposite directions (180° out of phase). This corresponds to K positive.

Only one wave-length (with its harmonics) can be detected. It would appear, therefore, that the action of the valve prevents any phase change once the oscillation has commenced, except in special cases, which are considered later.

(4) (*a*) When an aerial and earth were connected to the plate and filament the circuits behaved as if the aerial and earth were an additional capacity placed across the plate inductance

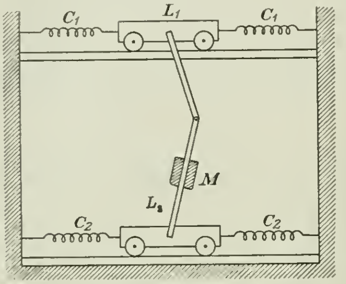

Fig. 2.

Two wave-lengths could be detected, when the circuits were buzzed; the upper one was radiated with the ordinary connection and the lower one when the reactance was reversed, *e.g.*:—

λ grid	λ plate.	Buzzed λ.	λ radiated.	
			K −ve.	K+ve.
980	1,620	1,700—800	1,700	790
1,580	1,760	1,820—1,460	1,820	1,460
610	2,300	2,320—540	2,320	Not oscillating

It is clear that the attachment of aerial and earth does not invalidate the reasoning given.

(4) (*b*) In order to make the circuits used capable of rapid adjustment a "dummy aerial" condenser was first employed (Fig. 3).

The aerial-plate circuit (Fig. 4), is an auto-coupled circuit, and has by itself two wave-lengths which can be measured by buzzing either across C_1 or across C'. The coupling between these circuits will be tight or loose, according to the ratio of L_1 to L_1+L'.

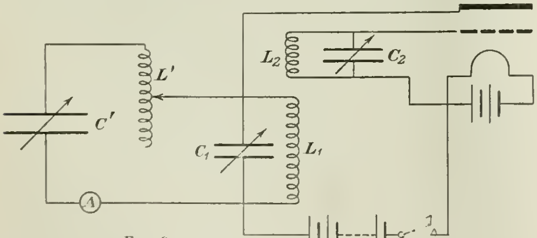

Fig. 3.

In one case these wave-lengths were 1,980 metres and 690 metres. When the grid circuit (wave-length alone 1,190 metres) was coupled as in Fig. 3 above, three main wave-lengths were shown by the buzzer.

2,050 ... 1,070 ... 610 (faint).

When the coupling was lessened from $K=0{\cdot}5$ to $K=0{\cdot}23$, the upper one fell to 1,970 and the middle one rose to 1,150, showing that they obeyed the rule given (*see* equation (A)). The value of the condenser C' had been varied until a typical case of the peculiar behaviour associated with the use of the "anode tap" in transmission was found.

When C' was less than 0·0007 mfd. the valve gave a large ammeter reading (0·25 ampere). On increasing C' beyond this value the oscillation became unstable and suddenly dropped till 0·07 ampere only was shown in the ammeter.

When the condenser value was slowly decreased the aerial current kept low until the critical value was reached and then suddenly rose to the larger value.

The wave-lengths sent out were measured with especial care in each case.

Valve oscillating freely: coupling $K=0{\cdot}5$.

$\lambda=2{,}050$ very strong.

Other wave-lengths, 1,030 (strong), 690 (strong), 510 (weak).

Valve giving only 0·07 ampere:—

$\lambda=1{,}070$ strong. 2,150 (weak), 530 (strong).

The value of the long wave-length was then measured as C'

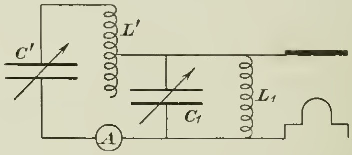

Fig. 4.

was very slowly increased, and it was found that very strong signals could be obtained until λ was very near 2,150 ($C'=0{\cdot}00077$ mfd.), when the oscillation suddenly changed.

For all values of C' above 0·0007, however, the oscillation was unstable and was not given when the key was repeatedly tapped.

Similar results were obtained when aerial and earth were used in place of the condenser C'.

In this case the wave-lengths λ and λ′ given when the circuits were "buzzed," were: 1,260 metres and 690 metres.

With the aerial current large the wave-length radiated was 1,300 metres with a weak harmonic at 650 metres. The coupling was then loosened very slightly and the aerial current fell sharply. A complete change of wave-length was observed and now the strong wave-length was 690 metres with a weak harmonic at 1,360 metres.

Similarly, in a large number of such cases it appears that the sudden change of wave-length, which often accompanies the use of the "anode tap" connection on a continuous wave transmitter, is due to the fact that when the plate is connected part of the way down the aerial tuning inductance, two auto-coupled circuits are produced. When the circuit in Fig. 3 is buzzed it shows two resultant wave-lengths. The valve when fitted up in the circuit of Fig. 3, will radiate a wave-length greater than the upper of these, if K is negative and vice-versa for K positive. If these two wave-lengths λ and λ′ are harmonics, *e.g.*, 1,360 and 690, or 2,150 and 1,070 above, the wave-length may drop suddenly to the lower one and the valve be oscillating as in case (5), *though the reactance is not actually reversed.*

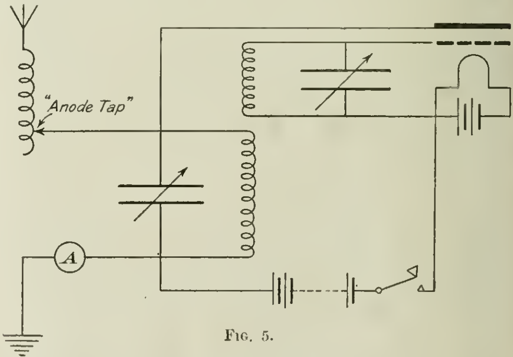

Fig. 5.

The experiments described in this connection were made with aerials whose natural wave-length was small compared with those radiated. It appears unlikely that "anode-tap" anomalies will be found with longer aerials.

Wireless in the Royal Flying Corps During the War.*

By Major T. VINCENT SMITH, M.C., M.I.E.E., R.A.F.

In the light of modern achievements, it is not easy to realise how profound was our ignorance on the subject of aircraft wireless in August 1914.

It is only by realising the insignificant amount of data existing at the outbreak of war that the details of the development of aircraft wireless assume a correct perspective.

It was obvious that observing for the Artillery was one of the most important services that the Flying Corps could render, and for this purpose efficient communication was of primary importance. Only one machine of those which went with the original Expeditionary Force was fitted with wireless, and though a few had been added by the time I went to France in February, 1915, I found a rather cumbersome signalling lamp the most popular means of communication between air and ground.

The earliest form of spark transmitter we used was of the simplest possible kind, using an accumulator battery and closed oscillating circuit, the inductance of which was common to closed and radiating circuit in the form of the well-known auto transformer. A wandering plug enabled the closed circuit to be tuned to the aerial, or the aerial could be brought into resonance with the closed circuit by lengthening or shortening.

There was another somewhat similar set made by Leslie Miller, but having an inductive coupling, another squadron was using a French engine-driven set, having the auto transformer coupling and a multiple rotary spark gap.

The power and weight of these three sets were respectively, 40 watts, 50 lb.; 100 watts, 65 lb.; and 150 watts, 78 lb.

The ground receiving arrangements consisted of an 8-section 30-ft. tubular steel mast, a 150-ft. silicon bronze wire aerial, a rather unwieldy tuner, and two kinds of crystal detectors, also two pairs of Brown's high resistance phones. Two copper gauze mats as counter-capacity completed the outfit. The tuner was eventually replaced by a good and efficient instrument.

A few days after my arrival I was appointed wireless officer to No. 3 Squadron of the 1st Wing, which comprised in addition Nos. 2 and 16 Squadrons. Each squadron consisted of 12 machines divided up into three flights of four machines, of which one flight was wireless, the remaining two flights worked with signal lamps.

There was considerable rivalry between the lamp and wireless as a means of signalling, but the latter soon made the lamp method obsolete, when owing to the success of the wireless flights, all machines in No. 3 Squadron were ordered to be fitted. The more the use of wireless extended the greater were the difficulties that arose, but in spite of annoying failures it was justifying itself, inasmuch as it would have been impossible to get through anything like the amount of work by other means.

One realised that the whole future of the application of wireless on a large scale in the Air Force in war depended upon the successful solution of the new problems which were constantly presenting themselves.

To do this demanded the fullest possible knowledge of the nature of the work, the conditions under which it had to be carried out, the personnel who did it, and finally investigation into the causes of failures with a view to their elimination.

These were done as far as possible, and by spending two days with each squadron, flying, keeping their machines in working order, and visiting the ground stations with the guns.

My front, which corresponded to that of the 1st Army, extended from Armentieres to Mazingarbe, about 25 miles, and contained about 30-40 batteries. It was by far the most active piece of line and embraced the three most important operations of 1915, namely, the battles of Neuve Chapelle in March, Festubert in May and Loos in September.

The first battle in which wireless became a serious factor was that of Festubert. Our preparations for this battle consisted of observing for the artillery whilst they registered their guns on the trenches and important points within the enemy's lines. It is also memorable as being the first occasion upon which machines were specially detailed to observe the battle and to report progress by wireless. This work was done by No. 16 Squadron under Major Holt, and four of their machines fitted with Leslie Miller transmitters kept watch successfully all day over the battle.

As the attack did not develop there was nothing much to report, but the wireless worked quite successfully and the machines remained in touch with their stations throughout the operations.

Foundations were thus laid which resulted in the development of that very important branch of aerial activity known as the close contact patrol for the purpose of reporting infantry movements

Another squadron, No. 10, had now been added to the wing, and apart from ordinary troubles, jamming or mutual interference steadily increased, but the experience gained by this time enabled one to begin reform and organisation in real earnest, and the first thing done was to standardise the apparatus.

Both for its light weight and simplicity I chose the No. 1 transmitter and found immediate relief from jamming owing to the smaller power used by it. The effect of eliminating powerful signals was very marked and the simplification through having only one kind of transmitter materially added to reliability. So much was this the case that all machines in the wing, amounting to 48 in all were ordered to be fitted.

I redistributed the wave-lengths on the following plan :—

The three flights of the most northerly squadron were given 100 m., 180 m. and 260 m., the next squadron was given 140 m. to 220 m. and 300 m., and so on alternately down the line. The beneficial effect of this change was sufficient to meet the large increase in machines.

The transmitter was now taken in hand and a lot of useless connections removed, and the radiating circuit altered by disconnecting the aerial from the top of the inductance and attaching it to a wandering plug, thus enabling the aerial to be loosely or tightly coupled as required. The component parts were assembled in a neat gas-tight box and the inductance calibrated in wave lengths, thus reducing the weight of the whole set to 26 lb. including all fittings, and its bulk by one half. A further addition of 24 machines was made to our wing These naturally brought more trouble in their wake, as we now had 72 machines fitted

To relieve the somewhat severe pressure I received permission to recommend four of my most suitable operators for commissions to take charge of their respective squadrons. This resulted in considerable diminution of failures, but the jamming trouble was again to the fore.

In reviewing the situation, and in the light of past experience, I determined to try the effect of reducing still more the power of the No. 1 transmitter, which was done with almost startling results.

The battery was cut down to three cells and the adjustment of the spark gap and primary make and break very carefully attended to, with the result that the rasping guttural splutter gave place to a pleasing flute-like note. The effect was truly magical and gratifying, as not only were the operators delighted at the change but jamming lost many of its terrors. In addition to which, owing to the power being reduced to 20 watts, the trembler and spark gap remained clean and in adjustment for a longer time and the weight of the battery was also reduced.

It was found that the trembler could be made to vary its note within small limits by careful adjustment. This was of great assistance to the operators, and the soundness of these principles in the prevention of jamming was amply proved later on, when their development enabled the number of machines capable of working without mutual interference to be greatly increased.

Evidence of the success of our work was shown unmistakably by the attempt on the part of the enemy to jam us, a sure sign of their technical inferiority, more particularly as they entirely failed in their object.

About this time another very important detail was added to our organisation in the establishment of a squadron wireless control station, situated between the guns and the squadron. It was connected to squadron and batteries by telephone and its prime duty was to listen to the machines working with their batteries and to take down as much as possible.

These records formed an invaluable means of locating causes of failure, as the assertion on the part of the pilot that he had sent a certain signal, of the operator at the battery that signals were weak and unreadable, received from the control station definite proof of their truth or otherwise. Another duty was to lay out a signal on the ground indicating to a machine on its way from the squadron to the lines, the quality of its signals. By this means a fruitless journey was saved to a machine whose apparatus was not functioning properly.

Owing to its situation, the control station was naturally freer from jamming than a battery station ; consequently it was possible owing to their being connected by telephone to accept signals from a machine and phone them to a battery that was for some reason not getting its signals. The first of these stations was started at Vielle Chapelle in May 1915, though its full uses were not developed until later on.

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* Paper read before the British Association at Bournemouth.

In July the first introduction of the thermionic valve took place, and one was brought out to demonstrate its powers of amplification. It was a Round valve, of the soft type associated with the Round magnifying circuit, and was very delicate in action, requiring considerable training on the part of the operator; but it obviously possessed great possibilities and I reported accordingly.

Preparations for the Loos offensive in September were now in full swing, and registration of the guns was the order of the day.

Over 600 targets were registered by the machines of the 1st Wing during the week preceding the offensive.

The battle took place and was a great opportunity for proving the use of wireless on a large scale, and it emerged triumphant. In spite of there being about 20 machines always working in the salient to about 60 ground stations with the guns, no serious failure took place.

Lord French's despatch on the battle said:—"The R.F.C. is becoming more and more an indispensable factor in combined operations. In co-operation with the artillery in particular, there has been continuous improvement both in the methods and in the technical material employed. The ingenuity and technical skill displayed by the officers of the R.F.C. in effecting this improvement have been most marked."

The war now settled down again to trench warfare.

About this time another small but effective improvement was made. I found that large capacity accumulators were conducive to failures owing to the mechanics forgetting when they were last charged. By substituting accumulators of sufficient capacity for only one spell, they had of necessity to be recharged after every flight. Not only did this eliminate failures due to exhausted accumulators, but the weight of the battery was reduced by 25 per cent., and the whole transmitting set, including all fittings, to 18¾ lb.

Another matter arose demanding earnest attention, and that was danger from fire. Obviously the close association of the electric spark and petrol required that every possible precaution should be taken. A machine may crash when landing or by engine failure when trying to get off. In either case the petrol tank invariably bursts, to the imminent danger of the pilot and observer. As a switch might easily be moved in the case of a crash, I decided that the only really certain remedy was a complete disconnection of the accumulators from the wireless apparatus by means of a plug. This fitting was made compulsory throughout the R.F.C., and orders issued that no machine was to leave the ground or land again with its battery connected.

So far as I am aware no fire caused by wireless occurred after this.

In February, 1916, I was ordered to organise the wireless repair section of No. 1 Aircraft Depot at St. Omer. One of the most important things undertaken by this section was the fitting of all the machines as they arrived from England in the safest and most efficient manner, instead of leaving it to squadrons to carry out. When it is remembered that only 20 watts were being used by the transmitters, the greatest care had to be taken to avoid leakage by conduction and induction.

The transmitter and its battery were mounted on a tray which slid into a little cupboard in the fuselage. In the early days officers were taught to adjust and tune in the air; but experience showed that it was much safer and better to leave all that sort of thing to be done by the trained mechanics on the ground. The whole set was entirely overhauled after each flight, and they were responsible that everything was in perfect order before the machine left the ground. These precautions practically ensured the apparatus against breakdown, and it was only natural that the pilots came to have implicit trust in the reliability of their wireless.

The confidence of the pilots was a very important factor in the success of wireless, and to gain this one had had to participate in and appreciate as far as possible some of their difficulties and dangers. This knowledge profoundly modifies the design of any apparatus that can be used in war successfully.

To call upon a pilot to make even one adjustment may easily add 20 per cent. to the failures, and it was found by experience to be far better to sacrifice a certain amount of electrical efficiency and to provide apparatus which was able to do the work required, and could be used by as many thousands of pilots as operations in all theatres of war might demand.

I feel called upon to make these remarks in defence of the No. 1 transmitter, and in answer to the criticism by wireless engineers who had no opportunity of appreciating the conditions under which this work was carried out on the Western Front.

Early this year Major Prince brought out a valve transmitter with telephony attachment of his own design. This was successfully demonstrated to Lord Kitchener, who was visiting France at the time. He was able to hear every word from a machine flying 40 miles away, and was much impressed.

I mentioned at the beginning of my remarks the absence of data from which we suffered, and an interesting fact developed in ascertaining the correct length of aerial for a definite length of wave.

Whilst this relation is well known for different kinds of aerials on the ground, I found the ratio in the air differed with each type of machine, and presumably depended upon their different electrical capacities. The ratio of 1 ft. of aerial for a wave of 1 metre was true only within small limits, and after about 150 ft. of aerial for a 150 metre wave different makes of machines required anything from 240 ft. to 320 ft. for a 250 metre wave.

Amongst the requirements for the following year the need for a 100 mile transmitter was felt. Major Whiddington's spark transmitter having proved its capability, was adapted provisionally until valves were sufficiently developed for this work, which occurred the following year.

Although the continual increase of the R.F.C. showed that the general principles already in use in wireless were sound, it was clear that an extension of the range of notes, as distinct from wave-lengths, was desirable. Accordingly the wireless repair section set to work and produced a simple but very effective little device which was easy to fit to the trembler of the primary of the transmitter. By a simple adjustment the note could be varied over a range of about six whole tones, thus giving a very great variety. Our little workshop made them, and a flight in every squadron on the whole front was fitted in a month and proved a great success.

I was appointed officer in charge of wireless at R.F.C. headquarters in March, 1916.

It became necessary to turn our attention seriously to the reception of signals in aeroplanes. The instruments hitherto sent out for trial had not proved satisfactory, and a G.H.Q. Intelligence report that the enemy was using such a device put our little wireless section on its mettle. With the assistance of Col. Blandy, of wireless H.Q. signals, three days later we were able to give a demonstration of the reception of signals from a standard army station by an aeroplane at 20 miles range. We used three valves associated with fixed coupled circuits designed for one wave-length only. This made for extreme simplicity, as the apparatus only required to be switched on to function without further adjustment.

The whole front was by now standardised and organised on the lines which had been found so successful in the 1st Wing, and preparations for the Somme offensive were put in hand.

A school was started at St. Omer to train operators in the latest methods and codes. This included an important development of arrangements for a moving battle, and methods for putting the guns on to fleeting targets.

A part of H.Q. moved to an advanced position, and an enormous concentration of all forces took place. As the time for the attack approached, the rôle of air co-operation became more and more important in neutralising the enemy's artillery fire and hampering his movements generally, and in ensuring the barbed wire in front of his trenches was effectively cut. As the Somme operations took place during July, August and September, when the days were very long, the strain on the operators of listening in from dawn to dusk was immense, especially as there were over 600 ground stations in the battle area with only one operator at each.

The arrangements for putting the guns on to fleeting targets worked splendidly, and over 100 signals an hour of this kind were dealt with a Group Headquarters. Co-operation with the infantry also proved successful, and similar arrangements had been made to work with the cavalry had they got through.

The work of the officers was not less strenuous than that of the operators; but we felt amply rewarded when at the close of operations the following special order of the day was published:—

"The General Officer Commanding wishes to express his great appreciation of the work done by the wireless personnel of the R.F.C. during the present operations. They have very responsible duties, and the way they have carried them out, in spite of long hours and under fire, has contributed in no small measure to the success achieved by our artillery.

"Wireless officers are requested to bring this order to the notice of all operators."

At the end of 1916 I was appointed to the Air Ministry, and when I left France the total wireless personnel numbered 200 officers and 2,000 operators and mechanics, or more than the total personnel of the R.F.C. at the outbreak of war.

The serious work of organisation, of training, supply, research and policy for all theatres of war was undertaken, also home defence, which became a necessity at this time.

It was probably in training that the greatest effect was made, inasmuch as by the policy of intensive culture by instructors drawn from the front the personnel were sent to France ready to take up their work on landing, which led to the closing of the School of Instruction at St. Omer. Specialisation was carried to the extreme, and with standardised apparatus and methods the system proved itself fully justified, and an ever-increasing stream of officers and men poured out to France, all highly trained in their own particular branch of wireless, whilst periodical visits were paid to the front by us all in order to keep thoroughly up to date.

Extremely good wireless work was done at the Battle of Arras and Vimy Ridge. In the latter operation the following figures are eloquent, and were officially reported as the work of the 2nd Wing working with 38 H.A. Groups, 55 Divisional Artillery and 187 Heavy and Siege Battery Stations.

256 Hostile batteries destroyed.
86 Gun pits destroyed and 240 hit.
103 explosions caused.
229 destructive trench shoots.
117 successful registration shoots.
2,843 fleeting target calls received at battery station.
406 artillery observation flights.
Wireless failures nil working with
30 machines simultaneously on a 7 mile front.

During the year continuous wave transmission and wireless telephony were developed to the point of standardisation and use at the front. In the latter case, intercommunication between the fighting machines in the air was leading to important results, and a range of 5 to 10 miles was achieved.

The visual reception of signals in aeroplanes utilising valves to work a relay was developed and demonstrated successfully in France by Capt. Murphy, but was not employed.

By the end of this year (1917) the following apparatus had been evolved for and by the R.F.C., and was in use in the field :—

Short and medium range air to ground spark transmitter.
Aircraft receiver for Morse and telephony.
Aircraft and ground telephony and C.W transmitter.
Ground spark tonic train and C.W. transmitters and C.W. and spark receivers, and directional receiving for aircraft was in an advanced experimental stage.

The total wireless personnel now numbered 300 officers and 3,700 operators and mechanics.

The figures for the month of September, 1918, which represented the full development of our last great offensive, which resulted in the final defeat of the enemy :—

2,120 shoots to destruction.
2,575 flash patrols.
74,201 fleeting target calls from the patrol machines.
11 wireless failures.

At the signing of the Armistice complete ground wireless communications had been established between all units. Between 400 and 500 machines were fitted with wireless, and the guns were provided with nearly 2,000 wireless stations. The whole personnel amounted to 520 officers and 6,200 other ranks.

It must, I think, be judged satisfactory that we were able to beat the enemy so thoroughly in a science in which at the outbreak of war they excelled so conspicuously. Of the truth of this assertion he has given us ample corroboration in a document captured by us, and of which I will give a translation in conclusion :—

Translation of a German Document.

XI. Army Corps. Staff.,
South of the Somme. Corps H.Q.,
Ic/Wing Commander No. 12358/1466. 1-6-18.
Relating to Salvage of Aeroplanes.

1. The salvago of aeroplanes must be pursued with still greater vigour. Valuable technical improvements, which have apparently been extensively applied by the enemy, have been lost to us hitherto. Labour and money spent at home on trials might have been saved by earlier information.

2. The enemy has secured a distinct advantage in his successful use in aeroplanes of continuous wave wireless apparatus, which possesses great superiority over the spark apparatus in use with us.

It is of the greatest importance to us to salve further enemy wireless apparatus of this description. In this way millions of money will be saved, as we have not so far been successful in constructing a continuous-wave wireless apparatus for aeroplanes which can work without certain disadvantages.

It is, therefore, the duty of all authorities to ensure the most indefatigable and careful salvage of wireless apparatus of enemy aeroplanes. Every particle is to be salved and collected if it is in any way possible. The ordinary men cannot recognise what value and meaning a single piece can have to an expert. As by unskilled removal this very delicate apparatus can easily be destroyed, the work of salvage is to be entrusted to Flying Corps or wireless personnel.

Having regard to the great importance of the apparatus for our own wireless telegraphy, the recovery and salvage premiums are correspondingly high They belong to the formation which, by informing the Flying Corps, permits of assistance and appropriate measures being taken for salving the object undamaged ; therefore such premiums will not belong to the Flying Corps unit.

This brief history of the wireless work done by the Military Wing of the Royal Air Force is a recital of small details, each so insignificant that one would hesitate to mention them individually Remembering the conditions obtaining in war, the difficulties of supply and training, and the enormous importance of time, the general results achieved must be accepted as justification for the policy adopted.

Transformer Tanks.

There has recently been placed on the market by the Empire Welding Company, of Sianey-street, Birmingham, a new type of transformer tank.

The accompanying illustrations and description are taken from their patent specification No. 130,805, and will no doubt be of interest to our readers.

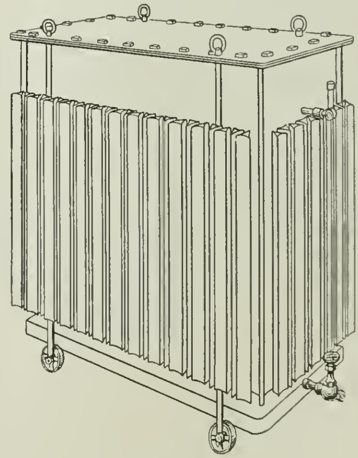

Fig. 1.

Fig. 1 shows a perspective view of the tank with the invention applied. It will be seen that vertical tubes are employed. Each tube is triangular in cross-section with a base preferably of greater extent than the sides, and provided with connections at the top and bottom which enter the walls of the tank. The connections are preferably welded or brazed to the tube and tank.

One set of these tubes is mounted with the bases toward the tank and the ridges directed outwardly, and a second set is nested into them in the reverse manner—*i.e.*, with the ridges towards the tank and the bases outward.

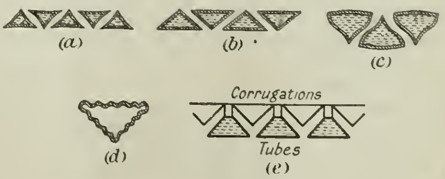

Fig. 2.

The tubes may be mounted any desired distance away from the tank side, and are spaced at suitable intervals from each other to enable the air to have free access to their radiating surfaces.

The usual shape and arrangement of the tubes is shown in Fig. 2 (*a*), but if desired they can be made as shown in Fig. 2 (*b*, *c*, *d*). It will be seen from Fig. 2(*e*) that the arrangement of the triangular tubes can be very readily attached to tanks with corrugated sides and of existing patterns. We understand that trials of the tanks have been made with very encouraging results.

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Trade Unionism.

At the present time there is no movement that is attracting more attention than the increasing activity and power of trade unionism. Originally, the movement was concerned with the increase of wages and consequently with a better standard of living for the various workers concerned. Later, active steps were taken in regard to conditions of work and in securing legislation, most of which must be regarded as beneficial. With the spread of trade unionism there has come increasing power, which necessarily carries with it a serious responsibility.

Recent events have shown that this responsibility is by no means always appreciated as it should be. This is no doubt largely due to ignorance among the rank and file, and even to ignorance among certain of the leaders, who see what appear to be possibilities in the future, but do not see to what evils these possibilities may ultimately lead. Above all things, therefore, it is desirable that trade unions should identify themselves with education. This interest has, of course, already been aroused to some extent. There has been increasing educational activity in various directions, and the unions are actually responsible for two residential colleges—namely, the Ruskin College, at Oxford, and the Central Labour College. The latter is now jointly owned by the South Wales Miners' Federation and the N.U.R. In these colleges whole-time education is given to young men from the working classes who are able to take advantage of them. There are also other organisations which carry on education somewhat on the lines of the extension courses of the universities. It may well be questioned, however, whether the education that is given is sound; and it is useless to expect a sound policy to be followed by the rank and file if the education that is given in such institutions is not itself sound. We are led to this reflection by reading Mr. G. D. H. Cole's book, entitled "An Introduction to Trade Unionism."* This book in itself is naturally educational, and from it we learn that the Central Labour College and its auxiliary, the Plebs League, inform their supporters they "can promise to be candid, but not impartial." According to Mr. Cole, they set out to teach definitely Marxian doctrines. We may well ask, Can good come of education which is knowingly given with bias? It is quite clear that if Marxian doctrines are taught and their fallacies are knowingly suppressed, a great responsibility rests upon the authority putting forward such a programme. It seems to us, however, that even greater responsibility rests upon the executives of the various trade unions, and more particularly those who support this institution. These executives include our best informed Labour leaders, men of experience, and men for whom the greatest respect must be felt. They must surely see the great danger of allowing teaching which merely consists of half truths.

Perhaps it is too much to expect of the Fabian Society that it should take a comprehensive view of such subjects, but we think that Mr. Cole owes it to the public to separate the possible from the impossible, and the good from th evil. Take, for example, the Industrial Workers of th World, who have been identified with much crime, and who would be willing for any country to commit industrial suicide by sabotage; yet reference is made to the I.W.W. as a world-wide movement, and no warning is given as to the mischievous and criminal character of the organisation. There is also reference to the part which education must play if the working class is "ever to achieve emancipation from the wage system."

The objection to such literature is that certain evils of the present system are pointed out not with a view to remedying these evils in a rational way, but with a view to overthrowing the entire social structure and organisation of a civilised state. Unfortunately, those who hold these ideas look at ideals instead of facts, and never pause to consider in detail (but only vaguely) what they would set up in place of existing institutions. What alternative is there to wages and salaries, and what is meant by the oft-quoted term "wage slavery"? Has it any real meaning?

Mr. Cole is among those who look forward to the time when the trade unions will supplant the employers and the State will supplant the traders and merchants, and with this object in view he sees some hope in the fact that the Labour Party is working to unite all classes of those who work, by brain as well as by hand. We do not think that this new method will secure his ultimate ideal, for brain will certainly continue to see that there is a great deal in the claims of capital, and that without initiative and capital very little can be done.

We hope that the executives of the various trade unions will realise without delay the pressing need for true education, for education of such a kind as will show the rank and file of Labour what is possible and what is impossible if any country is to maintain its place in the industrial and commercial world. When all is said and done, the workers of this country, or, for that matter, the rest of the population also, cannot feed on mere ideals. Co-operation will do far more for the true advancement of this country and for the happiness of its inhabitants than the control of industry or the elimination of the so-called Capitalist system.

Reviews.

An Introduction to Trade Unionism. By G. D. H. Cole. (London: Fabian Research Department and George Allen and Unwin.) Pp. 128. Price 5s. net.

The present small volume will be found useful by all who wish to obtain a ready idea of the position of trade unionism in this country. Mr. Cole, who is honorary secretary of the Fabian Research Department, is in a particularly good position to write authoritatively on the subject owing to the valuable collection of trade union materials which the Research Department has gathered together. Moreover, he has been in close touch with trade unions in the preparation of his manuscript.

The book is divided into four parts. The first deals with the structure of trade unionism, including such subjects as the classification of trade unions, their federation, international relations and the relation of trade councils to local labour parties. Section II. gives an account of the government of trade unionism, and outlines various methods that have been adopted. There are, for example, single branch unions on the one hand, and on the other there are national unions, resulting from amalgamation. Various methods are adopted by which branches are kept in touch with local conditions, and also with the main executive by means of district committees and advisory councils. To the general reader these two sections are not of great interest unless he wishes to look into the question of the internal working of trade unions. It is, however, useful to have an account of this kind. Section III. is of much greater general interest, as it deals with the problems of trade unionism. These include all the contentious subjects that have arisen from time to time, from the shop stewards' movement on the one hand to political action on the other. Among the various subjects to which the author refers is the position of the State as an employer. In his opinion, the State and local authorities have not been very satisfactory as employers; as they ought to have been "obviously better" than private employers, but in fact they have been "nothing of the kind." The concluding section deals briefly with the ideals of trade unions, education and the control of industry.

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* Published by the Fabian Research Department and by George Allen and Unwin. Price 5s.

The author is evidently numbered among the advanced thinkers in the labour world who see but little good in the present industrial and commercial structure. In the future he looks forward to the trade unions supplanting the employer and to the State supplanting the merchant. We should have thought that the record of State interference with industry had been sufficiently bad to prevent any responsible man desiring such an ideal as is outlined in this short statement. Apart from the mental attitude, however, the book will certainly be found useful, as it is quite a comprehensive survey in a small space. The criticism may be raised that the spread of trade unionism among salaried staffs is scarcely touched, nor its possibilities foreshadowed. This, however, is excusable, as the progress of this movement has been very rapid. It is rather curious to find this part of what may be termed management referred to as "professionals," and the casual reader may wonder, on first encountering the term, what is really meant by a professional. Naturally, the desire of the labour trade unionist, if trade unionism is to extend into the ranks of engineers and other technical men, is that the latter should be merely included in the ranks of labour trade unions. This would undoubtedly be a mistake from the point of view of the technical men, and it is not likely to come about.

It is unfortunate that a writer like Mr. Cole should show bias in dealing with certain aspects of labour questions. For example, the statement is made that in the course of their career trade unions "have suffered several set-backs as a result of judgments delivered by reactionary judges in the Courts." Mr. Cole should know that judges merely interpret the law. If the law is bad, that is not their affair. The type of judgment is not a reflection of the political or other opinions of the judges concerned. It has been the pride of this country that our judicial system is above that sort of thing, and such opinions expressed by responsible writers merely create prejudice among the ignorant. If trade unions have suffered from certain judgments this is merely due to the fact that, from their point of view, the law required alteration. As a matter of fact such alterations have been obtained by Parliament from time to time, though we fear that the legislation so obtained has not always been beneficial. For example, picketing is allowed by Act of Parliament, and although penalties are imposed for violence, intimidation, watching, besetting and following and other offences, it is perfectly well known that in the case of strikes those who wish to work are subject to intimidation and often require to be protected from violence. In other words freedom of action is eliminated, and loss of freedom of action may always give rise to serious abuses.

We refer in more general terms to this book in our Leading Article.

Memorandum on the Industrial Situation After the War. (London: Harrison & Sons.) Pp. 175. 2s. net.

This Memorandum was first privately circulated among employers, representatives of labour, and others in the early part of 1916, and was finally published in October 1916. The present book is a revised and enlarged edition. Owing to the fact that the original Memorandum was written during the war with a view to the position after the war, it has been felt that a mere reprint would not be sufficient. Consequently some parts have been re-written. For example, the section dealing with the "Industrial Situation To-day" has been entirely re-written. Most of the other sections still remain true, but the situation has been profoundly modified since the signing of the armistice. In the case of the sections dealing with the "Effects of the War on the Industrial Situation" and "Problems and Some Remedies," a less drastic method has been followed, although a few paragraphs have been entirely re-written in several parts and new paragraphs have been introduced where they seem desirable.

We hope that this little book will be widely read by those who have not perused the original edition. It is not a political pamphlet written by any political or economic group. It has been prepared after careful collation of suggestions and criticisms received from hundreds of labour leaders, employers, economists and social workers. The revised edition is the result of two years' close association with representatives of all the above classes. It is, therefore, a careful survey of the whole question, and we think it deserves the consideration of all those who wish to see the country enter into a better industrial and social future.

On Generalisations of Heaviside's Expansion Theorem.

By A. PRESS.

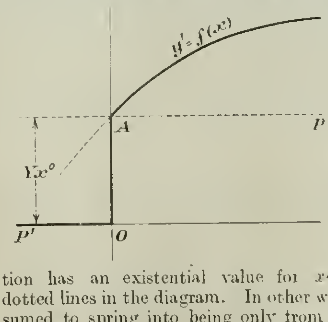
In the "Physical Review" for September, 1917, pages 217-225, Mr. John R. Carson establishes a theorem which appears to include the Heaviside expansion theorem as a particular case. In the following it is intended to show the original expansion theorem of Heaviside really applies to functions other than the exponential, and, in fact, includes Mr. Carson's work.

If we take the most general form of linear differential equation with constant coefficients it can be written in the form,

$$\frac{d^n y}{dx^n}+a\cdot\frac{d^{n-1}y}{dx^{n-1}}+b\cdot\frac{d^{n-2}y}{dx^{n-2}}+\quad .\quad .\quad +cy=f(x).$$

Here $f(x)$ is the forced function of physics (or engineering) so-called and necessarily implies that $f(x)$ has existential values from some arbitrary zero value for x. It corresponds to the particular solution of mathematicians.

However, the complementary solution of the mathematicians really corresponds to the impulse solution of Oliver Heaviside, which has led to the famous expansion theorem. If we assume that in the forced function,



$$y'=f(x).$$

y' has a value for $x=0$, then the impulse solution will follow, provided that for $x<0$, $f(x)$ does not exist, though normally the function has an existential value for $x<0$ indicated by the dotted lines in the diagram. In other words $f(x)$ must be presumed to spring into being only from $x=0$, and with finite ordinate Y for $x=0$. It will be *the change* along the finite ordinate Y that will cause the same transients, no matter what the original forced function may have been. The change idea is the important thing, and needs to be expressed mathematically.

Having grasped this notion the consequence is that even with a forced function such as ε^{ax} of Mr. Carson, it is necessary to postulate that the curve springs into being at $x=0$. If this were not so, then there could be no transients set up at $x=0$.

Since suggested proofs of the Expansion Theorem have heretofore depended on non-symbolic methods, the following proof is therefore given. It is unfortunate that symbolic methods, which have such manifest advantages in the solution of physical problems should be avoided rather than met in the development of the subject. The crux of the symbolic method is the expansion by ordinary division of operator functions as if they were ordinary algebraic expressions. This seems to have been lost sight of.

To solve symbolically we have equation (1) in the form

$$[x_1{}^n+ax_1{}^{n-1}+bx_1{}^{n-2}\ .\ .\ .\ +c]\,.\,y=f(x).$$

$$\varphi x_1=x_1{}^n+ax_1{}^{n-1}+,\ \&c.$$

$$y=\frac{f(x)}{\varphi(x_1)}.$$

There will then be two solutions; the one will correspond to the usual forced function solution, but the impulse solution must be obtained by noting that in

$$y'=f(x),$$

when

$$x=0,$$

$$y'=Y.$$

We then have

$$y''=\frac{Y\,.\,x^0}{\varphi(x_1)}=Y\,.\,\frac{x_1x^0}{x_1\,.\,\varphi\,.\,(x_1)},$$

from which to obtain the impulse transients, because

$$x_1x^0=0,$$

except for $x=0$, where x_1x^0 is infinite, and x^0 is Heaviside's unity function, which is zero for $x<0$ and unity for $x>0$. The multiplication above and below by x_1 gives the rate of change in x^0 referred to above.

Developing according to partial fractions the function in x_1, that is, $1/x_1\,.\,\varphi(x_1)$, as if it were a pure algebraic expression, this will give, according to the methods of the ordinary calculus,

$$\left(\frac{\frac{1}{x_1}}{\varphi(x_1)}\right)\,.\,x_1x^0=\Sigma\left[\left\{\frac{1}{x_1\left(\frac{d}{dx_1}\,.\,\varphi x_1\right)}\right\}\,.\,\frac{x_1x^0}{x_1-a_n}\right]_{x_1=a_n}$$

However, it is well known that

$$\frac{x_1x^0}{x_1-a_n}=\varepsilon^{a_nx}=\frac{x^0}{1-a_n/x_1}.$$

This latter can be established by developing in series the function $x_1/(x_1-a_n)$ in powers of $1/x_1$, and then performing the indicated integrations on x^0. Thus, Heaviside's Expansion Theorem is established. That is

$$y''=Y\Sigma\left[\frac{\varepsilon^{x_1x}}{x_1\left\{\frac{d}{dx_1}\,.\,\varphi x_1\right\}}\right]_{x_1=a_n}$$

for the transient terms only *due to a vertical line at the origin.*

Institution of Electrical Engineers' Visit to Holland.

At the invitation of the Society of Directors of Electricity Works in the Netherlands, of which Mr. J. G. Bellaar Spruyt is President, a deputation representing the Institution of Electrical Engineers visited Holland from the 21st to the 28th September.

The deputation comprised Mr. C. H. Wordingham, C.B.E. (President); Mr. Ll. B. Atkinson; Mr. G. Balfour, M.P.; Sir T. O. Callender; Mr. B. Drake; Mr. W. W. Lackie, C.B.E.; Dr. E. W. Marchant; Mr. C. P. Sparks: Mr. W. B. Woodhouse; Mr. P. F. Rowell (Secretary); and was accompanied by Mr. G. H. Parr, of the Department of Overseas Trade.

The visit was of great interest to all members of the deputation, and, owing to the kindness of their hosts and to the excellent arrangements made, a very large part of the country was seen, numerous electrical and other works were visited, and matters of more than engineering interest discussed.

The deputation was received officially by the Royal Institute of Engineers, by the municipalities of the principal towns visited, and by the Governors of the various provinces. In addition the members of the deputation were honoured by being received by Her Majesty the Queen of the Netherlands at her country seat, Het Loo.

The development of electricity supply in Holland has received a considerable stimulus as a result of fuel shortage during the war, and in this development the State, the Provincial Governments, the Municipalities and the Communal Authorities are all taking part. Certain company undertakings have been acquired by Provincial Authorities, and a Government Committee is preparing a report as to future developments and organisation. On this Committee the Society of Directors of Electricity Works is represented by Dr. W. Lulofs, the manager of the Amsterdam Electricity Works. Already, however, very great progress has been made towards the co-ordination of electricity supply throughout the whole country, a development much facilitated by the existence of a standard frequency of 50 cycles. Throughout each province there is a supply of electricity, distributed principally by means of overhead wires, a method which has been much facilitated by the compulsory wayleave powers now possessed by the supply authorities. The generating stations of the various authorities have been, or are being, interconnected to permit the concentration of generation by large units in suitably situated stations, and the development is on a wide scale throughout the country, designed to cater for the needs, not only of the towns and manufacturing industries, but of rural districts; the latter development taking place in conjunction with a general installation of electric pumps to replace the numerous windmills which form such a prominent feature of the Dutch landscape, and on which the security of the country against flooding has so largely depended.

The Dutch coalfields, situated in the Province of Limburg, have not in the past produced a sufficient output to meet the needs of the country, but it is anticipated that the steps taken to increase the output of coal, and the fuel economy resulting from the electrical developments, will make the country practically self-supporting. The vital importance of this may be appreciated when it is stated that industrial undertakings are now paying 10 times as much for coal as they did before the war. Little coal is being imported from England, it being found cheaper for the moment to import American coal.

From the point of view of British electrical manufacturers a few facts may be summarised. It is clear from the installations which were visited that the Dutch electrical engineers relied before the war almost entirely on German machinery for their generating stations and motor equipment, with the notable exception that a considerable amount of British cables have been laid in Holland.

During the war period, owing to the inability of British manufacturers and German manufacturers to supply, a great impulse has been given to the production of electrical plant in Holland, and some quite fine turbo sets built by the "Stork" Company, in collaboration with Brown, Boveri of Switzerland, are in operation or being erected in some of the modern stations, whilst other firms are specialising in smaller plant, such as motors, &c.

British cables by some of the principal firms were in considerable evidence, drums being seen in various towns and villages throughout the country. Although it is clear that the Netherlands Cable Factory of Delft is equipped to supply, and is supplying, very considerable quantities of large cables, the Dutch cable factory of Amsterdam appears at present to be confining itself to the supply of smaller wires.

As far as could be gathered from conversation, British and German prices, both for machinery and cables, were if anything rather in favour of British manufacturers if the £ sterling and the mark were at their original parity, but the great discount at which the mark stands is enabling Dutch buyers to obtain a much more favourable price from German manufacturers than from our own. Deliveries, on the other hand, from Germany still seem an uncertain quantity, and for quick deliveries the probability is that the British manufacturers could obtain the orders, particularly if they could state their price C.I.F. at a Dutch port.

As there seems some misapprehension as to the effect of the adverse rate of exchange affecting the power of a country like Germany to purchase its raw materials abroad, it may be worth while to point out that in a purchase by a country of raw materials abroad for the purpose of manufacture and re-export, the question of exchange rate practically cancels out, and the item that is really affected is that part of the cost, labour, management, use of machinery, &c., which are all internal to the exporting country, and which part of the cost is purchased at an actually low value by the external buyer. Thus, for instance, in the case of paper-insulated cables, Germany has in the past purchased copper and paper in external markets, and for her own consumption would be unfavourably placed buying to-day with the depreciated mark, but on re-export these materials reach the external market again at the external market price, while all the other items mentioned reach the external market at a lower price than similar goods from British manufacturers.

The general impression gained by manufacturers who took part in the visit was that it would probably be a wise policy to endeavour to set apart some proportion of their manufacturing facilities to supply the Dutch market, and creating a position there at a time when the conditions are more favourable for doing so than they ever have been in the past, or possibly are likely to be in the future.

Outline of the Tour.

The tour made by the deputation was briefly as follows :—

On arrival at Rotterdam on Sunday, the 21st September, the party were met by their hosts and conveyed by motor cars via Delft to Gouda. At Delft is situated the central Engineering College for the whole country. At Gouda a visit was paid to a large cheese store, and the party were entertained to lunch by the Municipality

Thence the route to Amsterdam was taken to show the large polders lying to the south of Amsterdam, with the elaborate system of dykes, waterways at various levels, and pumping arrangements. A disadvantage of pumping by windmill is that at times of heavy rain there is frequently no wind, and the water may lie on the land for some time before it can be removed by this agency. The electrical pumps may, of course, be used at any time desired, and in a recent inundation in North Holland it is understood that their use proved of the highest value and convinced the farmers completely of the benefit of the new system.

At Amsterdam an interesting trip was taken through the town canals. Here, as in other parts of the country, all the heavy merchandise is carried by canal, and the roads used only for the lighter traffic.

Mr. C. H. Wordingham, President of the Institution of Electrical Engineers, has been good enough to send us a number of photographs, some of which we reproduce, illustrating the visit to Holland. 1. Mr. Lulofs in earnest conversation. 2. Mr. Balfour, of Balfour, Beatty & Company, on stilts, which are more familiar in Holland than over here. Mr. Balfour possibly now feels that he is entitled to an elevated position, being an M.P. 3. Sir T. O. Callender and Mr. Ll. B. Atkinson. 4. Mr. Bellaar Spruyt discussing a knotty point. 5. Mr. C. P. Sparks pondering over the fact that it is a long way to Groningen. 6. The Palace, Het Loo. 7. Mr. B. M. Drake and Sir T. O. Callender, apparently engaged in a little philanthropy.

In the evening the party were entertained to dinner by the Society of Directors of Electricity Works.

On Monday a visit was paid to the harbour at Amsterdam, and the North Sea Canal which connects the port to the North Sea at Ymuiden.

The City of Amsterdam has a population of about 650,000 inhabitants, and was originally reached from the North Sea through the canals of the Zuider Zee. The silting up of this harbour made it necessary that a direct connection should be made to the North Sea, and the North Sea Canal now permits vessels with a draught of 18 ft. to reach Amsterdam. On the north side of the river the new electrical power station of the Amsterdam Corporation and the Central Refuse Destructor were inspected with great interest. The Refuse Destructor deals with the refuse from the whole of the city, which is collected by means of barges through the town councils. At the destructor the refuse is unloaded by transporters and delivered to moving belts. On these belts such articles as tin cans, old leather boots and cotton rags are picked out and dealt with separately. The tin cans are compressed for easy transport, and the tin is afterwards recovered. The rags are washed and baled ; the boots are baled, and it is understood are sent to Belgium, where the good leather is again used. The remainder of the refuse is delivered to the refuse destructor cells, fom which a certain amount of steam is raised. The steam so raised is conveyed to the adjoining electricity works, and it is understood that during the war a considerable proportion of the electricity works output was generated from steam raised in this way.

In the evening the deputation were entertained by the Municipality of Amsterdam.

On the 23rd September a visit was paid to a large diamond-cutting factory in Amsterdam, wholly electrically driven.

Particulars of the extraordinary development of electricity supply in Amsterdam were furnished by Dr. Lulofs. It appears that out of 140,000 houses 110,000 are provided with electric light, the pre-war connections being 30,000. Additional connections are being made at the rate of 500 a month. This large increase has been due to the difficulties of the inhabitants in obtaining any sort of light during the war ; neither gas nor candles were available and the

Corporation decided that every house should be provided with at least one lamp.

From Amsterdam the party journeyed to the Hague, where there was a reception by the President of the Royal Institute of Engineers, Dr. Croll, and Mr. H. Doijer, the President of the Electrical Section, and later in the day a dinner at which were present, in addition to members of the Council of the Royal Institute of Engineers, His Excellency Dr. H. A. van Karnebeek, Minister of Foreign Affairs; His Excellency Mr. H. A. van Ijsselteyn, Minister of Public Works; and Mr. Arnold Robertson, British Chargé d'Affaires at the Hague. At the dinner His Excellency Dr. van Karnebeek, Mr. Doijer and others proposed toasts, and the President (Mr. Wordingham), Sir T. O. Callender, Mr. G. Balfour and Mr. C. P. Sparks, replied.

The tenor of the speeches of our hosts at this and all other ceremonials evinced the greatest friendship towards the British nation, and both by words and deeds it was made clear to the deputation that they were heartily welcome.

Mr. Doijer, who is a member of our own Institution, in his speech pointed out that among the electrical machinery in Holland, English articles play an unimportant part, 80 or 90 per cent. being of German or Swiss origin. He said: "Your tendency to good workmanship of electrical articles is on an average more pronounced than that of the German and Swiss firms, but their art of manufacturing in large quantities is superior to yours, which makes their products less expensive. Your knowledge of electrical materials is more profound than that of your competitors, but their faculty and facility to calculate is more at the fingers' ends of their average man, enabling them, with all the dangers attached to it, to approach nearer to the minimum allowable dimensions of material, which makes their articles again a little cheaper. Your insight in the difficult electrical engineering problems is, in my opinion, superior to theirs, but their organisation to introduce their products over here is certainly more systematised than yours. To express it in a few words: You excel in the character of the individual, your competitors excel in the organisation of the masses."

On the 24th September the central station at the Hague was visited. Mr. G. J. F. Bakker, the manager of the Hague Works, and also Secretary of the Society of Directors of Electricity Works, explained the developments of electricity supply in the Hague, and a very interesting morning was spent in inspecting the works, the foundation problems in these works, as in others, being of particular interest, due to the water-logged and loose nature of the sub-soil. Here, as elsewhere, large use was being made of re-inforced concrete for constructional work.

Later in the day a visit was paid to Pooldijk. Scheveningen was also visited, and in the evening the party left by train for Maastricht.

At the Hague and on the journey from Rotterdam to Amsterdam, the electric railway from Rotterdam to the Hague was seen. This railway is an example of the high-pressure alternating-current system, the overhead contact wires being at a pressure of 10,000 volts.

On the 25th September the party journeyed from Maastricht to the State Coal Mine "Emma," passing on the way various other collieries. The present output of the Dutch coalfield is four million tons a year, of which approximately one-half is produced by the State mines, the other half by private enterprise. It is anticipated that the output will be substantially increased, and that in the near future some eight million tons will be produced. The surface works of the mine were inspected in detail, including the electric winding gears, and the electric power station, which supplies current not only to the mines but also to the Province of Limburg and the town of Maastricht. The system of transmission mains from this station is almost wholly underground. An interesting construction of ferro-concrete cooling towers with hyperboloidal shells was noticed, these towers being designed by the engineer of the mines.

On leaving the collieries the party journeyed to the house of Baron de Marchant d'Ansombourg, where they were entertained by the Baron and Sir Alphonse Michill van Kessenich. Returning to Maastricht the deputation were entertained at dinner by Mr. Bellaar Spruyt.

On the 26th September the party journeyed along the great military road to the north along the valley of the Maas. The towns and villages passed through had the invariable appearance of prosperity and cleanliness which is so marked a characteristic of the country. At Nijmegen the Maas was crossed, and at Arnhem, after crossing the river the party was received by the Provincial Authorities at lunch. Both Arnhem and Nijmegen are towns of great beauty.

The journey was resumed to Apeldoorn and the palace of the Queen, Het Loo. The deputation was received by Her Majesty and her Consort, Prince Henry, and the members were presented by Mr. Arnold Robertson, British Chargé d'Affaires at the Hague. The Queen evinced great interest in the views of the deputation, and inquired of each the matters of particular interest to him in her country. The party were afterwards entertained to tea, and continued their journey to Zwolle, where they were received by the Provincial Electricity Supply authorities. The journey to Groningen was completed by train.

Throughout the whole of the country the development of the supply of electricity was evident. Every little village had electric light provided by means of overhead wires, the construction being of the simplest possible character.

On the 27th September at Groningen a visit was paid to a straw board factory, worked on the co-operative system, the shareholders being the farmers who supply the straw. The machinery is driven by electricity from the public supply. With the exception of the paper machines, in which a fine adjustment of speed is required, the whole factory is equipped with alternating-current motors. The factory is an important consumer of the Groningen station, absorbing nearly one-half of the present output.

The central station at Groningen supplies the towns, the Province, and in addition furnishes a supply in bulk to the Province of Freisland. An example of recent developments in conjunction with the public electric power supply was inspected at the Electra Pumping Station, in the north of the province of Groningen. The pumping station is designed to deal with the rainfall over an area of 94,000 hectares, where is lifted from the low lands to the Reitdiep Canal, from whence it is discharged to the sea, through locks, at low tide.

At Zoutkamp two interesting examples were inspected of the use of electricity supply for agricultural purposes by the courtesy of Messrs. Mansholt. All the farm buildings were electrically lighted, and electric power was used for a variety of purposes, including the stacking in the large barns of hay, straw and clover by means of a simple form of motor-driven elevator and transporter.

The final day was spent by a portion of the party in a journey through the Friesland Lake District. Travelling by motor car to Schuilenberg, the party was met by the Governor of the Province and representatives of the Provincial Government and of the electricity department. The journey through the lakes was made by steam yacht. At Kruiswater the foundations of the steel towers carrying an overhead line across the canal at a height of 33 metres were inspected. At Grouw the overhead lines cross the water by a span of 190 metres, carried by steel towers, 48 metres high. At Sneek the boats were left for the train to Stavereng, the Zuider Zee being crossed to Enkhuizen, and Amsterdam finally reached by train. The party returned to England by Flushing.

Summarising the impression gained, it appears that the rapid development of electricity supply will call for a considerable extension of the generating stations and transmission systems, in which British manufacturers should take their part. The development of electrical manufacturing undertakings in the country is growing, but apparently not so rapidly as the demand for plant.

The extensive distribution in rural districts by means of overhead wires is made possible by the lenient regulations as to the method of construction, and by the compulsory wayleave powers possessed by the supply authorities. The extensive use of electricity for agricultural and domestic purposes should encourage the forward policy in this country.

Electric power supply is placed in an advantageous position by the high price of fuel; the national resources of coal are not great, and peat, though extensively used, domestically, is of little present value for power purposes. Many conditions are favourable to electric power supply, and the Dutch engineers are taking full advantage of them.

Everywhere was evidence of the closest co-operation between the supply authorities, companies, municipalities and provincial authorities, and in the industries associated with agriculture, such as sugar factories, dairies and the like, a number of the undertakings are working on the co-operative system. Mr. Wordingham summed up the matter in his concluding speech at Groningen in the words: "Co-operation is the keynote of the country."

The thanks of the deputation must be expressed to all who welcomed, entertained and instructed them. In a multitude of hosts, each a host in himself, it would be almost invidious to mention names, and one must be content to express to Mr. J. G. Bellaar Spruyt, the President of the Society of Directors of Electricity Works, the thanks of the party for the Society's kindness, to the Royal Institute of Engineers, to the representatives of the Provincial Governments of the Municipalities, and to those gentlemen associated with the various industrial concerns visited, and to all those who joined with them. To quote from one of Mr. Wordingham's speeches: "Nothing was too great for them to do, no detail too small to attend to."

Finally, must be recorded the deep appreciation of the deputation of the honour paid to them and to the Institution they represented by Her Majesty the Queen of the Netherlands.

Correspondence.

"PAPERS ON THE DESIGN OF A.-C. MACHINERY." ZIG-ZAG LEAKAGE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of August 1, 1919, Dr. Miles Walker draws attention to the fact that, in the formula for zig-zag leakage on p. 343, the M.M.F. is taken twice over, in consequence of which the value obtained for the zig-zag flux is twice as great as it should be. I must thank him for pointing out the error contained in this well-known formula and repeated by me. The simplest way to correct the error is to replace the 6 in the denominator by 12—the remaining parts of the expressions being left as they are. The effect of this alteration will be to reduce the inductance and consequently to increase the estimated short-circuit current; but, generally speaking, the difference will amount to a few per cent. only and may not be noticeable when comparing calculated with measured values.

With reference to the further point raised by Mr. Carr in your issue of August 15, 1919, it would be scarcely practicable in a Paper such as mine to go into greater refinements in calculating the leakage with different types of overhang. The formulæ as given will doubtless be regarded as sufficiently formidable by beginners and junior designers, whilst experienced designers mostly employ a considerable amount of what Prof. Walker aptly terms "judicious guessing" when dealing with leakage problems, which enables them to make fairly accurate predictions in connection with the class of machines to which they are accustomed.—I am, &c.

London, October 7. S. P. Smith.

The Record Ohmmeter.

Many of our readers will be pleased to hear that the Record Electrical Company, of Altrincham, have placed upon the market a cheap form of combined ohmmeter and generator for testing insulation. Owing to special design and the application of methods of "mass production" it has been possible to place this instrument on the market at a really reasonable price. It is particularly light, weighing only 12 lb. and, as appears from the illustration, it is provided with a shoulder strap which can be coiled up to form a carrying handle. The generator can be easily removed for inspection if necessary, and the instrument itself can be sealed apart from the generator. The instrument consists of a true moving coil ohmmeter, which is direct reading and dead-beat, the readings not being affected by the varying speed of the generator. Readings, can be obtained from 10,000 ohms up to 100 megohms. We feel sure there will be a large demand for this instrument, with its 12 months' guarantee, by those who cannot well afford the more costly instruments already in the market. It has been produced to replace the German instruments that came on the market before the war. In many respects we believe it is a better instrument than the imported article. It is not a make shift, and the low price has only been rendered possible by "mass production."

Record Ohmmeter.

Electricity Supply Commercial Association.

A meeting of members and others, to the number of 300 or more, took place at Caxton Hall, Westminster, on Monday evening under the presidency of Mr. Young, chairman of the London branch.

The Chairman spoke of the satisfactory increase that had taken place in the membership, but urged that all others who were eligible should join and strengthen the Association still further. He advocated frequent meetings of the branches or sectional meetings, to encourage intercourse, which would further the good-fellowship of the Association. The London Branch Council had this matter under consideration.

Mr. N. A. Chesterfield (president of the Association) said one benefit of the war had been to improve the outlook of all classes. Before the war it was difficult to obtain the redress of wrongs or consideration for just demands, but now they were able to make representations as to their status. That Association had been formed for the uplifting of their status in the industrial world, and it was up to them to uplift the Association.

Mr. G. R. Smith (hon. general secretary of the Association) then addressed the meeting, and commenced by recapitulating the history, aims and objects of the Association (which were digested in our reports of previous meetings on p. 379 of our issue of Sept. 26), and went on to say the nation had celebrated peace since the Association's meeting in April; but it had to deal with after-war problems, including labour unrest and the organisation of a big campaign of national economy, and it behoved every man to think out his position and organise to the utmost of his capability. During the war the need for trade unions was emphasised, particularly in certified electrical undertakings where the war bonus question was acute, so far as the staff men were concerned, and it was decided (in 1917) to form the Chief Commercial Officers' Association, the meetings of which were called to consider the one question of the inadequate war bonus. The Clerical Assistants' Association was formed in March, 1918, and these two were amalgamated into the Electricity Supply Commercial Association in February, 1919, just after both Associations had decided to register themselves as trade unions, and the Council took that matter in hand and got their certificate on May 13. which he thought very expeditious, as they only started drafting the rules in March. They had now nearly 340 members in London alone. It had been said that when an Association became a trade union there was a tendency to join the Trade Union Congress and meddle in politics; but that was not a necessary result, and it depended upon the policy of the rank and file of the members of the Association. They believed that co-operation of Capital, Labour and brains alone could build a new world, and that in an enlightened community change should come by consent, and not by force. What they claimed for the E.S.C.A. was that the "goods" offered to the employers were more in accordance with their specialised requirements than any other association could offer. A brochure, which would be distributed to members present, gave the wording of a draft clause, prepared by the Conference of Staff Associations (convened on the invitation of their Association), which it was proposed should be substituted for Clause 17 in the Electricity Supply Bill. The proposed new clause would be moved in Committee by Mr. Trevelyan Thompson, of Middlesbrough, and other clauses had been withdrawn in its favour. They had 95 members of Parliament pledged to support it, of whom 45 were in Committee B, which was going to deal with the Bill, and it was believed that the clause was safe. The general effect of the new clause would be to change "the Minister may" to "the Minister shall" give compensation for loss of office or pecuniary loss sustained by members of the staffs of electricity undertakings owing to their having been transferred under the Act. With regard to the Whitley Councils, the Government seemed to have forgotten when they brought about Whitleyism that there were such people as brain workers, and they were excluded from representation on the Councils; but the Ministry had now had in hand for some time a scheme to establish panels of the Industrial Council and district panels at which that Association and the E.P.E.A. would be represented. The Federation of Technical and Scientific Professional Associations, which included the Electrical Power Engineers' Association, the National Association of Industrial Chemists, the National Union of Scientific Workers and the Electricity Supply Commercial Association, now had a membership of about 30,000. He understood that the British Association of Chemists and the Society of Technical Engineers had also joined, and other associations had the matter under consideration. They wanted also to link up the Insurance and Bank Clerks' Unions and others with their Federation, which would strengthen any representations that might be made to the Government or Government departments and others. The question of the affiliation of the E.S.C.A. with the E.P.E.A. was, he believed, before the E.P.E.A. on the previous day, and, although he had no official information, he thought that, with the exception of certain formalities and the arrangement of details, the affiliation might be considered an accomplished fact. An arrangement had also been provisionally made for the "Electrical Power Engineer," the representative organ of the E.P.E.A., to be also the organ of the E.S.C.A., the expenditure being borne by the two associations equally.

Their relations with the employers' side of the Joint Industrial Council had been most cordial, and it was hoped that the bodies representing the employers would soon hold a conference, with the result that an award would be made in accordance with the Association's basic salary scheme.

which provided for greater increases in the cases of men under £200 than in the cases of those over £200 per annum.

Mr. Smith gave some further particulars of the Association's progress in the provinces, and concluded by advising members to take advantage of the facilities offered by the University of London to secure the new Degree of Commerce, as the Association could improve the status of its members the more quickly if the members improved their own efficiency.

A pledge to support the Association was taken from those present and appeared to be unanimous.

Heating and Cooking Notes.

THE "ELECTRO-VAPOUR" RADIATOR.

There are circumstances where a convection heater is preferable to a radiant heater, and the war demand for radiators which could be employed in the neighbourhood of inflammable gases lead to the development of electro-vapour and electro-steam heaters. Messrs. Benham & Sons, Ltd., were early pioneers in producing heating and cooking appliances; and their "Electro-Vapour" radiators show foresight in design in meeting the requirements of consumers.

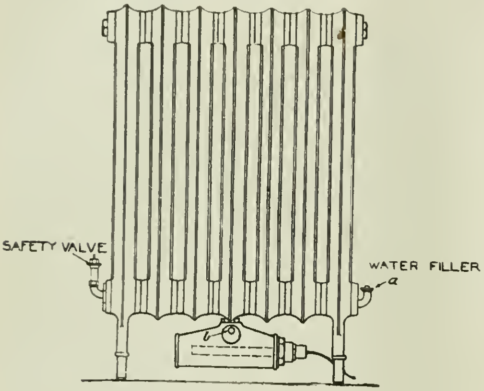


FIG. 1.—"ELECTRO-VAPOUR" RADIATOR.

These heaters consist of metal frames similar in pattern to the ordinary steam radiator, and a small vaporising chamber is fixed at the base. Heat is supplied to the vaporising chamber by means of a tubular enclosed electric heating element. The loading of the element varies from 350 watts for a heating capacity of 400 cubic ft. to 1,100 watts for a heating capacity of 1,200 cubic ft. It will thus be seen that an allowance is made of a trifle under 1 watt consumption of electrical energy per cubic foot of heating space. The radiators become hot in about 30 minutes from switching on.

Fig. 1 illustrates the ordinary pattern heater in outline, and indicates the internal arrangements. A similar type is also made with a slightly different frame, and suitable for permanent fixing, whereas the type illustrated can be conveniently moved if desired. The coil pattern heater shown in Fig. 2 has been specially designed for use in airing linen and clothing cupboards, particularly in the larger residential houses and flats and in hotels. A similar pattern to Fig. 1 is also made with tubular rail suspended above the heater, for use as a towel rail in bathrooms and lavatories.

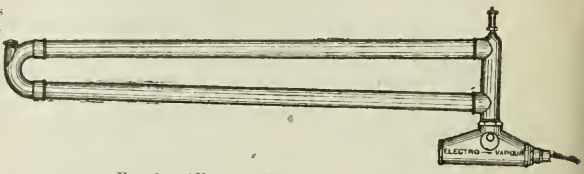
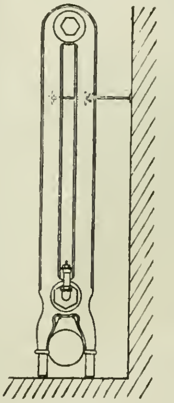


FIG. 2.—"ELECTRO-VAPOUR" CUPBOARD AIRER.



A NEW "EDISWAN" BREAKFAST COOKER

A good type of boiling plate and grill, built as one piece of apparatus and usually termed a breakfast cooker, forms a very suitable medium for first introducing electric cooking into the home. The "Ediswan" breakfast cooker consists essentially of a hotplate hob and a grill element mounted on a cast-iron frame. The hob consumes 750 watts, and the grill element 1,000 watts, so that the consumption of the apparatus on full load is 1¾ units per hour. Control is provided by means of two tumbler switches, but it would have been an advantage to have had two-heat control on the hot plate in order to facilitate simmering and similar operations. Whilst for breakfast purposes boiling only may be required, it should be borne in mind that this class of apparatus can be quite suitably used for preparing other meals. The finish looks well, being black enamel with nickel-plated facings, and the hot plate is completely nickel-plated. The apparatus is supplied complete with grilling pan and grid.

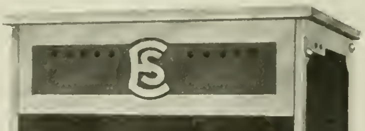


FIG. 3.—"EDISWAN" BREAKFAST COOKER.

Electricity Supply and Increased Output.

In a speech delivered at Histon on the 9th inst., Mr. C. A. McCurdy, K.C., M.P., urged the need for increased output and indicated ways in which industrial development could be helped. He said our difficulties would not be solved by reducing the reasonable profits of industry; high wages meant increased purchasing power, increased consumption and production. Three things were essential for making wealth—men, machinery and motive power. In order to get more wealth it was necessary to speed up either the men or the machinery or supply more motive power. Before the war the American worker was far better equipped than the British working man; he had in his factories newer and better machinery, and he used 50 per cent. more motive power (steam or electrical) to help him in his task. We might double the efficiency and output of the British working man by giving cheap and abundant motive power. After a reference to the report of the Coal Conservation Commission, Mr. McCurdy said that the motive power of the future would be electricity. At present there were 600 separate authorities generating electricity for public purposes, apart from private companies or firms that supplied themselves. It was a wasteful system, and we must have a centralised supply with abundant and cheap distribution of electricity in the interests of British trade. Other countries had taken steps in the same direction; Sweden, for instance, had spent £4,000,000. In addition to cheap power for every town and village, we wanted a proper transport service for all the sparsely inhabited parts of Great Britain. Cheap power and efficient transport would revolutionise our agricultural industry. In France, Italy, Sweden and Germany electricity was being used for agricultural purposes; from extensive power stations overhead lines carried electricity to the farm where electric power was used for a great variety of purposes. The application of science to agriculture was only in its infancy, but to greatly increase our production of food it was only necessary to apply the knowledge we already had got. The war had emptied the larders and warehouses of the world, and the openings for British commerce were never so great as to-day. We only required the wisdom and courage to see our opportunity, to scrap obsolete methods and to overhaul our industrial system.

Farewell Dinner to Mr. W. W. Blunt.

In order to mark the occasion of the retirement of Mr. W. W. Blunt from his post of director of the Metropolitan-Vickers Electrical Company, Ltd., he was entertained to dinner by his colleagues from Trafford Park and the district offices at the Midland Hotel, Manchester, on the 10th inst. Mr. Blunt has taken up an active partnership in an engineering business with his brother in the United States. The company was 150 strong.

Capt. R. S. Hilton, managing director of the company, was in the chair, and, following the toast of "The King," proposed the health of Mr. Blunt. He said it was a source of gratification to know that Mr. Blunt retained a connection with the old company, and would represent it in an important position where he would help to build up and cement the entente cordiale between not only the British company and the American company, but between the British and the American nations. There could be no better ambassador. Mr. Blunt had seen 23 years with the company; the history of the old British Westinghouse Company was the history of Mr. Blunt, who left many firiends scattered through the commercial and engineering institutions of the country, and not a single enemy. There was no need to emphasise what a loss Mr. Blunt's absence would be. For years he had been head of the commercial organisation of the company, and he had trained a good many of the staff. It was, perhaps, the human side of Mr. Blunt that attracted everybody; he had a most likeable and lovable character; he was absolutely straight, and he retained throughout his career the fullest confidence of all his colleagues. Musical honours and considerable acclamation were awarded Mr. Blunt at this stage of the proceedings.

In handing to Mr. Blunt the silver coffee service and flask which had been subscribed for by his colleagues, Mr. P. N. Rand added to Capt. Hilton's eulogy of the guest. After some amusing reminiscences, Mr. Rand quoted with telling effect Rudyard Kipling's "If," remarking that it exactly fitted Mr. Blunt's character. Mr. Rand also handed to Mr. Blunt a diamond brooch for Mrs. Blunt.

In his reply Mr. Blunt stated that he would value the magnificent gifts throughout his life and the remembrance of all his colleagues and friends in this country would mean more to him than he could tell. He particularly appreciated the delicate compliment to Mrs. Blunt. He had been largely dependent upon his own exertions, but none had had such loyal and grand support as had been given to him by the whole organisation of the old British Westinghouse Company. He predicted a brilliant future for the new Metropolitan-Vickers Electrical Company, which had the opportunity of playing a tremendous part in the development of both national and individual interest.

Mr. H. Mensforth, C.B.E., proposed the toast of the United States of America, and coupled thereto the names of Mr. J. C. Whitmoyer and Mr. O. H. Baldwin. Mr. Mensforth said that he had been in America during the last few weeks, and had pleasant recollections of his treatment there. The closer the co-ordination of American and British interests the better for the civilisation of the world; the ideals of the countries were exactly the same.

In their replies Messrs. Whitmoyer and Baldwin largely indulged in reminiscence, and many stories were told. They expressed their extreme pleasure in replying to the toast.

Mr. J. H. Tearle gave the toast of "The Chairman," and Capt. Hilton briefly replied. Musical items given by several members of the Metropolitan-Vickers staff interspersed the speeches.

The Gattie Transport Scheme.

The Committee on the Gattie transport scheme has resumed its sittings. At the last sitting Mr. W. B. Clode, K.C., counsel for the Railway Executive, stated that the London inwards and outwards goods traffic in 1913 was 46,300 tons of general goods, and 28,700 tons of coal and coke, exclusive of through traffic.

Mr. J. B. Harper, assistant general superintendent of the North-Eastern Railway, said he had not found any real necessity for any change in the present system of haulage or of dealing with wagons once they were loaded in the marshalling yards, but he had found the necessity of improving the means of dealing with traffic in large transfer goods yards. The best method of handling goods was overhead travelling cranes. If the container system was in general use, expensive machinery would have to be installed at all warehouses, private sidings, &c. It would be more costly to provide machinery for housing containers than the cost of the present shunting for locomotives; he did not think it possible to abolish shunting, because of the number of delivery places that had to be made. The Gattie system would save horse-power and time so far as the collection and delivery of goods was concerned. He thought the system deserved a test. If the carrying capacity of the containers were limited to 4½ tons it would be very doubtful if wagon stock could be reduced, and there would be an increase in the number of trains and train mileage, which would cause more congestion on the running lines than at present. If the Gattie system were tried on the North-Eastern Railway the most suitable place would be Leeds.

On Tuesday Mr. Percy Thomas, A.M.I.C.E. (on behalf of Sir John Norton-Griffiths), said that he had studied Mr. Gattie's proposal and estimated the cost of the proposed London clearing house at £8,980,000, exclusive of machinery and equipment or cost of site. He had also prepared figures for the construction of a wharf at Blackfriars made of ferro-concrete, with two decks covered by a roof. It would carry three railway tracks, which would be in communication with the South-Eastern and Chatham Railway. The estimate was £100,000, exclusive of the site, but inclusive of the rail tracks and connections. He saw no difficulty in the construction or operation of either of the works.

Mr. A. W. Gattie said that the estimated cost of the clearing house originally proposed was £2,075,000. That was a building of 100 million cubic ft., while the building now proposed was a structure of 180,000,000 cubic ft. The total cost of his scheme he estimated at £26,000,000: against that he estimated that the capital redemption account would in time work out at £50,000,000. In his estimate he included the value of the land now occupied in London, and particularly in the City, by railway goods depots. He believed there would be a saving of £22,064,000 per annum if his idea were adopted. He thought a Leeds clearing house was a profitable proposition given the co-operation of all concerned.

Patent Record.

SPECIFICATIONS PUBLISHED

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

117,443 Bosch Akt.-Ges. R. Double-current dynamos for wireless installations. (1/6/17.)
120,897 Scintilla (Firm of). Magneto-electric ignition machines. (2/11/17.)
131,963 Vaughan. Direction finders and the like for wireless signalling. (28/6/18.)
131,978 Smith. Automatic regulator for electric dynamos. (25/7/18.)
131,998 Electrolytic Zinc Co. of Australasia Proprietary. Treatment of zinc solutions preparatory to the recovery of zinc by electro-deposition. (17/8/17.)
132,016 Lewis. Variable speed alternating current motors. (31/8/18.)
132,019 Wrench & Engelke. Electric arc lamps. (2/9/18.)
132,020 Reyrolle & Co., Gregory & Clothier. Electrical switchgear. (2/9/18.)
132,021 Drysdale. Alternating current relays. (2/9/18.)
132,022 Hinton. Method of and means for determining the electrical characteristics of high-frequency oscillation circuit. (2/9/18.)
132,058 Western Electric Co. Power modulators for radio-transmission. (14/9/18.)
132,064 Jung. Refillable electric cartridge fuses. (17/9/18.)
132,080 Simon & Sarron. Electric resistance furnaces for heating gases. (24/9/18.)
132,081 Watson & Co., Greaves & Etchells. Electric furnaces. (25/9/18.)
132,101 Latour. Radio-telegraphy and telephony. (18/10/17.)
132,113 Kaplan. Galvanic cells. (2/11/18.)
132,114 Kaplan. Galvanic cells. (2/11/18.)
132,115 Henley's Telegraph Works Co. & Nichols. Removable electric fuse carriers. (4/11/18).
132,118 Latour. Radio-telephonic apparatus. (30/11/16. Divided application on 18,621/17).
132,131 McAlpine. Electric relays. (4/12/18.)
132,145 Lewis. Electric incandescence lamps. (30/12/18.)

1919 Specifications.

122,631 Soc. Des Moteurs Salmson (Systeme Canron-Unne). Magnetos. (23/1/18.)
125,373 Soc. Francaise Radio-Electrique. Utilisation of high-frequency alternators in telephony. (26/10/17.)
129,261 British Westinghouse Electric & Manufacturing Co. Protective apparatus for dynamo-electric machines. (29/6/18. Addition to 120,911.)
132,167 Marks (Splitdorf Electric Co.) Method of and apparatus for continuously interrupting electrical circuits. (7/2/19.)
132,170 Siemens Bros. & Co. & Laidlaw. Telephone systems. (8/2/19.)
132,174 Vickers, Ltd., Etchells & Stedman. Electrical switches. (2/3/18. Divided application on 3,721/18.)
132,196 Siemens Bros. & Co. & Pettigrew. Telephone systems. (28/3/19.)
132,203 Schneider et Cie. Electric apparatus for indicating and repeating movements at a distance. (29/4/19. Addition to 10,676/18.)
132,216 Siemens Bros. & Co. & Wood. Electric cable junction boxes or like arrangements. (26/5/19.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

September 3, 1919.

21,594 Round. Valves for wireless transmission.
21,595 Murray. Phonic motor drive for telegraph printer.
21,598 Constable. Electric cables and joint boxes for same.
21,599 Alltree. Shock absorbers for power transmission systems.
21,603 Townsend. Magnetic frictional variable speed gearing.
21,618 Jordan. Electric light fittings.
21,624 Western Electric Co. Transmission systems.
21,656 B.T.-H. Co. (G. E. Co.) Electric welding apparatus.
21,685 Weismann. Electric control mechanisms. (10/8/17, France.)
21,692 Macdonald. Electrically-locating oil bearing strata.

September 4, 1919.

21,712 Clauson. Appliance for disinfecting telephones.
21,714 Foster Engineering Co. & Dobson. Switches.
21,775 B.T.-H. Co. (G. E. Co.) Incandescent lamps, &c.
21,779 Selective Signal Co. & Lyons. Electrical oscillatory circuits.
21,783 Igranic Electric Co. Push-button controls of motor starters.
21,797 Chandler. Means for measuring electrical constants of an oscillatory circuit.
21,808 Frankling. Electric welding apparatus.
21,814 Fountain. Thermo-telephones, &c.

September 5, 1919.

21,829 Redmayne & Dean. Contacts for switches, fuses, &c.
21,835 Barry. Obtaining currents of two periodicities from one generator.
21,841 Hollingworth. Electromagnetic wave signalling systems.
21,842 Fuller. Wood separators for accumulators.
21,855 Electrical Improvements, Ltd., & Beard. Reactive windings.
21,868 Miller. Conduit fittings for electric cables.
21,876 Portholme Aircraft Co. & Cobbold. Electric plugs.
21,885 Filbar Electric Heater, Ltd., & Kratt. Electric water heaters.
21,891 Trichard. Electric wave form indicators or oscillographs.
21,892 Trichard. Frequency multipliers.
21,897 & 21,898 Belfield. (Westinghouse Air Brake Co.) Automatic electric couplings.

September 6, 1919.

21,957 Aspden & Bowman. Electrical equipment of motor vehicles.
21,966 Bauber, Burr & Merry. Electric pendant.
21,984 Johnson & Rahbek. Electric receiving apparatus for telegraphs, &c.
21,991 Akndona. Electrical systems for preventing collisions on single line railways.
21,992 Pudumjee. Electric fans.

September 8, 1919.

22,036 Thompson. (Soc. Francaise Radio Electrique.) Wireless telephone systems.
22,039 Scott-Taggart. Thermionic devices.
22,042 Suchostawer. Magneto motor.
22,068 Norske Aktieselskab fur Elektrokemisk Industrie Norsk Industrie Hypotekbank. Electrode for electric furnaces. (17/1/19. Norway.)
22,074 B.T.-H. Co. (G.E. Co.) Electrical apparatus.
22,090 Watkins. Electric tramways.
22,091 West & Co. & Breeze. Control devices for electric lifts, cranes, &c.
22,099 Redmond-Howard. Wireless telegraph and telephone apparatus.
22,105 O'Dell. (Western Union Telegraph Co.) Operating synchronous telegraph systems.

September 9, 1919.

22,114 Chadwick & Bishop. Pulleys for trolley poles.
22,118 Gray. Electric light fittings, &c., for vehicles.
22,127 Thompson. (Bethenod.) Electromagnetic wave navigational systems.
22,162 Berwick & Sizaire. Electrically-operated lifting jack.
22,165 Victoria Falls & Transvaal Power Co. & Price. Oil switches.
22,171 Hausdorf. Telephone receivers.
22,172 Scintilla. Fastening toothed wheels in magneto-electric ignition apparatus. (1/10/18. Germany.)
22,173 Akt.-Ges. Brown, Boveri et Cie. Apparatus for diminishing injurious earthing currents. (23/12/18. Switzerland.)
22,175 British Westinghouse Electric & Mfg. Co. & Lister & Cheetham. Electric relays.
22,184 British Westinghouse Electric & Mfg. Co. Cooling and ventilation of dynamo-electric machines.

September 10, 1919.

22,205 Waite. Locking electric switches.
22,206 Waite. Indicating faults in electric ignition of internal combustion engines.
22,247 Meyfarth. Electromagnetic braking apparatus for railway vehicles, &c. (19/9/18 Switzerland.)
22,263 B.T.-H. Co. (G.E. Co.) X-ray apparatus.
22,287 Mauron. Installation for charging batteries. (10/9/18. Switzerland.)
22,288 Mauron. Current-reversing devices for dynamos. (10/9/18. Switzsrland.)
22,289 Mauron. Automatic voltage regulation of dynamos. (10/9/18, Switzerland.)
22,290 Mauron. Automatic regulation of parallel working of variable speed dynamos and accumulators. (10/9/18. Switzerland.)
22,299 Harman & Le Bas. Dynamo-electric machines.
22,302 Taylor. Obtaining currents of any frequency from three-phase systems of any other frequency.

September 11, 1919.

22,304 Robinson. Intercommunication telephone systems.
22,313 English Sewing Cotton Co. & Bennett. Devices for cutting off current for electric lifts, &c., when gates are open.
22,319 Electric Construction Co. & Tonkinson. Means for starting up synchronous rotary converters.
22,331 Coughtrie. Series current relay.
22,332 Automatic Telephone Mfg. Co., Harrison, Smith & Redford. Telegraph printing machine.
22,358 Ellis. Control for battery-driven motors.
22,367 B.T.-H. Co. (G.E. Co.) Light reflectors.
22,371 Zweizbergk. Electric motor control systems.
22,378 Vyvyan. Means for punching telegraph tape.
22,391 Bonchardon. Generators of high frequency oscillations for wireless telegraphy. (21/11/18. France.)

September 12, 1919.

22,414 Hirst. Handle mechanisms for imparting step by step movement to rotary switchgear, &c.
22,428 Westrop. Electric wire or cord, &c., adjusters.
22,445 Cattell. Trolley guide for electric tramcars with overhead system.
22,494 G.E. Co. Thermionic Valves, &c.

September 13, 1919.

22,541 Metals Extraction Corpn., Williams & Harris. Electrolytic cells for deposition of metals from solution.
22,545 Railing & Taylor. Electric lamp fittings.
22,554 Gilbert. Locking electric switches of ignition circuits of motor vehicles.
22,555 Lawton. Electric lamps.
22,564 Driver. Regulating switch for electric clocks or time transmitters.
22,581 Ferranti. Transformers.
22,583 Bancroft. Portable electric lamps.
22,589 Calvert. Incandescent lamps.
22,592 Buckley. Starting rheostats for motors. (13/9/18, Australia.)
22,600 Adam. Electric light fixtures. (8/10/18. U.S.)
22,601 Wheeler. Electric joint, &c., box.

September 15, 1919.

22,609 Burdon. Telephone arrangement for firemen.
22,622 Barry & Taylor. Reducing lagging current on alternating current systems.
22,635 Sciaroni. Electric oven and shelving.
22,646 Edison Swan Electric Co. & Wrighton. Electrical indicators, &c.
22,655 Row[illegible]rth. Protection of live rails or conductors.
22,686 Oldham. Apparatus for charging galvanic batteries.

September 16, 1919.

22,714 Hiatt & Co. & Melson. Electric lamps for police, &c.
22,715 Jaks[illegible]chi. Starter for squirrel-cage induction motors.
22,725 Price. Electric heating device for use with cooking utensils, &c.
22,787 Oldham. Galvanic batteries.
22,790 Glass. (Lorenz Akt. Ges. C.) Electric machines for high frequencies.
22,791 Lorenz Akt. Ges. C. Means for producing electric oscillations by electric arc. (5/6/18. Germany.)
22,798 B. T.-H. Co. & Canter. High-speed electric &c. locomotives.

September 17, 1919.

22,863 Scott-Taggart. Electron discharge devices.
22,901 B. T.-H. Co. (G. E. Co.) Electromagnetic switches.
22,908 Roche. Electric switches.
22,913 Dukes & Kremenzky. Galvanic cells.
22,914 Sshneider et Cie. Windings for rotors of dynamos. (10/6/19. France.)
22,933 Taylor. Auto-selective fuses.

September 18, 1919.

22,960 Scott-Taggart. Negative and positive resistance vacuum tube devices for wireless telegraphy.
22,961 Walsh & Whipp. Electrical single and double preventer for exhaust openers and switches.
22,977 Metropolitan-Vickers Electrical Co. & J[illegible]. Commutators for dynamo-electric machines.
23,020 Davidson. Electric fuse holders.

September 19, 1919.

23,038 Worthington. Combination of water turbine and water wheel for generating electricity, &c.
23,051 Watson. Combined double pole switch and plug.
23,052 Fournier D'Albe. Selenium cells.
23,057 Earnshaw. Method of driving electric generators on bicycles, &c.
23,069 Grafton & Jones. Electric signalling telegraph.
23,073 Goldstone. Electro-medical or shocking coils.
23,096 Crompton & Co. Device for securing electric cables.
23,097 Crompton & Co. & Jones. Switches.
23,098 Crompton & Co. & Jones. Boxes for electrical apparatus.
23,099 Jones. Switches.
23,104 King. Dry battery.
23,117 Passmore. Electric welding.
23,118 Goldstone. Electric condensers, &c.
23,120 Cattermole. Switches.

Commercial Topics.

Trade with Italy.

The British Vice-Consul at Savona is prepared to receive, for the use of applicants at the Vice-Consulate, priced catalogues of various goods, including Diesel and Petters oil engines and electric motors for alternating and continuous current. Catalogues should be provided with notes showing the terms for the supply of the goods c.i.f. Savona or Genoa.

* * * *

Portuguese Electrical Schemes.

Among various industrial schemes for the development of Portugal are projects for utilising the water-power of the Douro and the Tagus for generating electric power for the industrial development of the country, and to render it independent of foreign coal. These schemes will, it is said, be carried out in co-operation with Spain. There are also proposals for electrifying important stretches of railway line. A good deal of capital will be required, but if the projects should be carried out there will be a good demand for hydro-electric plant, electrical supplies, rolling stock, &c.

* * * *

British Goods for Local Authorities.

The Industries and Manufacturing Department of the Board of Trade has issued a communication to local authorities on the economic position of the country, and suggesting the desirability of stipulating, as far as practicable, in all contracts placed by them that the goods to be supplied should be of British manufacture. The letter also states that where the prices quoted were unduly high compared with those of foreign manufacturers, or where an unduly long period was required for delivery, the Board of Trade would be glad to be so informed, and would be prepared to make inquiries.

We trust that local authorities generally will adopt the principle of the purchase of British goods whenever possible. In the past the Councils have not been conspicuous for their support of British electrical manufactures, but the war has no doubt altered their views; at least, we hope so.

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Engineering Products in South America.

We are pleased to learn that the Department of Overseas Trade and the British Engineers' Association have agreed to despatch an investigator to Chili, Peru and Bolivia in order to ascertain the conditions and prospects for the sale of British engineering products in those countries. The investigation will cover civil engineering, power plant and accessories, mining plant, plantation machinery, machine tools, electrical machinery and plant (but not electrical accessories), motor vehicles, &c.; and the investigator will also report upon import and shipping methods, tariffs, legislation, statistics and competition. British firms, who are not members of the association, may participate in the inquiry on payment before the receipt of the first report of a fee of 20 guineas. Communications should be addressed to the Comptroller-General of the Department of Overseas Trade or to the secretary of the British Engineers' Association.

* * * *

Trade Marks in Brazil.

Those who have, or contemplate having, commercial relations with Brazil, should take care to register their trade marks in that country in order to prevent unfair competition and infringement. It is only by prior registration that the goodwill and use of the trade mark may be reserved. According to Brazilian law a manufacturer or trader has the right to distinguish his merchandise or products by means of special marks stamped on the articles themselves or on the receptacles or wrappers containing the articles; but to secure the exclusive use of the trade mark, its registration, deposit and publicity are indispensable. Foreign trade marks must be presented to the "Junta Commercial" of Rio de Janeiro, and the application for registration must be accompanied by a declaration of what constitutes the trade mark and a full description of it, the class or industry it is to represent, the profession of the applicant and his address, &c. The British Chamber of Commerce of Sao Paulo has made arrangements with an eminent lawyer in Rio de Janeiro to execute all applications for the registration of trade marks. The cost of registration varies between £8 and £15, the average being approximately £10. The period of registration is for 15 years.

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Engineering Amalgamations.

Another important amalgamation of well-known engineering firms has recently taken place in order to increase production and to establish an efficient selling organisation. The amalgamated firms are: Messrs. Aveling & Porter, of Rochester; E. H. Bentall & Company, of Heybridge; Blackstone & Company, of Stamford; Richard Garrett & Sons, of Leiston; and James & Frederick Howard, of Bedford. These names are household words in the engineering industry of the country, and most of them have been established over 100 years. The amalgamation, which will be known as "The Agricultural & General Engineers, Ltd.," has a capital of three millions sterling, and has been formed with the view of employing a large amount of British labour on mass production. The firms in the amalgamation will not lose their identity, and their management will be unchanged. The various works will specialise in their chief products; they will be greatly extended, and already a large amount of this work and the purchase of new tools has been undertaken. The head offices of the new company will be at Central House, Kingsway, London, but until the Government Department which is now in possession of Central House has removed (which will be in the course of the next two months) the temporary offices are at 50, Pall Mall, S.W. 1

Electricity Supply.

Maidenhead Council has applied for sanction to borrow £5,500 for extension of mains, services, &c.

Mansfield Corporation has recently been authorised to borrow £20,500 for additional generating plant.

Islington (London) Borough Council has authorised an increase of a further 20 per cent. in the charges for the supply of electricity.

Middleton Electricity Committee has increased the price of electrical current supplied by them to 7d. per unit.

Mansfield Corporation is seeking authority to borrow £14,000 for extensions of the electric supply works.

Liverpool Corporation has received sanction to borrow £67,845 for mains, £4,000 for switchgear and £48,000 for boilers, economisers, &c.

Bandon Local Board have entered into a contract for the electric lighting of the town for the coming winter. The local gas works have been closed down.

Thirsk Parish Council, having considered the tenders of the local gas company and of the Northern Counties Electricity Supply Company for the public lighting, has accepted the latter company's estimate.

Llandudno Urban Council is recommended to make investigations into the possibility of utilising the water power available at their water works in Carnarvonshire in generating electrical energy.

Ilkley Urban Council has applied for sanction to a loan of £5,000 for the electricity supply department—£2,000 for excess expenditure and £3,000 for addditional mains and services.

The North Wales Power & Traction Company, which has under consideration a scheme for the supply of electric current to Portmadoc, Criccieth, Pwllheli, Nevin, &c., has informed Glaslyn Rural Council that the cost per mile of the overhead transmission line would not be less than £1,500, making a total of £60,000 for the scheme.

Glasgow Corporation has applied for sanction to borrow £20,923 for additional land for sub-stations, £244,075 for sub-station buildings and for the new Dalmarnock power house; £377,091 for machinery and plant, £300,000 for mains and cables, £18,000 for meters and £64,000 for transformers in consumers' premises.

It is suggested that the clinkers from the Marylebone Borough Council's electricity department should be made into slabs for paving the footways. The price asked by the Highways Committee for the slabs is 7d. and 9d. per square foot, compared with 10½d. per foot, the present contract price for artificial footway paving slabs.

The Secretary for Scotland has authorised the Corporation of Edinburgh to borrow a further sum of £950,000 for the executing of the capital works under the Edinburgh Electric Lighting Order, raising the whole sum authorised to £2,280,000. The additional sum is required for the new works at Portobello.

Hawarden Rural Council, which discussed the question of electricity supply before the war, is now anxious to proceed with a scheme for Hawarden, Queensferry, Caergwole, Hope, &c. The clerk has been instructed to notify the Board of Trade of the intention to apply for a provisional order for the whole of the districts, and a committee of five members has been appointed to deal with the matter.

Owing to the increased cost of fuel and other charges, King's Lynn Corporation has increased the charges for electric current as follows: For lighting, from 6d. to 7d. per unit; large power consumers, from 1¾d. to 2¼d. per unit; and for other power consumers, to 6d. per unit.

The Council will supply electrical energy to the West Lynn shipyards by carrying a cable across the river Ouse by way of the Cut Bridge.

The Board of Trade is actively engaged upon the preparation of the promised Bill for the Development of Water-power in order that the scheme may be presented to Parliament in the early days of the autumn session. The Government propose to establish local boards for developing water-power, but the boards will have authority to safeguard the needs of localities where water-power exists.

Owing to the increased cost of fuel, labour, &c., Torquay Corporation has applied to the Board of Trade for sanction to increase the present maximum rate for the supply of electricity from 8d. to 1s. per unit. The Council has also decided, unless the local tramway company agree to pay a fair price for current, to apply to the High Court, under the Courts (Emergency Powers) Act, 1917, for the suspension of the present contract for the supply of electrical energy.

Luddenden Foot Council, which has been in negotiation with Halifax Corporation and the Yorkshire Electric Power Company in regard to the supply of electricity to Luddenden Foot, has decided to accept the terms submitted by Halifax, and an application is to be made for the necessary order. We are also glad to learn that Luddenden Foot Council contemplate installing electricity in the houses to be erected under the local housing scheme.

On Friday last the Birmingham Electric Supply Committee placed contracts to the amount of £120,000 for the supply of plant to the new Nechells station. Good progress is being made in the early constructional work. The concrete piling on the site is nearly finished, and steps are being taken for the erection of the first part of the steel framework. The material is now being delivered with reasonable regularity. It is anticipated that the work will be sufficiently well advanced by April next to allow of the introduction of the first instalment of machinery, and that generation of current will be commenced about this time next year.

Electric Traction.

Neath Town Council has decided to borrow £100,000 for constructing electric tramways.

Llantrissant Rural Council has decided to promote a Bill for the extension of the tramways from Penrhiwfer to Gilfach Goch and from Tonyrefail to Pontyclun.

Lancaster Corporation has refused to co-operate with Morecambe Council in the purchase of the tramways of the Lancaster & District Tramway Company.

Bournemouth has authorised the relaying of a portion of the tramway lines, at an estimated cost of £184,000, and to purchase new tramcars at a cost of £60,000.

Cardiff Parliamentary Committee recommends that powers be sought in next year's Corporation Bill to construct extensions of the existing tramway routes, to operate motor omnibuses, &c.

At Lincoln work is proceeding on the substitution of the overhead trolley for the G. B. surface contact system. Motor transport is to be provided in parts of the city not covered by the municipal electric tramways.

Since the introduction of electric traction on the Manchester tramways in 1901 £1,326,891 has been devoted from the net profits to the relief of the local rates. The largest amount contributed in any one year was £111,891 in the year ended March last.

At the meeting of Blackpool Town Council last week it was stated that £250,000 would be required for the transfer of the undertaking of the Blackpool Fleetwood Tramroad Company, and the Tramways Committee expected to require £24,000 and the Electricity Committee some £10,000 for improvements and extensions.

Salford Tramway Committee has ordered 500 tons of Sandberg silicon steel tramway rails at £19 per ton, and 250 pairs of steel fishplates at £25 per ton. The Committee has also accepted the following tenders: Hadfields Limited, steel tie bars, £573. 2s. 6d.; W. T. Glover & Company, light cable, £338. 10s.; British Insulated & Helsby Cables Company, service fuse boxes, £694. 7s.

The scheme of the Sunderland Tramways Committee for construcing a new loop line in the centre of the town, via High-street West John-street and St. Thomas-street, has been rejected by the Council in favour of a larger loop line running from High-street West and along John-street, joining the existing line in Borough-road. Application is to be made to the Board of Trade for a provisional order authorising the construction of the line at an estimated cost of £5,000.

The Board of Trade have extended by one year from Aug. 7 the period limited by the Newcastle-upon-Tyne Corporation Act, 1914, for the completion of tramways authorised by that Act. The Board have also extended by one year from Aug. 28 the period limited by the Swansea Corporation Light Railways (Extension) Order, 1914, for the purchase of lands and for the completion of railways Nos. 1, 2 and 3.

For the position of manager of the Teesside electric tramways (Middlesbrough, Stockton and Thornaby Corporations) 35 applications were received, and the following have been selected for interview: Messrs. Arthur C. Baker (chief assistant engineer, Birmingham Corporation tramways), Chas. T. Baker (traffic manager, Blackpool), W. A. Luff (assistant general manager, Yorkshire (West Riding) Electric Tramways Company), T. G. Richardson (Colne), A. B. Slater (Burton-on-Trent), and John Telfer (Warrington).

The Wolverhampton tramway fares have been increased ½d. on all stages, the minimum ordinary fare being 1½d. The advances are due to the increased expenditure, which is now 150 per cent. over pre-war running costs. The tramways have been re-assessed to £10,960 from £5,843. In addition, the whole of the telephone and pilot cables have to be renewed at an estimated cost of £16,000, and out of the renewals fund of £56,685 has to be provided £13,257 for six new tramcars.

An unfortunate tramcar accident occurred at Burton-on-Trent on the 8th inst. A car on the Midland Railway Company's Burton and Ashby service was going up Bearwood Hill, Burton, when (it is stated) the power suddenly failed, and the vehicle began to run backwards. The driver applied all his brakes, but without appreciable effect. When the car got to the bottom it left the rails at the curve and fell over on its side. One passenger was killed, and about 20 others injured.

On subsequent investigation it was found that the brakes and mechanism were in order, and the damaged car was driven under its own power to the depot, five miles away. The Board of Trade inquiry was held in private on Tuesday.

For the first time in its history the Glasgow Corporation tramways Department shows a deficit of £19,435 for the first three months of the current financial year—from June 1 to August 31. The traffic receipts were £417,764. 11s. 6d.; and sundry receipts, £4,021. 0s. 10d., a total of £421,785. 12s. 4d. Traffic expenses were £201,358. 1s. 3d.; general expenses, £55,831. 5s. 10d.; repairs and maintenance, £73,764. 12s. 9d.; power, £35,049. 3s. 8d.; Clydebank bridges, £455. 16s. 9d.; and war allowances, £3,550. 15s. 7d., a total of £370,009. 15s. 10d., and leaving a balance of £51,775. 16s. 6d., but the following payments have to be met: Paisley Tramways Company, £2,902. 3s. 1d.; interest, £395; sinking fund, £338. 11s. 6d.; income-tax, £21,575. 9s. 3d.; and depreciation and permanent way renewals, £46,000, a total of £71,211. 3s. 10d. The Department, which is still running on a pre-war basis of fares, will now be compelled to increase the fares or shorten the present tramway stages.

Imperial and Foreign Notes.

According to a recent Customs Decision, electric sterilisers suitable for dental use can be imported into New Zealand duty free.

There is demand for the termination of the arrangement by which current from the Government power station at Perth (Western Australia) is supplied to the Perth ratepayers—through the medium of the municipality—as it does not add to the Government's profit, while it enhances the charge to the consumers. Originally the electricity station was owned and operated by the Municipal Council; subsequently the Government purchased the station and allowed the Council to act as distributors.

It is proposed to extend the plant and mains of the Copenhagen municipal electricity undertaking at an estimated cost of 4,900,000 kroner.

At the recent annual congress of the U.S.A. National Safety Council at Cleveland, Ohio, the Westinghouse Electric & Mfg. Company had an interesting exhibit of safety devices or models designed for use in the various departments of the Westinghouse works where over 30,000 men and women are regularly employed.

A company was recently formed at Madrid, with a capital of £200,000, for the purpose of investigating various schemes for the conversion of Spanish railways to electric traction. Several hydro-electric companies, the Altos Hornos of Vizcaya, the Constructora Naval and the Banco de Vizcaya, are interested in the new company.

It is estimated that in Finland there is over 3,000,000 H.P. of water power, of which over 1,000,000 H.P. can be of direct use in industry. Only about 150,000 H.P. is at present utilised. The "Bulletin" of the Federation of British Industries reports that of the 79 waterfalls in Finland with potential capacities of from 5,000 H.P. to 300,000 H.P., 42 range from 5,000 H.P. to 20,000 H.P.; 25 from 20,000 H.P. to 50,000 H.P.; six from 50,000 H.P. to 100,000 H.P. and six from 100,000 H.P. to 300,000 H.P.

The Governor-General of Madagascar has approved a scheme for the supply of electrical energy to Tamatave, the principal port of the colony. It is proposed to utilise waterfalls situated 10 to 15 miles west of Tamatave, on the Ivondrono River, which will supply about 3,000 H.P. It is also suggested that the railway from Tananarive to Tamatave, a distance of 229 miles, should be converted to electric traction, while energy for electro-metallurgical and electro-chemical industries, &c., could also be supplied. If the colony and the Municipal Council support the scheme the colony's expenses will, it is estimated, be 625,000 fr., and those of the municipality of Tamatave 1,225,000 fr. As a rule all contracts for public works in Madagascar are awarded to French citizens only.

The Brazilian Government recently asked the sanction of Congress to enter into contracts for the electrification of the main line of the Central Railway from the Central Station to Barra do Pirahy, including the ascent of the Serra, and also of the suburban lines serving Rio de Janeiro. It is considered urgently necessary, in view of the growth of the city, that a greater and more rapid railway service be provided at low rates. The preliminary surveys have been completed, and the cost of electrifying the lines referred to is estimated at 5.593 contos (£340,000), and that of rolling stock, power stations, &c., at 17,230 contos (£1,050,000) When the sanction by Congress has been obtained tenders will be invited, and liberty will be provided for the adoption of any suitable system of electrification as well as suitable bases for payment.

According to "The Times" Trade Supplement, the American International Corpn. is likely to secure important electrical and engineering concessions in Italy, including the harnessing of the water power of the Trentino, the electrification of railways in Northern Italy, and the systematisation of the port of Genoa, &c. The cost of the works is put down at 60 million sterling, and, in addition, the corporation will lend the Government 80 million sterling for immediate financial needs. The arrangement provides that Italian labour and materials shall be used as far as possible, and only supplemented from the United States where they do not suffice. It is stated that the proposal is not viewed with favour in Italian financial and industrial circles, who claim that they are in a position to carry out big undertakings in Italy. Companies have already been formed to undertake the electrification of the railways. Co-operation on the part of British industry has always been, and would still be, welcomed in Italy.

The scheme for the supply of electrical energy to the province of Limbourg, Belgium, has recently received the royal approval, and tenders have been invited for the supply of current to one or more suitable points within the province. The cost of the undertaking is estimated at about 12,000,000 fr., and the successful tender will be required to form a limited company, with capital consisting entirely of shares, and must satisfy the authorities that he possesses sufficient financial and technical powers to carry out the arrangements. British firms should apply (until Dec. 1) to Prof. Gillon, 99, Rue des Flamands, Louvain, either personally on Tuesdays or by letter. The Commune of Beyne-Heusay has also called for tenders for transforming and improving existing installations for the distribution of electrical energy on its territory. Tenders will be received at the Maison Communale, Beyne-Heusay, up to the 31st inst. The cost of the work is estimated at about 200,000 fr. Particulars can be seen at 276, Grand Route, Bayne-Heusay.

Educational.

A course of six lectures on Thermionic Detectors, Oscillators and Amplifiers in Telegraphy and Telephony will be delivered at the University of London, University College, by Prof. J. A. Fleming, on Wednesdays at 5 p.m., beginning Oct. 29. The course is open both to members and non-members of the University. Applications for tickets of admission should be made to Mr. Walter W. Seton, M.A., D.Lit., University College, Gower-street, W.C.1.

An attractive series of University Extension Lectures on "Scientific Discoveries and their Practical Applications to Every-day Life and Industry" will be held on Monday evenings at 6.30 at Gresham College, Basinghall-street, E.C., by Prof. John Cox, M.A., LL.D. Last Monday's lecture dealt with the story of the X-rays, and amongst other topics treated in the course may be mentioned the motor and the dynamo. Lord Kelvin and the Atlantic cables, long-distance telephony, wireless telegraphy and telephony, architectural acoustics, stream lines and aeroplanes, sound ranging, listening under water, directional wireless and radio-activity. The course will be illustrated where necessary by lantern slides, experiments, &c.

Marconi's Wireless Telegraph Company claims to have solved the problem of how a Londoner engaged in business can widen his education attainments without throwing undue strain on the nerves and physique. Commencing this week, the company has introduced as an optional item in their head office routine a series of classes in subjects likely to be of value in a business career. The office day closes at five, and at that hour all members of the staff wishing to attend the new classes are provided free of charge with light refreshments. The classes, which commence at 5.15 and last one hour, embrace elementary Spanish, elementary and advanced French, mathematics, book-keeping and theory of commerce (elementary and intermediate). They have been arranged by the company's welfare superintendent, Mr. W. Randell, and are conducted by eight certified L.C.C. instructors. The entire expenses are borne by the Marconi Company, which has joined the Association for the advancement of education in industry and commerce.

Miscellaneous.

It is announced that Sir Evan Jones, Bart. M.P., has resigned the position of Controller of Coal Mines.

The will of the late Mr. Albert Vickers, formerly chairman of Vickers, Ltd., has been proved. The estate is valued at £886,584, with net personalty £759,747.

The Council of the I.M.E.A. announce that the reprint copies of Ald. W. Walker's Paper on "The Application of the Whitley Report," as read at the last annual convention of the I.M.E.A., can be obtained from the Secretary of the Association, Electricity Works, Factory-lane, Croydon, at 6d. per copy, postage extra.

At Blackpool, on Oct. 8, Richd. Smith, Thos. Albin Smith and Jos. Regan were committed for trial on a charge of stealing from Bispham electricity works a quantity of copper cable, &c., value £50. Some of the property was sold to a metal dealer for £5. 12s. 8d. Defendants pleaded not guilty.

We are glad to be able to announce that the Strike of Iron founders core makers and metal dressers, which lasted about three weeks and threatened to paralyse the engineering industry, has been settled. Under the terms of settlement, the present rate of wages will be continued until Sept. 30, 1920, and negotiations will take place upon questions arising out of the introduction of the 47-hour week; but the men's application for a general advance in wages has been adjourned until after the decision of the Court of Arbitration on the next periodical year.

In the course of a Paper on Private House Installations, read before the Birmingham and District Electric Club on Saturday last, Mr. C. M. Walter and Mr. R. G. Marsh referred to the increasing popularity of Private Electric Plants for house lighting. It was stated that in the Birmingham suburbs householders were getting into the habit of installing small electric plants, and were becoming more and more independent of the municipal supply, so that when anything happened to the latter they were able to "carry on" as usual. The authors gave a large amount of interesting information about the recent designs of small engines, dynamos and storage batteries, with the results of their investigations into relative prime costs, running costs and efficiencies. They also gave some account of research work done during the war in connection with the improvements in design of storage cells for both mobile and stationary work. It was hoped that the experience gained would be fruitful, and might make possible a great extension of usefulness in quite small lighting sets for the lighting of small houses, &c.

The first case under the Profiteering Act which affects the electrical industry has been brought before the Acton Tribunal. Complainant (Mr. J. H. Warrall) stated that on Oct. 2 he bought six 30-watt Ediswan lamps at 3s. 6d. each from the local branch of the Metropolitan Electric Supply Company. He said the average pre-war price of the lamps was approximately 2s. 8d.; that the present lamps were of inferior quality, and alleged that there was a ring to keep up prices. He asked the Committee to summon before them the engineer, the local manager, accountant and the invoice clerk, with books of account showing prices before and after the war, and any agreement with manufacturers bearing on the "ring" allegations.

The Committee considered that the question of a "ring" was one for a higher tribunal, and made no order as to the evidence which respondents should submit. They decided, however, to hear the case.

Tenders Invited and Accepted.

Ilford Council require tenders by Oct. 18 for a double-ended tramcar wheel lathe. Particulars from the Tramways Manager and Engineer.

Walsall Corporation want tenders by Nov. 1 for one year's supply of grease, castings, oils, trolley wheels, &c., to the tramways department.

Blackpool Corporation invite tenders by Oct. 20 for 2,000 tons of steel tramway rails.

Glasgow Parish Council require tenders by Oct. 24 for 12 months' supply of electric lamps and fittings, bell furnishings, &c. Forms of tender from the Inspector and Clerk, 266, George-street, Glasgow.

Belfast Electricity Committee require tenders by 11 a.m. Oct. 21 for structural steel work for their new harbour power station. Specifications, &c., from the City Surveyor.

Bournemouth Council require tenders by noon Oct. 23 for the supply of 2,000 tons of tramrails and 26 tons of fastenings. Specifications from the Tramways Manager.

Manchester Waterworks Committee require tenders by Oct. 31 for a set of electrically-driven high-pressure centrifugal pumps. Specification, &c., from the Secretary, Waterworks Offices, Town Hall, Manchester.

Bolton Electricity Committee require tenders by noon Nov. 11 for the supply of an 8,000 kw. turbo-alternator with condensing plant, and four water-tube boilers. Specifications, &c., from the Borough Electrical Engineer.

The directors of the North-Eastern Railway Company require tenders by 9 a.m. Oct. 27 for the supply of (1) telegraph apparatus and (2) telegraph wire and line stores for six or 12 months. Forms of tender from Mr. C. H. Ellison, Telegraph Superintendent, York.

The directors of the North-Eastern Railway Company also require tenders by 9 a.m. Oct. 27 for six or 12 months' supply of various stores and materials, including electric lighting, sundry fittings, electric wires and cables, steel and iron signal wire and signal cord, metals, &c. Forms of tender, &c., from the Stores Superintendent.

Birkenhead Guardians have accepted the tender of the Automatic Telephone Mfg. Company for an automatic switchboard at £650; and that of the Electric Power Installers, Ltd., for wiring work at £575.

Hammersmith (London) Borough Council has placed an order for the supply of 1,000 yds. 1 sq. in. and 2,000 yds. 0·05 sq. in. l.t. cable with the Pirelli General Cable Works, Ltd., at £387. 15s. and £520. 18s. 6d. respectively.

Last week Birmingham Electric Supply Committee placed an order with the Davenport Engineering Company for 17 wooden cooling towers for the Nechells power station at a cost of about £60,000. An order has also been placed with the Mitchell Conveyor Company for the telpher coal-handling plant at about £30,000. A third contract (for machinery, and principally transformers) was let at about £30,000. The transformers will be supplied by Messrs. Ferranti Limited for the permanent station at Nechells and the sub-stations at Summer-lane and Bournville.

Appointments Vacant and Filled.

A head of the physics department is required at Clifton College. Applications to the Headmaster by Nov. 8.

The Council of Armstrong College invite applications for the professorship of engineering; commencing salary £1,250 per annum. Applications to the Registrar, Armstrong College, Newcastle-on-Tyne by Oct. 21.

A relief shift engineer and an assistant consumers' engineer are required in the Stepney (London) electricity department. Applications to the Engineer and Manager, 27, Osborn-street, Whitechapel, E.1, by Oct. 22.

Lecturers on (*a*) mathematics and physics, (*b*) practical mathematics and mechanics, and (*c*) engineering subjects, are required at Rutherford Technical College, Newcastle-on-Tyne. Applications to the Acting Director of Education, Newcastle, by Oct. 18.

A lecturer is required for the electrotechnics department of the South African School of Mines and Technology, Johannesburg. Salary £450, rising to £550. Applications to Messrs. Chalmers, Guthrie & Company, Ltd., 9, Idol-lane, London, E.C.3, by Oct. 20.

Newport (Mon.) Corporation require an engineer-in-charge (Salary £300) and a meter mechanic and test room assistant (wages £4. 10s.) for the electricity department. Applications to the borough electrical engineer and tramways manager, Mr. A. Nicholls Moore, by Oct. 20.

Applications are invited for the position of lecturer in electrical engineering at the University of Cape Town. Commencing salary £350, rising after three years' service by annual increments of £25 to £450, plus war bonus. Applications to the Secretary, High Commissioner for the Union of South Africa, 32, Victoria-street, S.W., by Nov. 30.

The Corporation of the city of Cape Town invite applications for the position of station engineer. Salary £600 per annum. Applications by noon Jan. 3, 1920, to the town clerk, Mr. J. R. Finch, City Hall, Cape Town; but candidates resident in the United Kingdom must send their applications to the office of the London agents of the Corporation, Messrs. Davis & Soper, Ltd., 54, St. Mary Axe, E.C., by the 15th prox. The Corporation also invite applications for the position of temporary assistant engineer in the electricity department, salary £60 per month. Applications to the town clerk (Mr. J. R. Finch) by noon of Jan. 10, 1920; but British candidates must send in applications to the London agents, Messrs. Davis & Soper, Ltd., 54, St. Mary Axe, E.C., by Nov. 15.

Mr. S. R. Windle, chief assistant electrical engineer at Sunderland has been appointed Borough Electrical Engineer at Doncaster.

Business Items.

From Messrs. F. J. Shenton & Company, of 68-69, Shoe-lane, E.C. 4, we have received their price lists of steel conduits and of enamelled conduit fittings.

Mr. Walter Watts, electrical engineer at the Training College, Caerlon, Mon., has resigned, and will shortly join the firm of W. Watts & Company, engineers and contractors, Newport.

The General Electric Company (of New York) notify the formation of the International General Electric Company (Inc.) for conducting their foreign business. The address of the International Company is at 83, Cannon-street, London, E.C. 4.

An important Sale by Auction of electrical plant, including electric motors, transformers, switchboards, electrical instruments, &c., will take place at the National Shell Forgings Factory, Edge-lane, Liverpool, on Oct. 28 and three following days. Further particulars and catalogues may be obtained from the auctineers, Messrs. Geo. H. Dixon & Company, 41, Castle-street, Liverpool.

Messrs. Fuller, Horsey, Sons & Cassell Will Sell by Auction at the Coventry Ordnance Works, Coventry, on Nov. 11 and following days, a number of high-class engineers' machine tools, some electric motors, rotary converters, transformers, &c. Catalogues (2s. 6d. each) may be obtained from the representative of the Disposal Board at the factory at Coventry, or of the Auctioneers, 11, Billiter-square, London. E.C.3.

In connection with the new Tricity Showrooms which were recently opened by the British Electric Transformer Company at 50, Oxford-street, W., the company have prepared "Introduction" books, which they will be pleased to forwardto contractors applying personally or by letter for same at their London address. The forms are to be filled up by contractors in order to introduce clients desiring to see demonstrations of cooking apparatus. Each book contains 25 forms. A map with various bus routes is given on the back of each numbered form or slip, so that customers should have no difficulty in finding the premises.

The G.E.C. announces that it is once more able to effect prompt deliveries to the trade of G.E.C. Solid Drawn Conduit. Until recently the whole of the output has been reserved for urgent war requirements, and the trade has consequently suffered by not being able to obtain this high-grade conduit, which is preferred by a large number of consulting engineers and wiring contractors engaged on electrical installation work demanding the use of solid drawn conduit. In addition to the saving due to the reduction in the number and magnitude of Government orders, the company has been able very considerably to augment its output, thus ensuring that all inquiries for solid drawn conduit will be promptly met.

Companies' Reports, &c.

An interim dividend of 3 per cent. has been declared by the Anglo-Portuguese Telephone Company, Ltd.

Sir George Touche has been elected chairman of the Anglo-Argentine Tramways Company, Ltd., to fill the vacancy caused by the death of Mr. J. B. Concanon.

Messrs. Siemens Brothers & Company, Ltd., have declared an interim dividend of 1s. per share, being at the rate of 10 per cent. per annum, tax free.

The City & South London Railway Company announces that interest for the half-year ending Oct. 31 on the 4 per cent. perpetual debenture stock will be payable on and after Nov. 1.

The Metropolitan District Railway Company announces that interest for the half-year ending Oct. 31 on the 4 per cent. prior lien debenture stock will be payable on and after Nov. 1.

The directors of the Indian Electric Supply & Traction Company have decided to make an issue of 120,000 non-cumulative preference shares of £1 each for extensions of plant and mains.

The accounts of the Cape Town Consolidated Tramways & Land Company for the year 1918 show a loss of £622, which increases the debit balance to be carried forward to £12,607.

The directors of the Brisbane Electric Tramways Investment Company, Ltd., announce an interim dividend of 8 per cent. per annum (4s. per share), tax free, on the ordinary shares for the past half-year.

The directors of Babcock & Wilcox, Ltd., have declared an interim dividend at the rate of 12 per cent. per annum (1s. 2⅖d. per share), free of tax, on the ordinary shares for the past half-year.

The Westminster Electric Supply Corporation announces that fully-paid share certificates for the new issue of ordinary shares are now ready, and can be exchanged for allotment letters and bankers' receipts.

The directors of the Oriental Telephone & Electric Company, Ltd. have declared the following interim dividends: 3 per cent. on the 6 per cent. cumulative preference shares for the current year (less tax), and 4 per cent. on the ordinary shares, tax free. The warrants will be posted on the 1st prox.

The report of Hurst, Nelson & Co., Ltd., for the year ended July 19 states that, after deduction of usual charges, including provision for excess profits duty, the gross profit is £84,224. Deducting £10,190 income-tax and interest, and £18,072 depreciation, the balance is £55,960, which, with the amount brought forward, makes £76,803. The directors propose to place £20,000 to reserve, and pay a dividend of 10 per cent. on the ordinary shares and a bonus of 5 per cent. It is proposed to increase the ordinary share capital and to capitalise a portion of the reserve and distribute one new preference share for each £10 share held, also five new shares for each £10 ordinary share.

New Companies.

BODMIN ELECTRIC LIGHT & SUPPLY COMPANY, LTD. (159.205)—Private company. Reg. Sept. 30. capital £7,000 in £1 shares. First directors are G. B. Treverton. J. C. Willis. W. E. Bennett (chairman). J. E. Bray, A. J. Bray, A. C. Hawke, J. C. Jane. F. Liddell. E. A. Luke and J. H. Pellow. Secretary : E. W. Gill. Reg. office : 45, Fore-street, Bodmin.

BRITISH WATER POWER DEVELOPMENT COMPANY, LTD. (159,325)—Private company. Reg. Oct. 6, £20.000 in 19.048 ordinary shares of £1 each and 10.040 deferred shares of 1s. each. Objects : To carry on the business of hydro-electric. electric and power engineers and contractors, &c. Directors : D. Spencer. Lieut.-Col. R. H. Mackenzie. D.S.O., M.C. (managing director). W. Muirhead, R. M. Wilson. Qualification 50 shares. Secretary : W. F. Harwar. Reg. office : 41, Parliament-street, S.W.1.

W. BRUNTON & COMPANY, LTD (159,199).—Private company. reg. Sept. 29. capital £10.000 in £1 shares, to take over the business of safety fuse. electric fuse and electric detonator manufacturers carried on at The Lodge. near Wrexham. Denbigh. as "W. Brunton & Company."

CHAS. W. WEBBER, LTD. (159,063).—Private company, reg. Sept. 24. capital £5,000 in £1 shares, to carry on the business of engineers, electrical and motor engineers, &c. First directors are C. W. Webber and C. D. Sampson. Reg. office : 35, George-street, Weston-super-Mare.

CHRISTIAN BERGH ELECTRIC COMPANY, LTD. (159.258).—Private company, reg. Oct. 2. capital £5,000 in £50 shares, to carry on the business of electrical engineers. &c. Solicitors : Swapstone & Company, 9, St. Helens-place, E.C.

COMAC MFG. COMPANY, LTD. (159,327)—Private company. Reg. Oct. 6, capital £2.000 in £1 shares. Objects : To carry on the business of manufacturers. repairers and vendors of and dealers in electrical and medical machinery, appliances, machinery, &c. First directors are C. Hellyar (chairman and managing director for life), J. W. O. Taylor and L. Mildenhall. Reg. office : Ordnance Works, Gordon-road, Kingston-on-Thames.

CROWTHER & SLOAN LTD. (159,144).—Private company, reg. Sept. 26, capital £3.000 in £1 shares, to take over the business of electrical factors carried on by Crowther & Sloan at Greenock-road, Armley, Leeds, to carry on the business of electrical, mechanical and general engineers, &c., and to enter into an agreement with H. Crowther and J. D. Sloan. First directors are H. Crowther and J. D. Sloan (both permanent, subject to holding 100 shares each).

FARNDON'S ELECTRIC, LTD. (159.066).—Private company, reg. Sept. 24, capital £10,000 in £1 shares (5,000 preference), to carry on the business of electricians. mechanical engineers and manufacturers, &c. First directors are F. Farndon (managing director). P. Farndon, 186, Balsall Heath-road. Birmingham ; H. M. Watson, 76, Carnarvon-road, Stratford. E. ; and H. King (all permanent). Reg. Office : 32, Romford-road, Stratford.

HARLAND ENGINEERING COMPANY, LTD. (159.403)—Private company. Reg. Oct. 8, capital £100,000 in £1 shares. Objects : To take over the business (except the Canadian portion) of power engineers and contractors carried on by F. C. Anderson. C. A. Atchley and F. G. Warburton as the "Harland Engineering Company." First directors are F. C. Anderson. C. A. Atchley and F. G. Warburton (managing directors). Reg. office : 196. Greengate, Manchester.

JAMIESON & TODD, LTD. (159.241).—Private company. Reg. Oct. 1, capital £2,000 in £1 shares. Objects : To carry on the business of motor, electrical. marine and general engineers, &c. First directors are W. A. Todd and J. Jamieson (both permanent, subject to holding 500 shares each). Sec. : W. A. Todd.

L. E. M. COMPANY, LTD. (159,242).—Private company. Reg. Oct. 1, capital £3,000 in £1 shares, to carry on the business of general merchants, consulting representatives, brokers and factors for every department and branch of the engineering trade, importers and exporters of all kinds of engineering and commercial commodities and accessories, transport and forwarding agents, &c. First directors are E. W. Clarke and J. Parkinson. Reg. office : Dacre House, Victoria-street, S.W.

MELROSE MFG. COMPANY, LTD. (159,343)—Private company. Reg. Oct. 6, capital £2,000 in £1 shares. Objects : To acquire the several connections of the Melrose Mfg. Company and to carry on the business of mechanical and electrical engineers, machinists, electricians, &c. First directors are G. A. Bassett, W. B. Sanderson, F. Thompson, J. Lawrence and F. Dickie. Reg. office : 11, Beaumont-road Acton Green, W.

METAL DEPOSITION, LTD. (158,857).—Private company. Reg. Sept. 17, capital £5.000 in 4,000 preference shares of £1 each and 20,000 deferred ordinary shares of 1s. each. To acquire, exploit and turn to account any process for the deposition of metal on aluminium, or other substances, &c. Secretary : G. H. Glover. Reg. office, 32, Charing Cross, Whitehall, S.W.1.

M. T. C. LTD. (159,373) Private company. Reg. Oct. 7, capital £1,000 in £1 shares. To carry on the business of mechanical and electrical engineers. machinists. wiredrawers, tube makers, &c. T. Young is the first director. Reg. office : 153A, Corporation-street. Birmingham.

SWIFT ELECTRICAL COMPANY, LTD. (159,495) Private company. Reg. Oct. 10. Capital £3.000 in £1 shares. Objects : To carry on the business of electrical merchants, suppliers of electric lamps and fittings, &c. First directors are J. H. Butler. H. E. Leigh and L. J. Evans. Secretary : H. E. Leigh. 145, St. Thomas-road, N.4.

PEARLITE ELECTRIC WELDING COMPANY, LTD. (159,299)—Private company. Reg. Oct. 3, capital £10,000 in £1 shares, to carry on the business of welders of steel. iron and other metals. mechanical and consulting engineers, &c., and to enter into agreements with J. J. Heyes and R. T. Heyes & Company. and with Charles Howson & Company. First directors are G. H. Fraser (chairman), J. J. Heyes (man. director) and W. Barnes. Reg. office : 21, Dale-street, Liverpool.

STAR ELECTRICAL ENGINEERING & MFG. COMPANY, LTD. (159.320.) Private company. Reg. Oct. 4. capital £10,000 in £1 shares, to carry on business as indicated by the title. First directors are J. P. Beckett (managing director). G. W. Parker, W. Rouston and A. Gidley. Secretary : J. P. Beckett. Reg. office : 134. Victoria-street, Grimsby.

THOMSON BENNETT (MAGNETOS), LTD. (159.248).—Private company. Reg. Oct. 1. capital £100 in £1 shares. Objects : To carry on the business of manufacturers of electrical and other component parts. accessories and fittings used in the construction, starting, running, driving and regulation of stationary engines, &c. Reg. office : Well-st., Birmingham.

VICTORIA PATENTS SYNDICATE, LTD. (159,421)—Private company. Reg. Oct. 8, capital £2,200 in 2,000 preference shares of £1 each and 4,000 ordinary shares of 1s. each. To acquire from L. A. de Becker the exclusive licence to manufacture and sell an electic lamp, an electric switch and a gramophone record filing cabinet. First directors are L. A. de Becker and C. Kyriakidis (both permanent governing directors). Reg. office : 54, Great Tower-street, E.C.

W. S. R. SYNDICATE, LTD. (159,200).—Private company, reg. Sept. 29, capital £3,300 in 3,000 ordinary shares of £1 each and 6,000 deferred shares of 1s. each, to carry on the business of mechanical and electrical engineers, machinists, wire drawers, tube makers, &c. First directors are G. Ward, P. M. Faraday and H. M. Edwards. Reg. Office : 10, New Broad-street, E.C.

Prices of Metals, Chemicals, &c.

TUESDAY, Oct. 14.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£114 0 0	£3 0 0	—
Electrolytic bars ...	,,	£121 0 0	£1 0 0	—
H.C. wire basis......	per lb.	1s. $4\frac{1}{16}$d.	$\frac{1}{8}$d.	—
Sheet	,,	1s. 4d.	$\frac{3}{8}$d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. $8\frac{1}{16}$d.	$\frac{1}{8}$d.	—
Brass 60/40—				
Rod, basis	,,	0s. $11\frac{3}{8}$d.	$\frac{3}{8}$d.	—
Sheet, basis	,,	1s. $2\frac{3}{4}$d.	$\frac{3}{8}$d.	—
Wire, basis	,,	1s. $2\frac{5}{8}$d.	$\frac{3}{8}$d.	—
Pig Iron—				
Cleveland Warrant	per ton	Nominal	—	—
Galvanised steel wire, basis	,,	£32 10 0	—	—
Lead Pig—				
English	,,	29 0 0	£2 5 0	—
Foreign or colonial	,,	27 15 0	—	2s. 6d.
Tin—Ingot	,,	283 15 0	£1 15 0	—
Wire, basis	per lb.	0 3 6	—	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £21.

,, (Roll Brimstone).—Per ton £21.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6d.

Shellac.—470s. December delivery 455s.

Rubber.—Para fine, 2s. 6d. ; plantation 1st. latex 2s. $2\frac{1}{4}$d. lb.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Oct. 11, 1882.]

SOUTH AMERICA.—It is officially announced that telegraphic communication has now been established with the States of San Salvador, Guatemala, Honduras (Independent), Nicaragua and Costa Rica in Central America ; and with Ecuador in South America ; and that telegrams can also be sent to Buenaventura and other places in the United States of Columbia, besides Colon and Panama.

THE TELEPHONE AND BALLOONING.—At the beginning of this week several ascents were made by members of the Academie d'Aérostation Mét-rolgique, from the Place Saint Jacques, Paris. Amongst other things, conversation was carried on with people on the earth by means of a telephone line suspended from the balloon. The height at which the balloon is said to have been was 500 ft.

MERSEY TUNNEL.—On the occasion of the visit of the Lord Mayor of London, the Mayor of Liverpool, and a distinguished company last Wednesday, the 11th inst., to this place, the tunnel was brilliantly illuminated with the electric light. A Brush dynamo machine was used, together with 50 c.p. Lane-Fox incandescent lamps. The whole work has been placed in the hands of the Hammond Electric Light Company, Liverpool, and has been efficiently carried out under the superintendence of Mr. James Shaw, the district manager, and Mr. Rowley, the electrician to the company for this district.

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Notes.

Tramway Wages and Fares.

As has been evident in recent meetings of the tramway associations, the present financial position of tramway undertakings has recently been a matter of serious concern to those responsible for their management. The position has now been rendered still more difficult by the award of the Interim Court of Arbitration, which has raised by four shillings per week the wages of all tramway, light railway and omnibus employees who are 18 years of age or over, and if under that age by two shillings a week. We doubt whether the Court has been wise in giving such an award at the present time, when the tendency is to increase the wages of organised labour at frequent intervals, and thus to add to the difficulties of the community as a whole. We have every sympathy with all who feel the increased cost of living, but it must not be forgotten that if the demands of organised labour are satisfied in this respect, so that no discomfort is felt by that particular section of the community, the remaining sections feel the hardship all the more heavily. Further, it must be remembered that tramway and omnibus men are not directly productive in the sense of labour engaged in manufactures, and that there is no ready possibility of increased production to meet increased wages in these lines of activity. Thus, such increases merely mean more dead weight. The net result of the present award, according to the Municipal Tramways Association, is to place the whole industry in a very difficult position, and it will, of necessity, lead to a further increase in fares in order to meet the expenditure of another million pounds per annum. This increase will, of course, come as a further burden upon the community as a whole. Moreover, under present conditions it is doubtful whether the Statutory Undertakings Temporary Increase of Charges Act, 1918, will meet the case, as this is simply a war measure. It will, therefore, be necessary for further legislation to be introduced. Whether the House of Commons in the session that has just opened will feel in the mood for this kind of legislation may be doubted. Many people are beginning to realise that, as a nation, we are very materially worse off through the war than we were before the war, and that ever increasing rates, taxes and other charges are not the way to secure prosperity, and will in due time lead us into still greater difficulties.

Electricity Supply and Political Problems.

THE problem of Nationalisation is one which has a precise and immediate interest for the electricity supply industry, especially in view of the Electricity (Supply) Bill now before Parliament. It is apropos of this that we note an article in the "Nineteenth Century" by Mr. J. A. MARRIOTT, M.P., on "Nationalisers and the Nation." The Article has a special interest owing to its authorship. It will be remembered that Mr. MARRIOTT did yeoman service for electricity supply companies during the passage of the Bill through Committee B last session. His speech on the amendment of the Purchase Clause was, perhaps, the best speech of the Session, certainly so from the side of the companies, and their case in regard to terms of purchase has never been put forward more convincingly. His article, therefore, merits perhaps an added attention. Although the article deals with Nationalisation in general, it is obvious that it has direct incidence on the re-organisation of electricity supply. In general, while fully appreciating the demands of the trade unions in regard to conditions of work, wages and the position of labour generally, Mr. MARRIOTT does not accede to the proposition that Nationalisation is the panacea for all the ills to which Labour is heir. It cannot be recognised too clearly that the complaint and the remedy are two independent and diverse things. Just at present the trade unions are adopting a certain nationalising phase of Socialism which they are told by the promoters is the speediest way of attaining high wages, short hours and general prosperity. Mr. MARRIOTT disagrees with the nationalisers both in their diagnosis of the situation and their panacea. He thinks that the demand for joint control is as much social as economic in origin, and that socially it might be conceded while industrially and commercially it must be resisted. Assuming this view, he considers that private management gives far more scope for just that personal touch, human appeal and elasticity of method which is needed, and he urges private enterprise to exploit to the full these intrinsic conditions. A preliminary would be, of course, getting Labour to come to a reasoned judgment on the political panaceas which are offered to them for their troubles. Mr. MARRIOTT claims that there is a very insistent need for a great educational campaign, and that the educational field has been held too long by the apostles of Socialism, who have brought to the task of propaganda "intense missionary zeal."

The Need for Education.

Whatever opinions may be held on the subject generally, everyone must agree that Mr. Marriott is correct on this latter point. Employers generally appear to have done very little indeed in regard to educating their employees on any political points. In the past, perhaps, this might be the more excused, since suitable literature was not readily forthcoming; but at the present moment this excuse does not hold good. Readable pamphlets at an almost negligible cost can be readily obtained for distribution. Coming closer home, we should be interested to know if anything has actually been done in this connection by managers and engineers in the electricity supply industry. The industry is, of course, comparatively small from a labour point of view; but, on the other hand, it occupies a paramount position as a "key industry." The fact is that everybody seems to think it everybody else's business. Managers, engineers, directors and others in control are unanimous, of course, in their general chorus of deploring the mistaken views of the trade unions; but in how many cases could they say they have taken the slightest step to put any other views before the men who are directly under their control. A further consideration also presses itself on us, and one that we mention with great diffidence—namely, what about the employers educating themselves? The employers must first be themselves clear on the issues, and they can do this by first of all getting an accurate idea of the aims and objects of trade unions, discriminating between the rightful and wrongful claims of labour; and, secondly, in getting into their own minds something of a coherent and working set of economic principles. Masters must have a clear idea of what they are fighting for before they can hope to convince. And then, as Mr. Marriott suggests, plenty of propaganda, to which we would add, wishing to be practical, by everyone in the companies under their direction.

The Telephone Service.

The deputation of the National Union of Manufacturers which waited upon the Postmaster-General on the 16th inst. in order to represent to him the present inefficient state of the telephone service obtained very scant satisfaction. It must be remembered, however, that certain difficulties exist which cannot be overlooked, and to some extent there are misconceptions. Take, for example, the charges for telephonic service. Reference is frequently made to the low cost of the telephone service in a country like Sweden, and it is suggested that equally low charges should apply in a district like London. By those who advocate such a course it is forgotten that the service which is given in London is infinitely greater than the service with which comparison is made in Sweden. It is impossible to give a service to a mass of subscribers without the cost being higher than when a service is given to a comparatively small number. Consequently, the service in London must be somewhat expensive, and we think it will be generally agreed by those acquainted with the subject that the present charge is not unreasonable. What the position will be in the near future remains to be seen. As to the quality of the service that is given, it must be admitted in common fairness to the Government that it has been necessary to abandon extensions during the war, and also a great deal of other work that would have been undertaken under normal conditions. Consequently, from this point of view, the service must be inferior. What, however, most people feel is that, even after allowing for these adverse conditions, the quality of the service is still very bad. Lack of plant and similar limitations might lead to a slowing up of the service, but it should not lead to the multitude of errors which are so annoying at the present day and often render the use of the telephone quite an exasperating performance. Here it must be largely a question of inefficient *personnel*, but it is difficult to say what should be the cure for this state of things.

A Building for Technical Societies in South Africa.

We notice that the advantages of a common meeting place for scientific and technical societies, which we have so often emphasised in these columns, have recently been the subject of discussion in South Africa. Among the chief bodies concerned are the South African Institution of Engineers, the Chemical, Metallurgical and Mining Society of South Africa, and the South African Institute of Electrical Engineers. The scheme in contemplation would involve primarily a common meeting place, and joint ownership of a suitable building. But the provision of reading, smoking and refreshment rooms, besides meeting rooms, is suggested, and also the nucleus of a good scientific library. Further suggestions include the provision of bedrooms for the benefit of members coming from a distance—doubtless an important item in South Africa, where members are necessarily scattered. The building would thus also fulfil the functions of a club. The total membership of the societies concerned is 3,860 and a fund of £110,000 is considered necessary for starting the scheme. A possible additional source of income suggested is the letting of free rooms in the building as offices for professional men. The position would naturally be a good one for the transaction of business, and we imagine that such offices would be in great request. We are glad to notice this evidence of enterprise in South Africa, which should serve as a stimulus to the Old Country to speed up its own efforts in the same direction.

Batti-Wallahs' Society.—It is announced that during the forthcoming winter months the Batti-Wallahs' Society will hold five or six informal evenings, the first of which will take place on Nov. 5. There will also be one smoking concert and an annual dinner

National Union of Scientific Workers.—There will be a social evening of the members of this Union at 52, St. Martin's-lane, London, W.C., on Thursday, Oct. 30, at 7.30 p.m., for the purpose of inaugurating a London branch. London scientific workers are invited to attend.

Wireless Society of London.—At the next general meeting of the Wireless Society of London which is to take place at the Institution of Civil Engineers, Great George-street, on Tuesday, Oct. 28, at 6 p.m., there will be much to interest members and prospective members, including an exhibition of wireless apparatus.

Society of Technical Engineers.—The first general meeting of the Winter Session (1919-1920) of the Birmingham branch will be held on Friday, Oct. 31, at the Chamber of Commerce, New-street, Birmingham, at 7 p.m., when Prof. F. W. Burstall, M.Sc., M.A., &c., will give a lecture on "The Problem of Transport." All technical engineers are cordially invited.

Household Fuel and Lighting Order.—The Coal Controller recently intimated, as a result of representations made by the Diesel Engine Users Association, that applications for exemption from the operation of the Household Fuel and Lighting Order would be considered in the case of electricity supply undertakings making use of oil as fuel. The Felixstowe power station of the Suffolk Electricity Supply Company, where Diesel engines are used, has now been granted exemption from the provisions of the Order.

A "Strike Issue" of the "Electrical World."—Owing to the strike of the printers in New York, the issue of our contemporary, the "Electrical World," which has most recently come to hand, consists of an editorial covering a single quarto typewritten sheet. In this editorial Mr. H. Onken, jun., briefly explains the reason for this unusual form of production, and makes certain announcements of urgent current interest. It concludes: "While it is appreciated that this very shallow summary of the news cannot take the place of a regular issue of the 'Electrical World,' still, we trust that it will help to keep readers posted on the high spots until such time as labor can adjust its internal organisation squabble and permit us to print again." We commend our contemporary's pluck on this occasion, and wish them a speedy delivery from their troubles.

Commercial Oxygen.—With the exmaple before us of the marvellous development in the production of helium on a large scale during the war, one may well wonder what possibilities are in store in the direction of increased and cheaper production of more familiar gases. It is probable, for example, that if cheap oxygen were abundant, its applications would be almost endless, and it would revolutionise some industries. There is reason to believe that the manufacture of artificial nitrate by atmospheric fixation, with oxygen as a by-product, will have a notable effect in this direction. The "Bulletin" of the Société de l'Industrie Minérale suggests, among other possibilities, the admission of a small percentage of oxygen to raise the temperature of metallurgical furnaces, enabling inferior fuel to be used; the production of calcium carbide in the blast furnace by a purely thermal method, and the reduction of alumina with carbon; the melting of auriferous quartz; new possibilities for the electric furnace, and the development of ozone on a much larger scale than at present.

Transatlantic Wireless Telephony.—On Wednesday afternoon Prof. J. A. Fleming, F.R.S., gave an interesting public lecture at University College (London), on "Speaking Across the Atlantic by Wireless Telephony." Reference was first made to the phonetics of the subject and the general principles underlying the transmission of speech by waves as used in wireless telegraphy. The three-electrode amplifier was then illustrated and its function as an oscillator explained, both with the usual battery and with an alternator and rectifier in place of the battery as used for military purposes. Prof. Fleming, at the end of his lecture, gave brief particulars of recent experiments by the Marconi Company in speaking across the Atlantic. The experiments were carried out at Ballybunion, in Ireland, and transmission was to Nova Scotia, a distance of 1,800 miles. The object was to determine the current that was necessary in practical working, and thus differed markedly from the performance of telephoning from the U.S.A. to the Eiffel Tower in Paris. For this reason, signalling was carried on for 10 or 12 days during the daytime, that is, when interference is more serious. A 3½ H.P. alternator was employed, the aerial being 500 ft. high and the wavelength 12,000 ft. The current in the aerial was 16 amperes. It was found that the speech, which was received by the usual commercial amplifying apparatus, was quite good enough for easy reception.

Mr. Hirst on Electrical Progress.—In the course of a recent address to the Batti-Wallahs' Society, Mr. Hugo Hirst gave his views on the future needs of the electrical industry.

He said that, for himself, in the past he was never happy with the status of the industry. He knew there were people who thought that in those days we were ahead, and well ahead; but he felt sure this was the wrong point of view, and that when we compared our position with that of our competitors we had no real cause for satisfaction. The principal causes for this state of things, he considered, were free importations, resulting in heavy overhead charges and a depression of prices which left no margin for development. Though we had a certain home market, it might almost be said that abroad the British electrical industry did not exist; and even at home there was stagnation owing to the limitations imposed by confining electricity supply within municipal frontiers. The supply of electricity did not lend itself to such limitations, and the result was confusion of systems, voltages and frequencies, the effect on manufacturing being disastrous. This multiplicity of units, again, meant high overhead charges, high cost of production, with the inevitable result that it was difficult to compete with foreign enterprise. With regard to the future, it was no use to expect Government assistance to do everything. Colonial preference, a more enlightened policy in regard to trade marks, and the erection of super-power stations would, no doubt, be something; but the great thing to be borne in mind was that we must help ourselves, and to do this we must not only work ourselves, but make others work. The worker was entitled to higher wages and more leisure, but in return for this he must work harder during the working hours with a view to increasing output. Another direction in which Mr. Hirst thought progress might be made was towards the standardisation of education throughout the Empire. It would be a tremendous advantage if technical training were on the same lines in Glasgow as in, say, Calcutta. The idea he had in mind in making this suggestion was the creation of bigger minds and bigger men, of which the Empire at the present moment was feeling the lack. The great thing needed was to work with greater efficiency and bigger units. These were the best weapons which could be devised to meet existing conditions, and he was, therefore, glad to see that amalgamations of electrical firms were taking place. These amalgamations should not be considered to be the mere whim of the capitalist. They were, indeed, the outcome of a search for efficiency, as they meant better control of raw material, which at the present time, in contradistinction to the state of things before the war, was scarce, and everything that could be done to cut out intermediate profits was therefore an advantage. It was, indeed, only the big concerns that could shorten the road from the raw material to the finished product. In conclusion, he felt that the position at the present time was most encouraging, and there was never such a chance for the British electrical engineer as at the moment.

Obituary.

The death is announced of Councillor Thos. Robert Knowles, chief engineer of the Patent Shaft and Axletree Company, and chairman of the WEDNESBURY Electric Lighting Committee for a number of years.

The death recently took place at Adelaide (S. Australia) of Mr. E. S. MOULDEN, chief assistant engineer of the Adelaide Tramways Trust, at the age of 36 years.

Personal.

Major Rupert Stanley, late R.E., B.A., M.I.E.E., has been appointed Principal of the Belfast Municipal Technical Institute and director of technical instruction for the County of Belfast.

Mr. A. C. McKinstry, general manager in Australia of the Metropolitan Vickers Electrical Company, has resigned his position as one of the Victorian Government electricity commissioners in order to come to England on business connected with the company.

Capt. H. Hincks has been appointed by the President of the Board of Trade to succeed Mr. J. W. Hands, O.B.E., as Controller of the Profiteering Act Department. Mr. Hands, who accepted the post during the organisation of the Department, has now resumed duty in the Board of Education.

Arrangements for the Week.

FRIDAY, Oct. 24th (to-day).

UNIVERSITY COLLEGE.

5 p.m. At University College, Gower-street, London, W.C. A Public Lecture on "Recent Developments in Public and Private Lighting," by Mr. W. C. Clinton, B.Sc.

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Papers to be read on "The Effect of Pressure and Temperature on a Meter for Measuring the Rate of Flow of a Gas," by Dr. N. W. McLachlan; "A Cheap and Simple Micro-Balance," by Mr. J H. Shaxby, B.Sc., and "The Resolution of a Curve into a Number of Exponential Curves," by Mr. J. W. T. Walsh, M.A.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Address by the President.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W.1. Lecture on "Fire Prevention and Protection in Factories and Workshops," by Capt. Stanley W. Thorpe.

SATURDAY, Oct. 25th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At the Grand Hotel, Colmore-row, Birmingham. Ninth Annual Ladies' Night.

MONDAY, Oct. 27th.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

5.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Paper to be read, by kind permission of the Air Council, on "Aircraft Telephones," by Capt. B. S. Cohen.

TUESDAY, Oct. 28th.

WIRELESS SOCIETY OF LONDON.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. General Meeting and Exhibition of wireless apparatus.

Inter-Imperial Communication Through Cable, Wireless and Air.[*]

By Sir CHARLES BRIGHT, F.R.S.E., M.Inst.C.E., M.I.E.E.

(Concluded from page 442.)

NATIONAL INTERESTS AND PRIVATE INTERESTS.

It is an unfortunate fact that national and private interests are often fundamentally opposed in matters that concern the entire country, and this is notably so in regard to the subject dealt with here.

With a private company, the primary object is naturally to secure as high a dividend as possible. With the nation, on the other hand, other considerations come in which clearly clash with private interests. More than once the State has required lines of communication mainly for strategic reasons, which private enterprise, on purely commercial grounds, have been unwilling to undertake, despite large reserve funds, Government subsidies, &c.

The question is whether telegraphic links are not intended to serve a wider and grander use to the community than the building up of dividends. If the answer is in the affirmative this raises another question, *i.e.*, whether inter-imperial communication should not be put on the same footing with the Navy, Army and Air Force—forming as it does one of the most important strategic weapons. If that is admitted, then surely it would be far more suitably charged proportionately on the Estimates of these three defence departments—and possibly also of others—than several items which are now a subject of public taxation.[†] All the telegraphic developments here pointed to would form but a small item comparatively on the Defence Estimate, though so vital an adjunct.

We have, too, to ask ourselves (1) whether Inter-Imperial trade cannot be greatly assisted by a considerable reduction in the Imperial telegraph rate, and, if so, (2) whether this object should not come before any vested interests where the two run counter? Is the nation to be sacrificed to vested interests, or is the nation to prevail where public and private interests do not coincide? It is obvious that they do *not* coincide, seeing that (*a*) the rates to outlying branches of the Empire at present bear some sort of proportion to distance, (*b*) the rates to some foreign countries are distinctly more favourable than to certain portions of the Empire. This will be clearly seen by a study of the accompanying table. Before leaving this matter it may be well to point out that it is just where the distances are greatest—and therefore the mail takes so long—that cheap telegraphic communication would be of such special value to the community and especially to trade. Here we have a notable instance of the clashing of public and private interests.

It should be further noted that, owing to the war wastage of ships, telegraphic communication is, generally speaking, likely to be for long of increasing importance to the trading public—especially in the case of great distances.

One has to feel very deeply before having the courage to suggest further public taxation to so august an economic organisation as Section F of the British Association. It is, however, contended that the object thus secured would soon bring its return to the country at a time when vastly increased national production stands only second to Imperial security. It is necessary for this purpose to primarily regard telegraphic communication from the standpoint of what it can achieve for the country and Empire in the matter of security and trade development, rather than mainly as a dividend-earning concern. It should be remembered too, in this connection that Empire trade is dependent on Empire security.

STATE ADMINISTRATION.

What has been implied above points to either (*a*) the ownership, or purchase by the State, of at least one main trunk of Inter-Imperial cables,[‡] supplemented by the aforesaid wireless chain—both being run at a quite low, common, Imperial rate, or alternatively by (*b*) substantial subsidies being paid to those cable companies whose rebates have so far not only been too tardy but too insufficient in character to be of any great value to the nation.

NATIONALISATION.

It appears to the author that many people generalise too much against Nationalisation on principle. Very little can be said in its favour where only individual or class interests are concerned.

Principal British, &c., Cable Route Stations, with Approximate Cable Distances from London, and Tariff therefrom[*] :—

Station.	Approximate cable mileage.	Ordinary rate.	
		s.	d.
Madeira	1,617	1	0
St. Vincent	2,744	2	2
Ascension	4.519	2	6
St. Helena	5,307	2	6
Cape Town	7,199	2	6
Gibraltar	1,501	0	3
Malta	2,618	0	4
Alexandria	3,483	1	0
Port Said	3,636	1	0
Aden	5,065	2	0
Bombay	6,910	1	8
Colombo	7,328	1	8
Penang	8,735	2	10
Singapore	9,135	2	10
Labuan	9,869	2	10
Hongkong	10,657	3	6
Shanghai	11,584	3	6
Zanzibar	7,024	2	6
Seychelles	8,145	2	6
Mauritius	9,210	2	6
Fremantle	14.289	3	0
Adelaide	15,834	3	0
Melbourne	16,500	3	0
Tasmania	16,700	3	0
Bathurst	3.319	3	0
Sierra Leone	3,785	3	0
Accra	4.807	3	6
Lagos	5.079	3	6
Bonny	5.400	3	6
Newfoundland	2.401	1	0
Nova Scotia	2,727	1	0
Halifax	3,150	1	0
Montreal	3,777	1	0
Vancouver	6,677	1	6
Fanning Island	10,358	2	6
Fiji (Suva)	12,401	2	8
Norfolk Island	13,383	2	8
Queensland	14,220	3	0
Auckland	14,101	2	8
Nelson	14.550	2	8
Sydney	15,352	3	0
Bermuda	4,000	2	6
Jamaica	5,264	2	6
Colon	5,894	2	8
Barbadoes	6.542	2	6
Trinidad	6,621	2	6
Pernambuco	4,606	1	7
Rio de Janeiro	5,973	2	7
Montevideo	7.135	2	9

NOTE A.—A reference to the "Post Office Guide" reveals the fact that in a number of instances the rates to foreign countries are lower than to various points in the Empire. *From an Imperial public standpoint* this is not as it should be.

NOTE B.—The wireless service of the Marconi Company was discontinued on August 4th of last year (1917). This was owing to the exigencies of war, as explained by Mr. Godfrey Isaacs in a letter to the Press at the time. Previously, however, the ordinary rates to the undermentioned important British centres were as follows: Newfoundland, 8d.; Nova Scotia, 8d.; Prince Edward Island, 8d.; New Brunswick, 8d.; Quebec, 8d.; British Columbia, 1s. 2d.; Bermuda, 2s. 2d.; Jamaica, 2s. 2d.; Barbadoes, 2s. 2d.; Trinidad, 2s. 2d. It will thus be seen that in normal times the tariff of the Marconi Wireless Telegraph Company is substantially more favourable than that afforded by cable organisations.

[*] From the author's "Telegraphy and Aeronautics in War." (Constable & Company, London, 1918.)

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[*] Paper read before Section F of the British Association at Bournemouth.

The term "communication" is here used in what is thought to be its more legitimate sense, the writer considering that railways and shipping are more correctly described as "transport."

[†] For instance, the Post Office telephone system is of far less general (and no Imperial) value than Inter-Imperial communication, which contributes so much towards national and Imperial security.

[‡] The purchase price should cover "goodwill" on an unquestionably liberal basis, and should include an adequately efficient staff. It would not, of course, touch any cables to foreign countries

but where the matter to be dealt with has directly to do with the whole community, the principle is surely right. Even so, it does not follow that a change should be made in favour of Nationalisation, if only because there are very few directions in which we are ready for it. This fact calls to mind a confusion of issues that seems to constantly occur. Thus, one of the most popular stock arguments against Nationalisation, ventilated by interested parties, is that every business that has been touched by Government departments has always been unsatisfactorily "run" as compared with similar efforts by private enterprise. Surely, however, all that that really points to is that Government offices are not worked on business principles by business men. That state of things would require to be entirely changed, of course, for the purposes of successful Nationalisation, and would involve (1) greatly changed Civil Service conditions, (2) some 2 years' business experience previous to Civil Service entry, (3) a changed Civil Service examination, (4) a changed educational curriculum.

All this would take time, and, if only for that reason, we are very inadequately prepared for actual Nationalisation at present. Moreover, at present there is a complete lack of *esprit de corps*, as well as co-ordination between the various Government departments. In its place we have inter-departmental jealousy and rivalry, the very idea of which is all wrong and would certainly require to be overcome before Nationalisation could be embarked on with any prospect of success. A great part of the case against departmental control is that it is departmental rather than national, and that it is in the hands of rival departments which work without reference to each other, often in ill-concealed mutual hostility.

Telegraph Control Board.

Whether State ownership should ever be applied is, of course, a big question, but in any case it will surely be obvious—in view of what has been said—that in National and Imperial interests some sort of State control is desirable in the matter of Inter-Imperial communications generally. A controlling organisation of some sort seems to be called for, if only for watching and securing public interests, where clashing with private interests, in return for favours granted by the State.

There are no less than seven Government Departments * (in addition to the Treasury) concerned in this matter. Hitherto one of these alone (H.M. Post Office) has been acting for the Government, and all questions regarding other Departments' interests had to be submitted to the Post Office. This was never very satisfactory in the result—neither was the part played by the Cable Landing Rights Committee satisfactory.

The author has for some 17 years advocated an Inter-Departmental Board to deal with Inter-Imperial Telegraphs of all sorts. By this scheme all the Government Departments concerned were to be represented and to meet periodically to discuss and settle all important matters as they arose.

The war made it clear to the Government that something of the sort was necessary; and the beginning of the present year saw the establishment of the Board here described, with a highly satisfactory chairman in Lord Milner—the whole coming under the ægis of the Committee for Imperial Defence.

Air Communication.

It has of late become a commonplace that England ceased to be an island since men learned to fly, and it is fairly generally recognised by those in a position to judge that the Air Force bids fair in the future to become—if it is not already—our most important and vital strategic weapon.

Yet it was only some 12 years ago (on March 7, 1907) that the then First Lord of the Admiralty wrote as follows to the brothers Wilbur and Orville Wright :—

> "I have consulted my expert advisers with regard to your suggestion as to the employment of aeroplanes, and I regret to have to tell you, after the careful consideration of my Board, that the Admiralty, whilst thanking you for so kindly bringing the proposals to their notice, are of opinion that they would not be of any practical service to the Naval Service."

Since that time, however, we have had the greatest war the world has ever seen, and nothing, probably, has done so much for the development of aviation : necessity is the mother of invention.

Then, again, the Atlantic Ocean has now been actually bridged by aircraft and with complete success.

Aerial development promises—if given a chance—to go on apace, following on the lines of the Civil Aerial Transport's report of last year, and the more recent International Air Navigation Convention.* There are still, however, a great quantity of rules and regulations to be worked out for the purpose of traffic in the air—including the whole problem of Customs, for instance.

It already seems pretty clear that aviation in its international or Imperial aspect must be kept under some sort of civil (rather than military) government control, without, however, unduly checking private enterprise.

Another point about which there can be little doubt is that we should now concentrate on commercial aircraft such as can be readily converted into strategic aircraft, if and when necessary, whereas the reverse does not correspondingly apply.

Imperial Air Routes and Propaganda.

A good deal has already been done in the way of propaganda, planning routes, &c.

The welfare of the British Empire is likely to be considerably influenced by the position we eventually take up in these matters—whether we are first in the field and the actual value of the air routes which we control. In days to come air stations will be at least as important as coaling stations are now. One might almost say that in the matter of Imperial routes everything is to hand for us, so to speak, seeing that our possessions are dotted, more or less, all over the world. About one thing, too, there can be little doubt, and that is that Egypt is admirably situated to become the Clapham Junction of the Air.

The ultimate success of Inter-Imperial commercial aviation really resolves itself into closely thought-out organisation, backed up by no stinting—without actual waste—of the wherewithal to carry things out. Lord Weir has become the chairman of a committee to devise, and advise on, the main air routes of the British Empire. With such a chairman highly satisfactory results should be achieved.

It will remain for the Air Ministry, in concert with the Foreign Office, to (1) work out the aerial navigation treaties with other countries, (2) prepare the necessary aerodromes, meteorological and wireless stations, and (3) find the staff for carrying out the duties connected therewith, whilst also making trial cruises with different types of machines on the various proposed, alternative, routes.

The air stations—with wireless and meteorological equipment at each—will require to occur at intervals of something like every 500 miles along each of the main air routes, at a cost of about £50,000 apiece. Emergency landing grounds at far closer intervals, but at quite small cost, will also have to be provided where possible (together with petrol supply and spare parts) to meet cases of engine failure. Airship sheds at distant intervals will be another important item to be provided for.

The Possibilities and Prospects of Air Travel.

The question of air travel has for some time been very much in the air—or at any rate in the Press.

There is still, perhaps, a prevailing feeling that, apart from the novelty of the thing as a sport, it will not be greatly indulged in. Many people make a great deal of the vagaries of the weather. Much the same class of argument terrorised the majority in the matter of sea travel in its early days,† and the air troubles are really no greater than the earliest sea troubles.

I for my part cannot certainly foresee a great deal of air travel for pleasure purposes *over long ocean stretches*, largely owing to the vagaries of the weather—though it is here that the gain in time by aircraft over the steamship would be especially marked.

Overland it is a simpler matter, for in the case of bad weather conditions supervening a vessel can effect an early landing after sending a wireless message to some suitable spot. On the other hand, the subjection to fog puts a limit on this at home.

No doubt, however, many business firms will have aeroplanes for their "travellers" on comparatively short distances, for then, barring fog, the journey can be made just when it best suits, and the time-saving would often be very great. There would, too, be an even greater advantage under the latter head when compared with a road journey by motor car.

For considerable distances, however, I cannot imagine air travel being indulged in on a large scale, except on emergency, partly because—at any rate, so far—a railway train is so much more comfortable as well as more reliable.

Certainly the Atlantic, with its rapidly changing weather conditions—and that greatest atmospheric "bugbear," fog—does not seem to lend itself to a great deal of air travel. The risks are still too great, and, even in a commodious airship, too suggestive of a watery grave rather than of comfort.

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* These are the Admiralty, War Office, Air Ministry, Colonial Office, India Office, Post Office and Board of Trade.

* Major-Gen. Sir F. H. Sykes, G.B.E., K.C.B., Controller General of Civil Aviation, took a leading part in this, and the reader is especially referred to his address on "Commercial Aviation" to the London Chamber of Commerce. Reference may also be made to a lecture by Brig.-Gen. Lord Montagu of Beaulieu, C.S.I., and to another by Lieut.-Col. Mervyn O'Gorman, C.B., to the Royal Aeronautical Society.

† If anyone goes back far enough he will even find railway travelling inducing much nervousness at the first.

Air Mails and Aerograms.

As is usually the way of things, however, where human disadvantages (from the point of view of comfort and risk) are greatest—*i.e.*, in the case of long stretches of the ocean—we have, as already suggested, the maximum advantage in other respects, for, whereas the mail to Australia takes over five weeks, an aeroplane of to-day can cover the distance in some 12 days. Think what that means! In such instances the air mail and the emergency traveller would be working at the greatest advantage.

In those regions which are practically immune from fog or gale, air mails—for all sorts of packages as well as letters—should have a considerable future, both as entirely outstripping the mailship over long journeys, and as correspondingly beating any telegraph system over comparatively short distances, also taking into consideration the fact that a letter serves a more satisfactory purpose than a telegram.* In fact, the air seems to be the most ideal medium for a sort of express letter and parcels service.

One here recalls to mind certain passages in Lord Northcliffe's recent letter to the heroes of the first wholly successful transatlantic flight. His Lordship said: "Just as in 1913, when I offered the prize, I felt that it would soon be won, so do I surely believe that your wonderful journey is a warning to cable monopolists and others to realise that within the next few years we shall be less dependent upon them unless they increase their wires and speed up."

The letters and parcels that have been carried in the "Airco" aeroplanes (as manufactured by the Aircraft Mfg. Company) between Folkestone and Cologne go to prove what can be done in this direction under properly organised conditions. The service was started on March 1st, and during that month 21 trips were made with 708 bags of mail outwards and 75 inwards. In April, 22 journeys were made with 823 bags outward and 218 inward. During May 1,001 bags were sent away and 457 received, an aggregate for the three months of 2,276 outward and 886 inward, in weather conditions as variable as they could be. This is the only record we have of sustained service, and the fact that correspondence leaving Cologne one morning has been delivered to all parts of England and Wales by the first delivery the following morning emphasises the necessity of giving to this form of transport the support it demands. The letters can be sorted en route, sorting boxes being fitted to the aeroplane. As a matter of fact, all postal work that is done in a train can always be done with equal ease on aircraft.

It seems quite likely, too, that the aeroplane could be turned to account for the purposes of a highly efficient express letter service between different important centres throughout the United Kingdom —except under foggy conditions.

Mr. Holt Thomas, the controlling force of the Aircraft Mfg. Company, has devised an ingenious plan of what he calls aerograms for coming to the assistance of comparatively short distance telegrams or cablegrams by forming an "aerial connecting link," wherever congestion arises, between given telegraphic and telephonic systems. This promises to be of special use for the purposes of more rapid communication between, say, London and Paris, where telegraphic congestion occurs *en route*—in this case on the trans-Channel cables.

High speed air transport having now found a place as a method of communication, its exact sphere of utility in various directions must be closely examined.

Certainly in several instances the letter carried by aeroplane will be more satisfactory than the deferred cablegram.

Great developments will now undoubtedly take place in the transport of correspondence by aeroplanes partly owing to the war wastage in ships. The principal problem of the future will really be that of reducing the weight of the correspondence to such dimensions as are consistent with economy. Various expedients to this end have been suggested; but if systems of scientific language condensation are employed, a lengthy business communication could easily be transmitted on a sheet of paper the size of an ordinary postcard. The authorised length of words fixed by the International Telegraph Convention, &c.—which have hitherto prevented the development of language condensation, by means of ciphers, to its maximum capacity—would not operate under a method which allowed the senders of messages utilising a given space.

Weight considerations are—in any case, eventually—likely to necessitate the adoption of private codes by all those transmitting correspondence by aircraft. By that plan many thousands of letter packets (conveying much in effect) could be carried where only a few hundreds could be sent conveying the same in ordinary plain language.

The weight carried by an aeroplane depends, of course, on its type, engine power, &c., but the problem will be for the several hundred pounds of mail matter that *can* be carried to be turned to the fullest account in effect.

Aircraft compares badly with the telegraph in one respect, *i.e.*, the latter is always ready to hand, whereas appreciable time is taken in loading up the aeroplane with its mail.

Air Trips.

Quite recently "Air Aircraft Transport and Travel, Limited" has also been running a passenger air service between England and France with the aid of especially commodious machines. This service more particularly devotes itself to the carriage of some 12 passengers, provision being made for fairly comfortable reading and writing, and even card playing forms part of the programme.

These experimental services should prove highly useful as a preparation and guide for the more extended routes—to India, Australasia, &c., *via* Egypt.

Air Finance.

At the moment when this Paper is being presented, the whole country is concerned with economy, and an order has gone out for all the Government offices to cut down expenditure to the lowest figure possible. This is all to the good and might well have been put in force some time ago; for, owing to carelessness and lack of business organisation, overlapping, &c., there has been much wasteful spending in almost every direction throughout the war and even previously. But it will be false economy, indeed, if we either risk Imperial security by seriously lowering out aerial strength, or if we impede the highly necessary development of production by checking the corresponding development of commercial aviation.

It would seem almost as though the Government—despite much far-seeing work—had failed here to give a moment's thought to the next decade. The British Empire must be bound more tightly together; this can best be achieved by accelerated transport—the fastest method being by aircraft.

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* One hesitates to enter too freely into the realms of prophecy when one remembers that, in the opposite direction, a late manager of the General Omnibus Company once clearly stated that the motor-bus would never come into practical use, so great was his faith in the "nimble" horse. Yet it was only a few months later that his directors decided to spend a million pounds on a fleet of De Dion and other omnibus chassis.

Causes of Breakage in High-Tension Insulators*

By E. O. MEYER.

A transmission line was constructed in Kreuzwald between 1911 and 1914, consisting of 320 km. of line, carrying current at 65,000 volts. At first there were breakages, due largely to accidental causes, mostly connected with transport and construction; but in the process of time, mostly in 1915 and 1916, the breakages increased considerably in number and caused numerous stoppages. At 65,000 volts, in bright dry weather, there is a marked hissing sound from an insulator; if it is defective, it gives either no sound at all, or a very strong extraordinary hiss. In either of these cases it ought to be changed without delay, to anticipate a possible breakdown. Records showed that in this case the cracks were exclusively on the upper part of the insulator, which consisted of three portions cemented together. There were always two characteristic cracks: the one goes radially in a plane through the axis of the insulator, tending to split it into symmetrical halves; the other goes somewhat in the form of a ring round the top. Prof. Petersen noticed exactly similar phenomena on lines that came under his observation, and stated that the breakages had of late increased seriously. It was resolved to investigate the matter carefully.

Mechanical causes did not seem likely to produce the result. The binding wire might be loose and tend to hammer the insulator in rough weather; but this was not found to be the case, as the binding was nearly always tight on the cracked insulators; neither could the expansion of the pin cause the breakages, as it would tend to break the lower parts as well as the upper.

Electrical effects were examined. Naturally, the uppermost phase is most exposed to direct and indirect atmospheric effects. Petersen thinks this is very marked if inferior material is used. But records on the line in question showed that the disturbances were not at all confined to the uppermost phase, but were nearly equally distributed, though the phase affected by lightning was more generally the uppermost phase. It was thought possible that the insulators were not big enough for the pressure; but it so happened that, owing to accidental causes, certain long lengths of the line were worked for some months at 10,000 instead of 65,000, and the breakages continued as before. Petersen noticed exactly the same phenomenon under exactly similar circumstances. This seems to show that electrical causes cannot account for the matter. A firm of makers suggested that as the cement dries it alters its electric conductivity, and consequently affects the distribution of the lines of force; but the author regards this suggestion as improbable, if it is intended to account for the ultimate breakages. Air bubbles in the cement might give rise to glow discharges, and to very slight internal heating; but this would scarcely be likely to attack or burst porcelain. Peasley, in America, put forward the suggestion that an insulator might be injured if it were subjected to a high-frequency surge as well as to a voltage of low periodicity; but this is not proved. Insulators tested under such conditions show no characteristic cracks.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," Nos. 16, 17, 18 and 24, 1919.

The shape of the insulator is next examined, as being possibly a contributory cause. Here a good many points arise which have been gradually elucidated in the course of years of experience; but, though the author examined this matter in some detail, he finds no clue to the solution of the problem in hand. He also collected together in tabular form such figures as are available with regard to the technical properties of porcelain itself; but there is no definite agreement as to these figures, and some makers felt themselves not to be in a position to make any positive statement on the point; but enough is generally known about this without any further discussion at the moment. Apart from the matter of raw material, which may in itself be variable, the firing of the ovens may affect the value of the end-product; but it is not reasonable to ascribe the present difficulty to anything connected with that. Occasionally a furnace may be badly handled, but this could not happen with any firm over a series of years. Some insulators have a rough and some a smooth fracture. The ones with rough fracture seldom show cracks; the fineness of the smooth fracture may be due to the raw material, or the method of working, or to too sudden cooling. Whether porcelain ages is uncertain; it is possible, but unlikely. If the porcelain itself were the cause of the fracture, small insulators made in one piece would crack as often as big ones cemented together out of several parts; but this is not the case. Also, in the multi-part ones, all the parts equally would crack; this, again, is not the case. A certain firm whose insulators broke in large numbers pointed out that many of their insulators had been in use since 1906 without breakage, and smaller ones for 30 years. In this case the connection of the two parts was done by glazing, and not by cement. All these facts seem to point to the conclusion that the porcelain is not in itself to blame.

It was next suggested that temperature effects might explain something. Glass is known to be unsuitable for insulators in the open. In the summer of 1913, 60 insulators made of good French glass cracked suddenly in a cold shower on a hot day. A good many experiments have been carried out by various observers with a view to finding out the effect produced on porcelain by sudden cooling. The author quotes tests which he carried out on porcelain balls; these certainly cracked if the change of temperature was very marked, much more so than is likely to occur in practice; but generally speaking, the cracks were across a meridian, and this is not of the characteristic type noticed in insulators. There was no distinct proof that anything could be due to this cause; but it is possible that the temperature may affect the cement, and so injure the porcelain indirectly. Records show that on the 65,000-volt line, to which this investigation had special reference, most of the breakages take place in summer. This has also been found to be the case on other lines, and not specially in thunderstorms, but in bright cloudless weather. Temperature, therefore, undoubtedly has some effect. Experiments with balls of porcelain and insulators show that temperature changes of 50°C. and more will produce cracks after repeated attempts; but this is a larger temperature change than is likely to occur in practice, but it may throw some light on the fact that the breakages only occur after several years. The colour of the insulators can only produce secondary effects, and is unlikely to be the prime cause.

Thus, finally, there remains only the question of the cement and its composition, and this will be found to be very important. Portland cement is now mostly used, and the views of Dr. Riepert on this subject are of great interest. He says that cement expands slightly on setting, but the expansion and possible subsequent contraction depend on the conditions—*e.g.*, whether it sets under water or in the air. This is common to all cements, but a poor cement also "drives"—*i.e.*, it is liable to crack and destroy anything within which it is enclosed. This "driving" begins sooner if it hardens under water than if it sets in the air. Cement can be tested by making a small block and allowing it to set for one day in the air, and then for a month under water. It ought then to show no cracks on the top, though some "driving" cements will show cracks in three days. There are sometimes curvatures and cracks on the edges of the block. The cracks run mostly in the direction of the middle of the block and gape most at the edge; often they are connected with a network of fine cracks. These cracks must not be confused with those which are liable to form while it sets in air as it dries; the latter form irregular curved lines over the surface. The blocks, while setting, ought to be protected from draughts and sunshine. Cements with more than 5 per cent. of magnesia, if burnt till they sinter, do not show marked signs of "driving" till several years have expired. Cement must be kept moist during the first stage of hardening, and is liable to crack if the block is put into water too soon. The "driving" of the cement seems, in the view of many competent persons, to be the main cause of the characteristic cracking. Since the magnesia content is the determining factor in the "driving effect," several cements were chemically tested which were taken from insulators that had cracked, some of them after having been in use seven years. The results of these analyses are given. In no case was there 5 per cent. of magnesia, the figures actually being 1·04, 2·4, 2·79, 0, and 0·92 in the five cases respectively. The "driving" and expansion of the cement cannot be entirely avoided, and there are other points in connection with the cementing process which require careful attention. The cementing mixture must not be too dry, and the moisture must be evenly spread throughout the mass. In some cases the cemented joint has shown on fracture a very uneven distribution of the cement. Sometimes there is too much on the one side or on the top. If there is a thick layer of cement on the one side and a thin one on the other, the crack will take place on the thick side. It is, therefore, necessary to see that the design only allows for a thin layer of cement, which must be evenly distributed. According to the experts, cement takes two years to set fully, and this possibly helps to explain why the fractures only take place after several years. After it has set, cement becomes a rigid substance, which is almost entirely a non-conductor of heat.

Improvements in manufacture are, therefore, an urgent necessity. The cause of cracking lies in the cementing process by which the parts are joined together. The specification of the latest type for 65,000-volt insulators prescribes a maximum thickness for the cement layer of 2 mm. at the top and 3 mm. at the sides of the cylindrical surface. On 45,000-volt insulators the manufacturing process has become so exact that the thickness varies between 1·5 mm. and 2·5 mm. Makers must also direct attention to the careful turning and fixing of the parts, so that there are no irregularities in the shape. The parts to be cemented together must fit exactly in point of size, and must be sorted for this purpose. The choice of the cement, the character of any admixtures, the preparation of the cement paste, its moisture while setting, and the keeping of the insulators a sufficient time in store without disturbance—all these things need attention. A coat of lacquer on the surfaces to be cemented has been tried, but this is not likely to effect much, as shellac oxidises and becomes hard and inelastic. A sheet of lead foil has been tried, also cork insets and metallic plates; but these are all useless. Lately a coat of graphite paint 0·1 mm. to 0·3 mm. thick has been tried, and also a thin copper ring; but this idea seems likely to fail, inasmuch as this constitutes no sufficiently rigid connection. Experimentally it has been proved that a slight movement is possible with these semi-elastic joints; this is likely to prove fatal in everyday work. The copper foil is so delicate that it is often injured in the cementing process. Drawings are given of two modern types of high-tension insulator, with dimensions and test pressures; in these cases there is a kind of hemispherical joint between the various parts. No kind of elastic joint is used. If improvements on these lines can be made, the pin insulator will be preferable to the suspension type, which costs in all at least three times as much, apart altogether from the fact that the poles must be 5 ft. or 6 ft. longer. Now that the cause of the cracking of pin insulators is understood, it is to be hoped that remedies will be found, and that they will again come into favour.

The Paper also contains a semi-theoretical investigation into the stresses caused by changes of temperature. This is divided into various sections, dealing with (1) the stresses between flat surfaces of porcelain and cement, (2) between cylindrical surfaces, (3) between spherical surfaces, (4) calculations of the stresses in the various parts of a pin insulator, with tables and diagrams.

Fire Alarm by Telephone.—According to the "Telephone Engineer" the city building, water works and main generating station at Delphos are connected to a single plug in the telephone exchange so that in case of fire they can all be called simultaneously.

A Back E.M.F. Booster.

By G. BOWRON.

While carrying on experiments illustrative of the back E.M.F. of a direct-current motor results were obtained which, while helpful to teachers and students, are also suggestive to practical engineers.

The first part of this Paper is devoted to a description of a method by which the value of the back E.M.F. can be made to exceed greatly that of the supply. Next follows a study of the effect of the special armature reactions which obtain. This is followed by a description of a method of reversing the armature rotation without reversing the direction of the incoming current in either the armature or the field magnets. Finally is outlined an arrangement by which the effective resistance of the armature of a motor or dynamo can be reduced, while a peculiarity in the commutation is pointed out.

The experiments were made with what had been a 240-volt series-wound fan motor, the armature resistance being 70 ohms. The fan was removed and the field coils were connected in shunt to the armature. The machine was run unloaded on a 100-volt supply. The brush gear was remodelled, two pairs of brushes being provided.

The two main brushes, shown as *M*1, *M*2 in Fig. 1, are connected to the supply. The normal position of these brushes is at the top and bottom of the diagram, but they are so arranged as to swing on either side of this position. In this way any desired lead forward or backward can be given to the main brushes. The second pair of pilot brushes, shown as *P*1, *P*2 in Fig. 1, are also adjustable; but, unless otherwise stated, *they are used in the position shown in the diagram.* They are connected to a voltmeter which indicates approximately the voltage generated in the armature by its rotation in the field.

Each set of experiments began with the brushes *M*1, *M*2 abreast of *P*1, *P*2—that is, in the normal position. As *P*1 and *M*1 rubbed on the same commutator bar, and *P*2 and *M*2 both made contact on the opposite bar, the voltmeter indicated the pressure of the supply. The armature ran at a speed corresponding to 100 volts. As the motor was unloaded the back E.M.F. was nearly equal in value, and, by calculation, was found to be 97 volts.

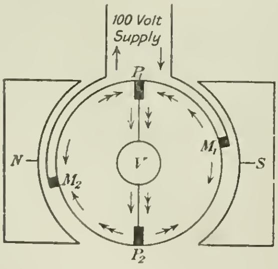

Fig. 1.

In the first set of experiments the armature rotated clockwise. The brushes *M*1, *M*2 were shifted by steps of 5 deg., also in the clockwise sense. The lead, therefore, was a forward one. Up to an angle of 30 deg. the speed was practically unaltered, while there was a slight drop of pressure between *P*1 and *P*2, due to C.R. loss. With a lead of 40 deg. there was a distinct rise in speed, accompanied by a rise in voltage at *P*1, *P*2. Each angular increase of lead showed a further rise in speed and voltage. At 60 deg. the voltage was about 160, and at 75 deg. the pressure reached its maximum at 190 volts. Beyond this point the speed and pressure dropped rapidly, and at 85 deg. the armature stopped. The results obtained are shown in the bottom left-hand curve in Fig. 2.

The brushes were then brought back to the normal position. They were then moved in the anti-clockwise sense while the armature still ran clockwise. The lead was, therefore, backward. The results are plotted in the top left-hand curve, which shows a maximum of 220 volts.

The armature current was then reversed and another two sets of readings were obtained, one set with forward lead and the other set with backward lead. The results are shown in the two curves on the right of Fig. 2. The curve with backward lead is again the higher of the two. The difference between the two *pairs* of curves is probably due to inequalities in the pole pieces. They were of cast iron and were not very soft.

The first point to notice in these observations is the high voltage generated in the armature. Although it was running at a supply pressure of 100 volts, it actually generated as much as 190 volts with a forward lead, and 220 volts or more with a backward lead. The reason for this anomaly can best be explained by dealing with a particular case. In Fig. 1 the brushes *M*1, *M*2 are shown with a clockwise lead of about 75 deg. Then, if the armature is rotating clockwise, the lead is forward. At this lead the generated pressure is about 190 volts—that is to say, that the back E.M.F. is nearly double the driving pressure. The explanation of this anomaly is made clear by an examination of the arrow heads in Fig. 1. The single arrow heads show the direction in which the supply voltage is exercised, and the double arrow heads show the direction of the generated pressure. Now, while a pair of brushes at *P*1, *P*2 will tap the full value of the generated pressure or back E.M.F., it is evident that, at right-angles to this position—that is, at *NS*—this generated pressure will be split up into two equal parts which are in opposition. The generated voltage between these two points will, therefore, be nothing. At the intermediate points *M*1, *M*2 there will be a resultant generated E.M.F., the value of which will be much less than at *P*1, *P*2. This reduced back E.M.F. at *M*1, *M*2 is accompanied by an increased incoming current from the mains to a much higher value than the normal. It is true that with *M*1, *M*2 in the position shown the torque per unit current is very low; but the increase of current more than compensates for this. Therefore the net torque is greater, and the speed follows suit. It is this increase in speed when the lead is great that accounts for the very high back E.M.F. shown at *P*1, *P*2.

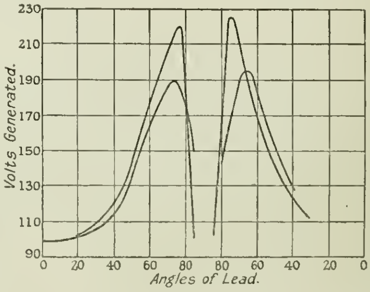

Fig. 2.

Armature Reactions.

The differences in the results obtained with forward and backward leads are due to armature reactions. In the first place, a forward lead in a motor strengthens the field and diminishes the speed. The important point is that the speed diminishes in a much higher ratio. The net result is that the back E.M.F. is diminished. This well-known fact holds good only for small leads. With the large leads dealt with in this Paper this effect operates to diminish the high back E.M.F. described above.

Conversely, a backward lead weakens the field and increases the speed in a much higher ratio, and the back E.M.F. is correspondingly increased. Secondly, there is an effect due to the shifting of the field flux. If armature reaction be absent, the field poles may be considered as concentrated at the middle points of the pole pieces N and S. With a forward lead and clockwise rotation, the *North* pole of the armature is under the brush $M1$, and it will attract the South pole of the field upwards. This brings the two poles nearer together, and thus reduces the torque. With a backward lead and anti-clockwise rotation, the *South* pole of the armature is at $M1$, and it will repel the South pole of the field downwards, thus increasing the torque and the speed.

Fig. 3 gives the value of the currents flowing in the armature at various angles of lead. The higher figures are obtained with forward leads. A lower back E.M.F. naturally allows a larger current to flow.

When an appreciable current is drawn from $P1$, $P2$ the generated E.M.F. is modified. As the current between $P1$, $P2$ increases, the angle of lead for highest voltage falls about 75 deg. to 60 deg. The speed is not so high, and the maximum voltage is therefore reduced. This drop is accentuated by the fact that the speed depends, not only on the angle of lead, but also upon the distribution of current in the armature. Even the current flowing through a moving-coil volt meter connected to $P1$, $P2$ produces an audible reduction in the speed. With a large motor this very small load would not have produced an appreciable effect, but a small change of load would produce a relatively large alteration of speed.

It has been already stated that, with no load on $P1$, $P2$ the voltage with a backward lead is higher than with a forward lead; but if a gradually increasing current is drawn from $P1$, $P2$ this advantage disappears, and finally higher voltages are obtained with forward leads. The reason for this inversion is not very clear, but the following explanation seems pertinent. If a current is drawn from $P1$, $P2$, the armature becomes a weaker magnet, and, when the lead is backward, its magnetism is partly reversed by induction from the much stronger field magnets. In this way the torque and speed are reduced. The effect is similar to that obtained when the south pole of a weak magnet is brought towards the south pole of a strong magnet. We get feeble repulsion and even attraction, because the strong magnet by induction tends to reverse the polarity of the weak one. With two dissimilar poles the weaker magnet is strengthened. Despite the lower generated voltage, the power efficiency is always greater with backward leads. This is due to the fact that the current from the mains is always less, as shown in Fig. 3.

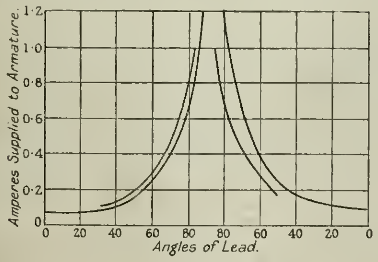

Fig. 3.

With a resistance of 2,000 ohms between $P1$ and $P2$ the voltage curves are similar to those in Fig. 2; but with a maximum pressure of 180 volts, with a resistance of 1,000 ohms we get the curves shown in Fig. 4, the maximum pressure is 148 volts, and the power efficiency is 40 per cent. With a resistance of considerably less than 500 ohms, the voltage never rises above that of the supply. A step-down effect is obtained, which, however, is not of sufficient interest for reproduction here.

Under no circumstances does the outgoing current exceed, or even equal, the incoming current. The explanation of this fact throws light on the armature reactions. These are more complicated than in an ordinary motor. Referring again to Fig. 1, the single arrow heads show the direction of the current flowing in from the mains. The double arrow heads show the direction of the current that would flow if the machine were acting solely as a generator. In the regions $P1$, $M2$ and $P2$, $M1$ these currents are opposed, and if equal will cancel out. Let us assume this to be the case. In Fig. 1 let $M1$ be + and the rotation clockwise. The lead will be forward. The incoming current will flow through the armature from $M1$ to $P1$, thence across the pilot circuit to $P2$, then once more through the armature to $M2$, and from that point back to the negative main.

There will thus be in the armature belts of current $M1$, $P1$ and $P2$, $M2$. There will also be zones of no current $P1$, $M2$ and $M1$, $P2$. This distribution of current will tend to place the north pole of the armature midway between $M1$ and $P2$, and thus to produce anti-clockwise rotation, or in the reverse direction to that postulated. As the armature cannot rotate in two directions at once, the assumption that the incoming and outgoing currents are equal is invalid.

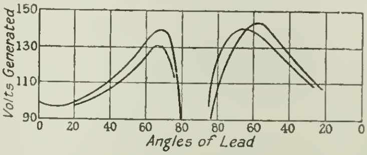

Fig. 4.

Reversal of Armature Rotation.

The above reasoning suggested further experiments. These had for their object first the reversal of the direction of armature rotation without reversing the incoming current; and, secondly, to obtain zones of no current in some parts of the armature. First $P1$ and $P2$ were connected by a short-circuiting wire, while $M1$, $M2$ had a lead of 75 deg. Whether the lead were forward or backward the armature stopped dead. This was half way towards reversal. The short-circuiting wire was then transferred to $P1$ and $M2$, with a backward lead of 50 deg. The speed dropped greatly. With a lead of 60 deg. the armature stopped, and with leads of 70 deg. and upwards the direction of rotation was reversed. If the lead were high, and a small current was drawn from $P1$, $P2$, then the speed of reversed rotation was increased. When $P1$, $M2$ and $P2$, $M1$ were both shorted at the same time, reversal was obtained with any lead from 40 deg. to 90 deg.

Zones of Variable Current.

If we consider the current flowing through the short-circuiting wire connecting $P1$ to $M2$, it will be evident that the current in this wire may have two components. One is the incoming current traversing the belt $M1$, $P1$. The other component is the generated current flowing through the armature from $M2$ to $P1$, and thence completing its circuit back to $M2$ through the short-circuiting wire. In order to investigate this point, the two short-circuiting wires from $P1$ to $M2$ and from $P2$ to $M1$ were replaced by two circuits, each containing variable resistance and an ammeter. We shall deal with the results obtained in the branch or shunt circuit $P1$, $M2$, bearing in mind that the effects are duplicated in the circuit $P2$, $M1$.

Starting with a high resistance in the shunt, the current through it is small. The current from the mains, after traversing the belt $M1$, $P1$, continues through the armature to $M2$, and thence back to the return main. As the resistance is diminished a larger and larger proportion of the incoming current flows through the shunt until a point is reached at which all the incoming current flows through the shunt, and no current flows through the armature belt $P1$, $M2$. If the resistance is reduced still further, it is then found that the current in the shunt is greater than the incoming current. A reverse generated current is therefore flowing in the zone $M2$, $P1$, with the result that a four-pole armature is rotating in a two-pole field.

It would have been well to provide two extra pairs of brushes for the experiments just described, leaving the main and pilot brushes to be used only for their original purposes. There was, however, only room for one extra pair of brushes ($P3$, $P1$), which were mounted on a rocking arm and used in conjunction with $P1$, $P2$, as shown in Fig. 5. For clearness, $M1$ and $M2$ are omitted. $P3$ was placed, say, 30 deg. to the left of the neutral point and $P1$ was placed 30 deg. to the right. The two brushes were then connected by a shunt wire in which an ammeter, A, was placed ; $P2$ and $P4$ were similarly connected. By shifting $P1$ a balancing point was found at which the current in the armature between the points $P3$ and $P1$ could be reduced to zero. Beyond this point the current was reversed. This method proved to be as effective as the method previously described, where a variable resistance was used.

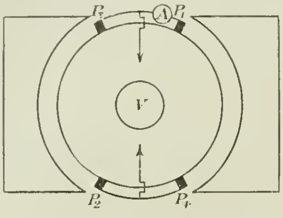

Fig. 5.

The commutation is peculiar. If the current in the armature between $P3$ and $P1$ be zero, then the current in an armature coil passing $P1$ to the left drops to zero and rises again to its full value *in the same direction* when the coil reaches $P3$.

As a Dynamo.

If the machine is used as a dynamo $M1$ and $M2$ are disconnected, and the remaining brushes are used as shown in Fig. 5. The current generated flows through a circuit which is in parallel with the voltmeter V. Then, if $P1$ is balanced against $P3$, and if $P2$ is balanced against $P4$, there will be no current in the armature zones $P1$, $P3$ and $P2$, $P4$, and the effective resistance of the armature will be reduced. If the angle between $P1$ and $P3$ is 60 deg., the effective resistance will be reduced by one-third. The commutation will be different to that taking place in the motor. The current in an armature section passing under $P1$ to the left will, after dropping to zero, *reverse* when the coil passes under $P3$.

Concluding Remarks.

A large motor used as a step-up booster as described should be efficient, but careful designing would be necessary in order to get sparkless collection. I understand that Messrs. Crompton, some few years ago, made an auto-converter with an extra pair of brushes. But as the machine was used to give a step-down effect, and the main brushes were in the normal position, the resemblance to the machine described above is superficial.

Reliable Method for the Approximate Determination of the True Antenna Constants.

By AUGUST HUND.

This procedure is based on the measurement of the fundamental wave-lengths λ and λ' for unloaded and coil-loaded antenna. The self induction L_0 inserted at the ground side ought to be large enough to provide for a linear decrease of the current distribution* towards the open end. The respective wave-lengths are then given by the solutions

$$\lambda = k\sqrt{\left[\frac{8}{\pi^2}C_A\right]\left[\frac{L_A}{2}\right]}$$

$$\lambda' = k\sqrt{\left[C_A\right]\left[\frac{L_A}{3}+L_0\right]};$$

and the true or static antenna constants by the formulæ

$$\left.\begin{aligned} L_A{}^H &= \frac{3\pi^2\lambda^2}{12\lambda'^2 - \pi^2\lambda^2} L_0{}^H \\ C_A{}^{MF} &= \frac{10^{-10}\ \lambda^2 m}{144\ \ L_A{}^H} \end{aligned}\right|$$

These results are therefore based upon the values $\frac{8}{\pi^2}C_A$ and $\frac{1}{2}L_A$ for the correct effective antenna constants of the unloaded antenna, and C_A and $\frac{1}{3}L_A$ for a condition of heavy coil loading, since in the latter case the antenna voltage is almost constant along the horizontal aerial and the effective antenna current decreases linearly to its zero value at the open end. These values happen to be identical with the ones holding for the open ended transmission line excited by a low frequency harmonic E.M.F., the frequency of which is much lower than the natural frequency of the line. Correctly speaking, C_A and $\frac{L_A}{3}$ denote the effective values for a heavy coil loading of the antenna under consideration, and the given formulæ apply all the more rigidly the larger the loading is chosen. The table shows the application in comparison to the analytical procedure. The loading self-inductions L_0 are purposely chosen small in order to pronounce possible errors due to the approximation. Even for such conditions the results agree very satisfactorily. Many measurements have shown that these formulæ hold for almost all commercial antennæ in very good approximation besides. They are practically correct for long horizontal aerials.

The results for the analytical method are based on the radio equation of a horizontal aerial, for which

$$L_A{}^H = L_0 \frac{2\pi}{\lambda'} l \tan \frac{2\pi}{\lambda'} l,$$

$$= L_0{}^H \frac{\lambda}{\lambda'} \pi\ 2 \tan (\lambda/\lambda' 90)^0,$$

for a quarter wave length distribution.

Measured Values.		Calculated Values.					Remarks.
				True Antenna Constants.		Analytical method.	
Loading self-induction L_0 in H.	Wave length λ' in m.	$12\lambda'^2$	$12\lambda'^2 - \pi^2\lambda^2$	$L_A = \frac{3\pi^2\lambda^2 L_0}{12\lambda'^2 - \pi^2\lambda^2}$ in H.	$C_A = \frac{10^{-10}\lambda^2}{144 L_A}$ in M.F.	$L_A = L_0 \frac{\lambda}{\lambda'} \pi\ 2 \tan \lambda/\lambda' 90$	
0·000246	1015	12,370,000	7,740,000	0·000442	0·000737	0·000466	For no load measured wave length $\lambda = 685$ m. $3\pi^2\lambda^2 = 13,900,000$ Loading self-induction L_0 variable and comparatively small.
0·000279	1055	13,350,000	8,720,000	0·000445	0·000732	0·000463	
0·000308	1095	14,400,000	9,770,000	0·000438	0·000744	0·000454	
0·000345	1130	15,300,000	10,670,000	0·000450	0·000725	0·000463	
0·000384	1161	16,200,000	11,570,000	0·000462	0·000705	0·000474	
0·000422	1190	17,000,000	12,370,000	0·000475	0·000686	0·000485	
0·000448	1225	18,000,000	13,370,000	0·000466	0·000700	0·000474	

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* The resonance wave-length λ' for the coil-loaded antenna should be about twice as great or greater than the resonance wave-length λ for the unloaded antenna.

A Year's Record of the Automatic Sub-station at Butte*

By E. J. Nash.

The design and construction features of automatic sub-stations have received considerable attention, but there has been comparatively little regarding their operating records. The first year's operating records of one of these stations may, therefore, be of interest. The automatic sub-station of the Butte Electric Railway differs, so far as is known, from any thus far described or installed. On account of the termination of a contract for power and also because the company wished to take care of the return current more satisfactorily, it recently became desirable to install a new system of distribution and to use the negative insulated return-feeder system for the mitigation of electrolysis. The location of a sub-station at the load-centre of the system was considered; the cost would have been $19,800 more for copper, plus additional annual line loss of $1,700, than if one sub-station was located at the centre of load distribution for the uptown district, and another was located in the South Butte residential district, where approximately 25,000 people reside. Even under these conditions it would have been more economical to use the copper and suffer the line loss than to install a manually-operated station in South Butte, because the company pays each operator $7 per day for an eight-hour shift. As this station would have to run at least 16 hours a day, making an annual operating charge of $5,110, it is obvious why the automatic sub-station was the economical solution of the problem regardless of an additional cost of $9,000 for buildings, land and equipment for the synchronous converter. It was estimated that one day's work per week was sufficient for cleaning and inspecting the apparatus, amounting to $364 annually as an electrician receives $7 per day, and that materials would cost $256 per year including necessary incidental supplies such as oil, waste, brushes, contacts, &c. The total annual charge for material and maintenance was thus estimated at $620; the actual cost was $355.80. Of the latter amount 82 per cent. was for labour.

The automatic sub-station has given very reliable service, for during the year it failed but four times. On two occasions an auxiliary relay failed to open. This relay keeps the station from starting when the alternating-current voltage is low. In failing the first time the clutch and trip coils were damaged as the voltage was too low for the oil switch motor to complete the closing operation. The damage would not have occurred had the circuit been properly fused as it was the next time the relay failed; this time the damage was simply a blown fuse. A relay of a later type was substituted, and no further trouble has been experienced. On another occasion the rotary was stopped on a very hot day by the operation of the bearing thermostat. This thermostat had a lower temperature setting than was necessary and the converter simply remained idle until an electrician arrived. On another occasion, before electrolytic lightning-arresters were installed on the direct-current feeders, lightning entered the station. All the damage in this case consisted in a blown fuse and the burning off of the insulation from the wire of the lighting circuit which was tapped to the feeder.

It happens that the machines in the railway company's central sub-stations are of the same type, style and capacity as that in the automatic, so that there is an excellent opportunity to compare the operation of these two sub-stations. The synchronous converters are 500 kw., 60-cycle, 660-volt, six-phase General Electric machines, diametrically connected. The full-load rating is 834 amperes, and they are designed to carry 50 per cent. overload for two hours and 100 per cent. overload momentarily. They have flash suppressors, or arc coolers. The two synchronous converters in the central sub-stations have flashed over, and have flashed to the pedestal. The short-circuit current for the manually-operated sub-station has been limited to less than 3,000 amperes. Although on one of the 500,000 circular-mil feeders the nearest trolley tap is more than 10,000 ft. from the sub-station, a pedestal flash was experienced from this circuit. In contrast to this, the automatic sub-station has demonstrated its ability to handle a short-circuit without flashing several times when the short-circuit current would have reached a value in excess of 4,000 amperes, the only indication of trouble was a faint squeak. In one test the trolley wire was short circuited to the rail within 1,000 ft. of the station. A flash started but was extinguished by the wire arc coolers. This non-flashing feature of the automatic sub-station is worthy of consideration. It is, of course, due to the use of the flash guards and the load-limiting resistors which have a cushioning effect. These resistors could be used in a manually-operated sub-station to supplement the circuit breakers.

As stated previously, lightning entered the automatic sub-station practically without doing any damage. It also entered the manually-operated sub-station, where it jumped to the low-voltage release of the synchronous converter circuit-breaker and blew the instrument fuses. A bearing was burned out in the manually-operated station, this also would not have occurred with automatic control.

The automatic sub-station, as will be seen from Fig. 1, is located in South Butte and operates in parallel with the central sub-station through an automatic sectionalising switch. The automatic feeds three separate trolley sections, utilising practically but one 500,000 circular-mil. feeder and the double trolley of the same circuits. This is done by the use of two General Electric automatic sectionalising switches at a point where two lines branch from the main line. The Oregon Avenue and the Race Track lines receive their power from the Englewood or South Butte lines through sectionalising switches S_1 and S_2. The contactors in the automatic sub-station for the Oregon Avenue and Race Track feeders are used to energise these circuits to close the automatic sectionalising switches in case they open through overload, as the breakers for the Englewood or South Butte feeders would not open to equalise the separate sections. The Oregon Avenue and Race Track feeders will (with a reduction in voltage) carry the loads of these stations in case the power is not on the Englewood section.

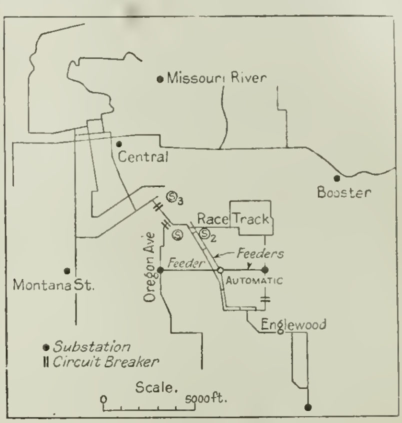

Fig. 1.

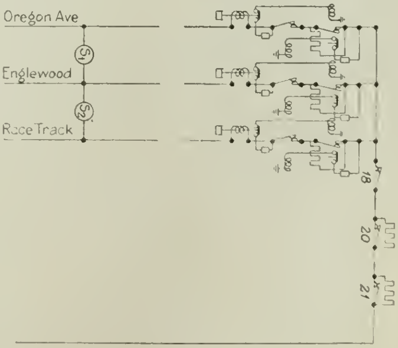

Fig. 2.

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* Abstract of an article in the "Electric Railway Journal."

Instead of using a single contactor for the feeders from the automatic sub-station, which is in parallel with the resistor, use is made of two contactors in each circuit, so that in case of a trolley break only the affected section is disconnected from the 'bus. As will be seen from Fig. 2, one contactor shunts the resistor and the other is in series with the line on the line side of the contactor and resistor.

The holding coil of the series contactor is wired from the 'bus through the contact of a thermostat placed over the resistor of that circuit. When the shunted contactor opens, through the opening of the contact of a series overload time-limit closing relay, current passes through and heats the resistor. If the temperature of this reaches a pre-determined value the contacts of the thermostat open, thus opening the holding circuit of the line contactor which disconnects the feeder from the 'bus. By the use of the connection of the holding coils as shown in Fig. 2, the contactors are closed whether the station is running or not. This is necessary, for at night when the automatic sub-station is not running the closed contactors furnish power for Oregon Avenue and the Race Track to close the sectionalising switches in case they open on account of overload.

The operation of the South Butte automatic sub-station has been so satisfactory that plans are now being made to add another sub-station of the same type to the system and to make the central sub-station automatic. By the addition of a second sub-station, copper to the value of $86,000 would be recovered and this station would be available in case one of the other units failed to function. That this would be economical is evident from the fact that the three operators in the central sub-station are paid $7,665 per year.

In conclusion, it may be stated that the population of Butte is given by the 1910 United States Census as 39,165. This figure includes only the inhabitants of the small area within the city limits, covering about 5½ sq. miles. There are a number of towns and residential sections adjoining the city with an aggregate population of about 70,000. Consequently, the total population served by the railway is at least 100,000

A Projected National Transmission Network in Spain.*

By GEORGE F. PAUL.

The construction of a national network of high-tension transmission lines linking all industrial centres of Spain with the larger waterfalls and coal mines has recently been proposed, and will probably be carried into effect eventually, because of the droughts and coal shortage that now hinder economical development of power.

The system as planned by a special commission devoting attention to this project would consist of a number of transmission lines passing through or near all of the leading commercial centres. Such important centres are situated mainly on the north and east coasts. The larger waterfalls would be used to generate power, and would be supplemented by the coal mines. Spain has several large coal fields where the grade of coal produced is so low that it cannot be handled commercially to advantage; but in a national scheme these low-grade coals could be burned in plants at the mines, thus producing electrical power at the seasons of drought, which are of annual occurrence in all parts of Spain, and make it impossible to place entire dependence on hydro-electric power. In the central part of the peninsula the water supply is greatly reduced from five to six months of the year, a period that usually begins about the second week of June. In the zone to the north-west, lying south of the Bay of Biscay, this season is reduced to three months, commencing generally about the first week in July. In the zone to the north-east, lying to the south of the Pyrenees, there are two periods of low water, one in September and October and the other in January and February.

In preparing a list of places where hydro-electric power could be generated, the commission listed only the waterfalls capable of producing more than 2,000 H.P. The results are given in the accompanying table. One great advantage to be derived from such a national network, apart from the continuous supply of cheap power to all consumers, is the unification of the frequency and voltage. The frequency is now standardised throughout Spain at three phase, 50 cycles, and the voltage would be regulated after a careful study had been made of the amount of power needed by the leading industries of the country. The commission recommends that for the main branches of the transmission line the potential should be not less than 120,000 volts.

Detailed studies have been made in order to determine the cost of this vast system of lines. The figures are based on the assumption that there will be 888 miles, with wires having a sectional area of 50 sq. mm. and 1,100 miles with wire of 100 sq. mm. area. The lines would be duplicate throughout, protected by a ground wire and provided with four telephone circuits. The supports, according to the practice of the three largest plants now operating in Spain may be of concrete and steel spaced at an average distance of 410 ft. The insulators considered proper are those of the suspension type, six elements in series. The total cost may attain 119,202,000 pesetas (approx. £5,000,000) for the entire network completed and ready for operation.

Spanish Waterfalls with Hydro-electric Possibilities.

	H.P.
Atlantic slope of Leon and Galicia	70,000
Asturias	40,000
Santander	30,000
Ebro, before reaching Zaragoza	65,000
Rivers from the slopes of the Pyrennes	490,000
Ebro, from Zaragoza to the ocean	130,000
Duero, in Spain	90,000
Duero, on the Portuguese frontier	150,000
Tributaries of the Duero	50,000
Tajo	110,000
Tributaries of the Tajo	50,000
Guadiana	35,000
Guadalquivir and other Andalusian rivers	40,000
Jucar and Cabriel	90,000
Other rivers on Mediterranean slope	60,000
Falls of minor importance	500,000
Total	2,000,000

The Commission goes into considerable detail in regard to the principal bases upon which a proposed law might be drawn up. It recommends that the enterprises which utilise this system of power distribution shall pay an annual fee representing the cost to the state in interest for obtaining the necessary capital, plus the cost of the care and the maintenance of the system, and such enterprises shall comply strictly with the regulative instructions issued by the Minister of Public Works, who shall also be able in each zone to establish the prices for the purchase and sale of power in that part affecting the national system. The lines of this general system may be utilised by consumers who require the total capacity of a line; also by enterprises which do not utilise the full capacity of the line, and which desire to furnish or take, or both, power of the national system, and in this case the State shall fix the prices of production and consumption, the difference representing the quantity which it is to collect as rental.

Enterprises desiring to come under this law must apply to the Ministry of Public Works, setting forth the condition of their installations and agreeing to conform to the general regulations. The State will require that the system must utilise chiefly electric power of fluvial origin, which may be created by establishing dams in the rivers. Enterprises which through insufficient means for assuring reliable and continuous service would cause loss to the consuming industry will be obliged to provide themselves with the necessary means for assuring such service, or must join the national system in order to remedy the defect. The State may accept within its systems power from private individuals who may place this power at its disposal. The general design of the system adopted will be entrusted to a commission of experts experienced in hydro-electric problems and in the transmission of high power at long distances. This commission will make a study of the utilisation of fuel of an inferior quality and low price, or coal which is found in regions incapable of being exploited owing to distance from consuming centres.

Any industrial operator may utilise the system for the marketing of power proceeding from hydro-electric or steam plants, delivering the power in a three-phase current, 50 cycles and 120,000 volts, or whatever pressure may be stipulated by the commission of experts. Any enterprise which takes advantage of this distributing system has to accept the conditions which the Ministry of Public Works may impose for the discontinuation of the service. This technical body will write the articles of the law and the regulations, and the law, prepared on this basis, will be passed to the Cortes. In addition, it is to study within the shortest possible time the project for the unification of voltages, both for the energy which is to be conducted by its own lines and for the distribution thereof to the consumers these conditions shall be obligatory for all new installations, whether they utilise the services of the system or not.*

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* Abstract of an article in the "Electrical World."

* Title of official publication: "Proyecto de Ley para el Establicimiento de Una Red Nacional de Distrubucion de Corriente Electrica." Ministerio de Fomento, Madrid, Spain, 1919.

Lorraine and Saar Steel Works.

The Commission appointed in the spring by the Minister of Munitions to visit the steel works districts of Lorraine and the Saar Valley, in order to investigate the condition of the plant and machinery, have presented their report, which is abstracted in the "Board of Trade Journal." We learn that the iron and steel works in the Saar Valley worked at high pressure throughout the war. In Lorraine, however, the iron and steel works suffered severely from shortage of fuel, especially during the later period of the war. There were also difficulties of transport caused by military exigencies, coupled with the bad condition of the railway systems and rolling stock in Germany. Some of the French-owned works in Lorraine were kept at work by the Germans; others just within the French border (*e.g.*, Jocuf and Homecourt) were idle since the beginning of the war, although the Germans made an effort to restart them. They apparently gave up the attempt, stole from the French works the bulk of the plant, tools and stores, and destroyed the remainder. The stolen plant, &c., was installed in German owned works in Lorraine, which were kept going as far as possible.

Towards the end of the war the difficulties due to fuel shortage were accentuated by the absence of lubricants, and there is considerable evidence of machinery having become seriously damaged, and finally rendered inoperative in some cases, by lack of lubrication. There was undoubtedly a great shortage of manganese during the later period of the war, and its allocation to the different steel works and for specific purposes, was in the hands of a special commission. As a substitute calcium carbide was tried, in conjunction with reduced quantities of manganese, and used for some time, but it gave very bad results, and about 30 per cent. of the steel so produced was scrapped, the tops of the ingots being very unsound and the waste in the mills much higher than usual, more especially in shell steel. Powdered anthracite was tried for deoxidising purposes in the same way as calcium carbide, but it was not a success.

At the time of the Commissioners' visit none of the blast furnace plants were in anything like full operation. As the steel works are dependent in all cases upon hot blast furnace metal these works in their turn were also only in partial operation, Bessemer shops, open hearth shops and rolling mills all being on short output. for lack of iron. The cause of the restriction is the acute need of furnace coke. The Germans have failed to carry out their obligations under the terms of the Armistice to supply a specified quantity of suitable coke. There are 68 blast furnaces in the Lorraine, and of these about 60 were found to be in good condition at the date of the Armistice, but only five were then in blast. The French authorities have had as many as 27 or 28 in blast at one time since they recovered Lorraine. Only one coke oven plant was seen in the Lorraine area, viz., at Moyeuvres works of Messrs. De Wendel, where there are 105 Koppers' ovens installed for producing coke for their own needs. Here is used in the ovens about 75 per cent. of Saar coal and about 25 per cent. of Westphalian coal.

The blast furnaces in Lorraine are, in most cases. well laid out for the production in bulk of basic pig iron from the phosphoric iron ores of the district. In nearly all cases a basic Bessemer steel works is attached, the necessary power for running the works and plant being obtained from the blast furnace gas. Where no steel works is at present established in connection with a blast furnace installation (Uckange, Maizieres and Carlshutte) the surplus gas is used in large as engines for supplying power to Metz and the villages in the district. The great and successful development in manufacture and running of large gas engines on low-power gas enables complete utilisation of the blast furnace gas to be effected. After rough cleaning part of the gas is used in the heating stoves of the blast furnaces and under steam boilers, the remainder, after further cleaning, being used for driving the large gas engines installed for blowing purposes (chiefly of the Klein type, two cycle) and for power generation (Thyssen, Erhardt and Sehmer, Nurnberg, and Société Alsacienne types, four cycle). The former gas serves the blast furnaces and the basic steel converters, and the latter gas provides the power for the rolling mills, cranes and plant generally. Steam engines are seldom seen, except in connection with the cogging and heavy section mills. Some of the later plants installed have electric drives throughout all their rolling mills; where this is the case it appears to be a common practice to run one or more steam turbo-generators parallel with the gas engines for generation of power, on account of the greater flexibility of the turbine, and its capability for taking varying peak loads more readily. At Hagondange 36·5 per cent. of the total generating capacity installed was by turbo-generator. At the different works visited the pig iron produced is nearly all for basic steel making; very little foundry iron is made. In Lorraine most of the works own their own mines. The distance between the iron and steel works and the mines varies, but in no case exceeds 18 km. The method of transport is generally by means of aerial ropeway; in a few cases it is brought by electric or steam locomotive to the storage bunkers. The modern plants are provided with "Pohlig" hoists or modifications of this system.

The great acquisition of further supplies of iron ore will enable France to develop her future trade at the expense of Germany. She should be able to produce 11,000,000 tons of pig iron per year, with an equivalent in steel, to dispose of in competition with other countries. Before the war the estimated resources of Germany in iron ore were 3,600,000,000 tons and of France 3,300,000 tons; but now the relative positions are 1,300,000,000 and 5,500,000,000 tons respectively. Before the war Germany produced 27,000,000 and France 21,000,000 tons per year, but the estimated production after the war is 7,000,000 and 42,000,000 tons respectively

The Telephone Service.

A deputation from the National Union of Manufacturers waited upon the Postmaster-General on the 16th inst., in order to make representations on the present inefficient service, and to suggest that a committee of business men be associated with the department in the reorganisation of the service.

In the course of his reply, Mr. A. Illingworth said that when the Government took over the service from the National Telephone Company there was practically no spare plant, and the position was far from satisfactory. In 1913 and 1914 the sum of £1,350,000 per year was laid out by the Post Office, but during the rest of the period of the war, up to March last the sum spent was only £280,000 a year, on account of the shortage of material and men. There were practically no extensions except for absolute war work and for Government departments. There was a great shortage of switchboards; they were not being made because there was no one to make them. As soon as the Armistice was signed, the Government went into the telephone question carefully, and drew up a programme for this year. Under that programme they intended to lay out £3,000,000 on new exchanges, improvement of lines, extra lines, extra switchboards, and generally make a beginning to get the service back into some satisfactory condition.

There were difficulties arising from shortage and inexperience of the staff. In 1914 there were only 4 per cent. of the operators who had less than six months' experience. Recently the average was over 45 per cent. Over 1,000 trained operators were taken for various Government private exchanges. A few of these had been returned, but there were still 800 highly-skilled operators working in various Government departments. It took six months to train operators to be of moderate use, and 18 months to two years to make them fully efficient. Before the war, girls of 18 received 16s. a week, which increased to 28s.; now they were starting at 37s. 10d. per week, which rose to 52s. 2d. The greatest care was being exercised to get the best material, and only something like 10 per cent. of those who presented themselves were employed. Recruiting was improving, although it was made difficult by the way in which telephone operators were abused by the Press. In spite of all that abuse, the recruiting was improving. The traffic, of course, had increased enormously. Before the Armistice the calls in London were rather under 1,000,000 a day; now they were rather over 1,250,000.

The remedy for the present state of affairs was perfectly obvious. They had to have increased accommodation, increased wires, trunk lines, exchanges and exchange boards, and they wanted a larger staff so that the operators would have a comfortable amount of calls to deal with. In London since the Armistice they had put in 14,000 lines, and at present they were doing them at the rate of 900 a week. They were laying wires underground in 20 large towns, so that they would not be broken down by storms. He outlined the programme of work for the present year, which was laid before the House of Commons in July. He hoped the Clerkenwell Exchange, which would accommodate 1,700 lines, would be opened in December or January. Other new exchanges to be opened were Bishopsgate, Tower, Holborn, Strand, Sloane-square and Marylebone. Some of these had been begun, and they were all going to be pressed forward as quickly as they were able to get material and labour. Extensions were to be carried out at the Avenue Exchange, Chingford, Hampstead, Harrow, Hornsey, Battersea Park, Stratford, Tottenham, Victoria and Waltham Cross. With the exception of two, these would be opened before next June. As to the appointment of a small committee of business men, he pointed out that one committee to deal with the subject would be kept working night and day for a long time. There were 50 committees of business men already in existence up and down the country. The London committee represented the Chamber of Commerce, the Corporation and the London County Council. He arranged some months ago to send experts to America to look into the telephone system there, and there were at present some American experts in this country looking into our system.

Referring to the complaints about the telegraph service, Mr. Illingworth said that, while mistakes were made, the British telegraph system was admitted to be the best in the world. He could assure them that mistakes complained of would be inquired into. As to the question of telephone charges, the Government had been considering the passing on of the extra charge to the consumer. They thought that, at any rate for the present, while trade was in a transition period, it would be more desirable to keep up communications as cheaply as possible, and really the Post Office was now being subsidised by the Treasury. He believed that the deficit this year would be two millions.

Japanese Labour.—In view of the general impression that labour in Japan is extraordinarily cheap it is interesting to note some facts recorded in the "Engineer." The average wage of an unskilled male labourer is 5s. to 7s. per day, but bonuses are given considerably increasing these rates, which are 70 per cent. above those prevailing in pre-war days. Working hours average 70 hours a week, but in general the amount of work done in a given time is only half that accomplished by a British labourer, where large jobs and heavy machinery are concerned. In light work, however, involving manual skill and dexterity, there is not much difference in output to be noted.

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The Manufacture of High Tension Insulators.

The high-tension insulator has not the same degree of commercial importance in this country that it has in some other parts of the world. In some quarters there is a tendency to suggest that the future of high-tension transmission will be best served by cables rather than by overhead poles and wires; and lately, when it seemed that the problem had settled down into a comfortable groove, and that nothing remained except expansion to ever-increasing voltages on old-established lines, the idea was mooted, from a quarter which inspires respect, that the future of high-tension transmission lies with direct rather than alternating current. If this is so, or even likely to be so, there is every reason to put the house in order betimes. The argument advanced in support of this novel thesis was that the charging current sets a limit to an increase of alternate current voltage; both increase together, and though the old proposition states that a high transmitting pressure promotes efficiency when the transmission takes place over a long distance, this entirely neglects the effects due to the charging current. The fact is that the charging current may become so serious in amount as to neutralise the value of a high alternate current pressure, and any increase of this pressure becomes useless beyond certain limits. The proposition, in fact, that an increase of pressure promotes efficiency in transmission is not true for very high pressures. But how, alternatively, power is to be transmitted at all by direct current, deponent sayeth not: he is content to leave that on the lap of the gods and to trust that the opportunity will produce the man. Dr. M. Dolivo-Dobrowolsky (whose article we gave in abstract in a recent issue) evidently has in mind conditions beyond those which have already been met by the Thury system.

This, however, is not the immediate point to which we wish to draw attention. The breakage of high tension insulators is a well-known phenomenon. No amount of testing at the works seems able to prevent it; though all the insulators may be passed as sound, even after the line is erected, it is known that in the course of time many will break down. Further, these breakages are by no means due entirely to bad weather, lightning, or other accidental causes. The patrolling of the line in order to discover defective insulators is a feature of all high-tension transmission schemes, and complaints as to these breakages continue and are often inexplicable. Some, of course, are due to the inevitable, that is, if any breakage in material things can be properly regarded as unavoidable by the skill of man. But for the present it seems not unreasonable to regard the effects of a severe thunderstorm, and the malicious throwing of stones, as things which must be endured. After allowance is made for inevitable causes there remain many others, which seem in their nature to be mysterious, to be assignable to no definite known agency, to be perhaps the effect of age in some form, and to be, therefore, subject matter for investigation. These breakages take place mostly in the summer, and generally speaking, some years after the line has been erected. For the initial period of working, the insulators in question seem to do their work satisfactorily, and then suddenly their end is announced, either by some temporary breakdown of the line or by the preventive care of the men who patrol the line. A large number of breakages of this sort took place in Germany shortly after the beginning of the war; they were noticed by different observers in all sorts of districts. In some instances the number of these breakages was so alarming that an instant investigation had to be made. The Paper by Mr. E. O. Meyer, of which we give an abstract, shows that the inquiry was thorough, and covered the whole field. Though there may be several minor contributing causes, and though opinions may differ as to the likelihood of this or that hypothesis, there is no doubt that the main disturbing cause was the cementing process used for joining together the various parts of the pin insulators in question. Portland cement is generally used for this; it takes quite a long time, even years, to set properly, during which time it expands somewhat. This is the main cause of the breakage. There are usually two characteristic cracks, both in the uppermost part of the insulator—one tends to split the insulator into two symmetrical halves, and the other tends to run like a ring round the top of the head. These are due to the expansion of the cement, which threatens to burst the insulator apart. The larger number of these fractures take place in the summer, and after the line has been in use some years; both these facts are to be explained by this hypothesis. The cement sets slowly, hence the period of time required before the fracture takes place, and, secondly, the setting is obviously accelerated by hot weather, and this is the reason why the breakages mostly occur in summer. Meyer's Paper should be consulted by those interested in the subject. He describes certain methods by which the suitability of a cement can be tested with a view to avoiding one which is likely to cause early breakdown. He also gives the chemical analysis of cements which have been taken from insulators that broke down. The curious, and probably very important, fact is noted that none of these cements contained 5 per cent. of magnesia, which is believed to be the minimum amount that should be present in a cement, suitable for the present purpose. It has long been known to the cement experts that cements containing more than 5 per cent. of magnesia differ in their setting properties from others; that is, they develop the cracking tendency much more slowly. The makers of insulators should bear this fact in mind; and it may be that some radical improvement may be introduced, now that it is understood that the cementing process is a source of danger.

Review.

Interior Wiring and Systems for Electric Light and Power Service. By A. A. Cook. (New York: John Wiley & Sons; London: Chapman & Hall, Ltd.) Pp. 416.

This book is divided into three sections, dealing respectively with illumination, power systems, and with interior wiring. The author follows familiar lines in dealing with lighting. A brief account is given in successive chapters of lamps, principles of illumination, lighting fittings, calculations and exterior lighting (the latter a subject that is hardly implied in the title). As is often the case in works of this description, the elucidation of scientific principles is apt to be sketchy, and some of the definitions somewhat loosely expressed. We think, too, that the author would do well in another edition to give the explanations of such terms as candle-power, lumen, foot-candle, &c., *before* using these terms in relation to lamps. Speaking generally, the recommendations are sound and the illustrations clear and adequate. The information on methods of supporting fixtures is fuller than usual, and the treatment of lighting calculations, aided by practical examples, quite good, within its limits.

Although the main title of the book is "Interior Wiring," a large proportion of it is concerned with other matters. For example, the section dealing with illumination occupies nearly a third of the whole. This is followed by a smaller section dealing with electric motors and their control, in which brief descriptions are given of the various types of motor available. Motor performance, starters and controllers receive attention, and, finally, there is a chapter on the selection of motors for industrial purposes.

Part III. deals with interior wiring, and occupies about half the book. To a large extent this refers to systems which are not of particular interest in this country, such as the knob and tube system. The treatment is on the usual lines; but, apart from the descriptive matter, it includes chapters on the calculation of direct and alternating current systems, and a number of examples are given illustrating the methods which should be adopted. A considerable amount of information is given in appendixes, such as the performance of lamps, power requirements, temperature ratings and overloads, power factor, skin effect, &c. The book should be found generally useful to those who are engaged in installation work.

Form Factor.

By F. M. DENTON, A.C.G.I.

Summary.—This article points out that the commonly accepted statement that a peaked wave has a higher form-factor than a flat-topped wave is often wrong. It discusses the bearing of form-factor upon iron loss, and finally describes a simple form of apparatus by means of which waves of voltage may be produced having a very wide range of form-factors and the values of these form-factors demonstrated.

The form-factor of a wave is defined as the ratio of the root-mean-square ordinate to the mean ordinate. Thus, the form-factor of a sine wave is $(\pi/2\sqrt{2})$, or 1·11, while that of a V-shaped wave is $(2/\sqrt{3})$, and that of a full flat-topped rectangular wave unity.

If two waves be considered of equal area and wave-length, and so of equal mean ordinate, the one which has the greater mean squared ordinate will have the greater form-factor.

To square a quantity is to multiply it by itself; hence, to square a small quantity is to multiply it by something small, while to square a large quantity is to multiply it by something large. Thus, the effect of squaring all the varying ordinates of a wave is much greater upon the long ordinates than upon the short ones, and that wave will have the greatest mean squared ordinate which has the greatest percentage of long ordinates. This simple common-sense reasoning may be resumed in the words: *A peaked wave has a greater form-factor than a flat-topped one.* But, like so many of the results deduced from simple common-sense reasoning, and expressed in language that everyone can understand, this is a vague and misleading, if not an actually incorrect, statement.

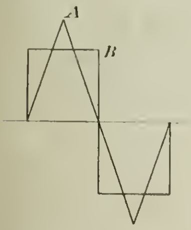


Fig. 1.

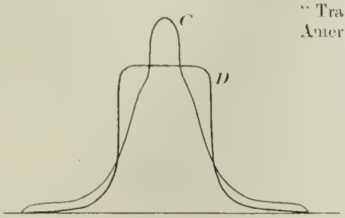


Fig. 2.

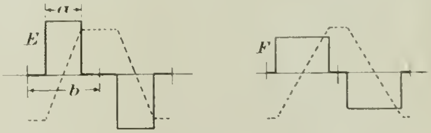


Fig. 3.

The weakness in the argument lies in the vagueness of the expression "the greatest percentage of long ordinates," and that of the statement lies in the lack of definition of the terms "peaked" and "flat-topped."

The wave *A* of Fig. 1 is "peaked" in comparison with *B*, and it proves to have the greater form-factor; but the obviously peaked wave *C* of Fig. 2 has actually a smaller form-factor than the flat-topped wave *D*, and a sine wave has a smaller form-factor than the wave of Fig. 3, in which the ratio (b/a) is, say, $(3/2)$.

In order, then, that the commonly accepted statement, by which the peakiness of a wave is associated with a high form-factor and flatness with a low, some definition ought to be found for the terms peaked and flat which would permit of the wave *D* being recognised as more "peaked" than *C* in Fig. 2.

The practical importance of this matter is seen when considering the bearing of wave shape upon iron loss.

It is a well-known fact that with a given root-mean-square value of applied voltage the hysteresis loss in a transformer is lower when the form-factor of the wave of applied voltage is high than when it is low. But with the present vagueness or lack of definition of the terms peaked and flat this statement about iron loss is not satisfactorily expressed by saying that a peaked wave of E.M.F. gives lower iron loss than a flat-topped wave. For with a given root-mean-square value of the applied voltage the wave shape *D* would give a lower hysteresis loss than *C*. Nevertheless, such a statement is often made by good authorities, as, for instance, by Chubb, who, in his Paper "Transformer Core Losses," read in June, 1909, before the American Institute of Electrical Engineers, says: "A peaked wave of voltage will cause a lower core loss and a flat wave a higher loss than a sine wave of the same effective voltage."

If we examine two such waves of E.M.F. as *E* and *F* in Fig. 3, the reason of the rule connecting hysteresis loss with form-factor becomes apparent.

Neglecting resistance drop in the windings of a transformer, the application of any wave of E.M.F. results in a wave of flux whose slope at every instant is equal to the ordinate of the applied E.M.F. wave at the same instant. The dotted curves in Fig. 3 show the waves of flux produced by the E.M.F.s *E* and *F*.

Now since the rate of growth of the flux is proportional at each instant to the ordinate of the E.M.F. wave, the maximum value to which, in each half wave, the flux will grow must be proportional (since it equals the product of rate of growth and time) to the area of the E.M.F. wave. But at a given value of the frequency over a wide range the hysteresis loss depends on the maximum instantaneous value reached by the flux; it depends, therefore, on the area of the E.M.F. wave. And, since the area is proportional to the mean ordinate, it follows that E.M.F. waves of given frequency having equal values of the mean ordinate result in equal hysteresis loss in the core of the transformer. Or for waves of E.M.F. of equal root-mean-square values the hysteresis loss will be less when the mean ordinate is less—that is to say, when the form-factor is greater.

It should be noted that this rule about hysteresis loss is true for all wave shapes of E.M.F., whether flat, peaked or indented, provided that the ordinates of each half-wave are of like sign—that is to say, that no indentation of a positive half-wave passes below the zero line, or of a negative half-wave above.

In practice it is seldom that waves of E.M.F., employed for commercial power supply, have form-factors varying greatly from that of a sine wave; but for purposes of demonstration it is sometimes desirable to obtain wave shapes having excessive form-factors. In such cases use may be made of the simple rectangular form of wave shown in Fig. 3. If the amplitude of such a wave be called unity, the width "a" and the length of the half-wave "b," the mean-squared ordinate will equal the mean, each being (a/b), and the form-factor will be the square root of (b/a). Thus, by narrowing the wave, b/a, and so the form-factor, may be made as great as is desired.

By aid of a rotating contact-maker a pulsating wave of current equivalent to a series of half-waves, like the positive half of Fig. 3, *E* or *F* may be sent, from a continuous-current source of supply, through a circuit consisting of a high ohmic resistance (to reduce the time-constant of the circuit) in series with two instruments of approximately equal range, one a root-mean-square instrument and the other an instrument of the ordinary permanent magnet type used for continuous current.

The instruments having been calibrated to give equal readings when the contact-maker is at rest, it will be found that on pulsating current variation of the relative duration of contact for each pulsation will make the root-mean-square instrument give readings differing widely from those of the permanent magnet instrument.

It is quite practicable, using a small cylindrical contact-maker, to obtain values as high as 30 for the ratio b/a—Fig. 3. The root-mean-square instrument then gives over five times the reading of the permanent magnet instrument.

In conclusion, it is perhaps worth while to mention that any rotary converter provides an interesting means of demonstrating form-factor. The P.D. between one brush on the continuous-current side of a rotary converter and one slip-ring on the alternating-current side is a pulsating one. Current sent from such a pair of points through a root-mean-square and a permanent-magnet instrument in series usually shows a difference of a good percentage between the two readings. If an oscillograph is available, the result may be compared with that obtained by examination of the actual wave shape. In the ideal case, in which the E.M.F. induced in each bar of the armature would be sinusoidal, the P.D. between the brush and the slip-ring would be a sine wave raised so as to stand upon the zero line, and the form-factor of the succession of positive half-wave thus produced would be $\sqrt{3/2}$, or about 1·23.

How the Progress Department Assists.

II.—The Costing and Rate Fixing Departments.

By W. J. HISCOX.

To the Costing and the Rate Fixing Departments the Progress Department can be of the utmost value, if its services are utilised to the fullest extent, and many firms, which in the past have almost despaired of obtaining anything approaching accuracy in their costs accounts, now rejoice in the fact that they can obtain figures which can be relied upon, thanks chiefly to the systematic co-operation of their Progress Department.

It is a most difficult matter to obtain reliable figures for any recording purpose in a badly organised factory, and in such a case instances are numerous where figures are "arrived at." This in itself defeats the whole object of the record, and the factory would be infinitely better off without it. With regard to costing, certain figures have been obtained at some remote age, and these are used time and again in connection with subsequent orders covering a similar class of material, thus giving no indication as to whether costs have increased or decreased.

In costing departments, the officials of which are conscientious in the discharge of their duties, the energy expended and the cost incurred in obtaining correct figures is out of all proportion to the result achieved. It often happens that these officials spend many hours per day running about the factory in search of the information which, in a properly organised factory, would automatically come to them.

The Progress Department stands for system and organisation, and immediately upon establishment its influence is felt by every department in the factory. On the surface there seems to be no connection between progress and costing, but actually the bond existing between the two departments is very strong. Every order in the factory is handled, first by one and then by the other of these two departments, and it is fairly obvious that the last department handling the order must to some extent be affected by the method by which the order was handled by the previous department.

This in itself provides better facilities for record keeping, but the assistance afforded by the Progress Department goes much further. To secure the maximum results, however, the department must be thoroughly exploited, which means that it must be understood and appreciated. This statement is made advisedly, as the writer is convinced that the Progress Department is not appreciated by the cost keepers as it should be, and as a result the full advantage is not taken of the assistance it can render.

It is generally understood that the Progress Department controls delivery and output, and that its object is to get as much stuff as possible out of the factory in a given time. Whilst this is true in the abstract, it must not be forgotten that cost is a most important factor, and cannot be disregarded, even by the Progress Department. During the war cost was at a discount; delivery was the only thing that mattered so long as the article was hustled through the factory, the question of cost did not matter, for the firm had but one customer—the Government; and so long as he got the goods to time, that customer was willing to pay. Now, however, the aspect is quite different. Competition once more enters the arena, and with competition comes cost. Delivery is there also, but where, during war time, delivery stood alone, it is now bracketed with cost for the premier honours, and the firm to succeed is the firm which can deliver quickly and at a low cost.

Many progress departments flourished exceedingly in war time, when delivery was the only thing to be considered; but they are being rigidly tested now, and some of them will not pass that test. It is one thing to put a job on a machine, pull it down, and set up for another, regardless of expense, simply because the latter job must be out of the factory first; but it is quite another thing for the progress man, with the question of cost ever before him, to plan his arrangements in such a way as to permit the most urgently required order receiving priority at all stages, and without exceeding the prescribed cost.

It is in this connection that the value of the Progress Department to the Rate Fixing Department becomes apparent. In the factory where the rate-fixing is in the hands of the departmental foremen, these latter will often take risks and incur extra costs in order to meet the demands of the progress man; the result being that figures are often juggled with, and an extra burden thrown upon the costing department. Where there is an official Rate Fixing Department, however, this is not so prevalent, as any deviation from the given rate must be satisfactorily explained.

The rate fixer is responsible for fixing the time in which a given operation shall be performed, and it is up to the Progress Department to so arrange deliveries as to ensure that no rate-fixing times shall be exceeded. This, of course, refers only to the question of delivery, and not to departmental causes, which from time to time have an adverse effect upon the estimates of the rate fixer. It is well for the progress man to leave no loopholes, otherwise these will be taken advantage of by unscrupulous foremen, who are not above crediting "delivery" with excess costs which have in reality been occasioned by the mismanagement of the foreman himself.

The efficient handling of detail by the Progress Department is the surest guarantee that the times as given by the Rate Fixing Department will be observed, and this obviously will simplify considerably the work of the Costing Department. It is necessary, therefore, for the Progress Department to be in possession of all information regarding time estimates, as this will be to the advantage of not only the rate fixer, but to the Progress Department also, inasmuch as it will be a valuable guide in planning deliveries.

The demands of the Progress Department upon the various productive departments are a great aid to economical production, for to meet these demands it is often necessary to devise quicker methods of working, resulting in a lower cost for a higher output. Thus is progressive policy maintained.

The troubles of the Costing Department are not confined to labour costs, for the question of material must also be taken into consideration. Here, again, in the unorganised factory, excess material is often utilised without the fact being recorded, and, even when this is obtained upon a foreman's requisition, much time and trouble is expended before the costing department can obtain anything like reliable information.

The Progress Department handles this problem in a systematic and business-like manner. At the outset, the precise amount of material necessary for any given component is tabulated, and this amount is issued from the store in due course. A record of this material automatically goes to the Costing Department, and, should the job go through without comment, the material cost is posted accordingly. Should, however, the material be scrapped, either through a flaw or through the fault of the operator, this fact is made clear upon an inspector's report, and a further supply of material is issued. A copy of the inspector's report, together with particulars of the subsequent issue of material, is sent to the Costing Department, and the information derived from this source will enable that department to apportion the costs accurately.

In some factories a certain proportion of losses occur in the various departments, and to replace these, of course, extra material is needed. The same procedure is adopted here as in the case of scrapped work, the extra costs on this count being charged against the foreman of the department. The question of work sent back for rectification can be handled quite easily by the Costing Department, as the inspector's report again gives all particulars, and unless the rectification is consequent upon some circumstance beyond the control of the operator, the work must be done on the original order, at the operator's expense.

It is the never-ceasing vigilance of the progress man that enables the Costing Department to obtain such definite and reliable information for his constant association with the detail at every stage, and the systematic methods he adopts, precludes any possibility of juggling. He works strictly in accordance with the system prevailing in the factory, and for his own sake he must take every precaution to ensure the speedy completion of any part in which he is interested. His records are such as will enable him to gauge the whereabouts of any given article at any time, and under such conditions it may be inferred that anything affecting the production of the article in question must speedily receive his attention.

All this surely shows that the assistance rendered by the Progress Department to the Costing and Rate Fixing Departments is considerable, and must have a most favourable effect upon the efficiency of these departments. The rate fixer, having estimated the time, naturally expects this time to be adhered to, and he sees no reason why delivery should upset his estimate. The cost keeper has the right to expect that the information at his disposal can be relied upon, and he should not be called upon to perambulate the factory in search of information which should come to him as a matter of course. The co-operation of the Progress Department should obviate these troubles.

Correspondence.

THREE-ELECTRODE VACUUM TUBES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: It is interesting to observe the large and ever-growing percentage of papers published in the electrical journals of to-day which deal with the three-electrode vacuum tube, and its multiform applications. It is almost impossible to pick up an electrical journal to-day without finding some such article. Your issue of September 19th contains digests of two interesting Papers by Dr. Eccles and Mr. Jordan read before the recent meeting of the British Association.

Apropos of the Paper entitled "A Method of Using Two 'Triode' Valves in Parallel for Generating Oscillations," I should like to point out that the symmetrical arrangements of two audion bulbs, or of one audion bulb embodying one filament, two separate plates and two separate grids as therein shown and described, are old, as inspection of the following U.S. patents issued to me will show:—

1,221,035, issued April 3, 1917, filed April 9, 1915.
1,311,264, issued July 29, 1919, filed September 4, 1915.
1,314,253, issued August 26, 1919, filed October 12, 1916.

All of these patents are based on work with the symmetrical double bulb, with one grid connected to the opposite plate, or with two simple audions with their elements similarly intermesh connected, which I began in 1914. At that early date I found that the inter-mesh connection of double plate and grid audion have greatly enhanced oscillating efficiency.

Regarding the ever-recurring new terminology, I had supposed that the lexicographers of the General Electric Company had practically exhausted the field for audion disguises, and therefore note with interest that Dr. Eccles has been able to add another name to the long list. As a matter of fact, I rather like the word "Triode." But why add to it that ancient misnomer "Valve?"

Certainly, enough is now recognised regarding the desirability of working the audion on the straight line part of its characteristic, to remove any excuse for still mis-styling the oscillating audion and amplifier as a valve, Fleming or otherwise.—I am, &c.,

New York, Oct. 4. Lee de Forest.

The Trinidad Asphalt Lakes.—The Trinidad pitch or asphalt lakes have long been a subject of interest from the scientific standpoint on account of the opportunity they present for studying the behaviour of large masses of plastic material. The "Engineering News Record" describes some sounding tests undertaken on the lakes with rather curious results. Although the asphalt appears to be of a substantially uniform character down to a depth of 150 ft., the slow continuous movement of the material makes accurate sounding very difficult. The pressure of the asphalt causes the drills to bend, and, what is curious to observe, the direction of motion appears to reverse at a certain depth below the surface—a phenomena which is akin to the circulatory system in a vessel of boiling water.

The International Electrotechnical Commission.

As announced in our last issue, the International Electrotechnical Commission has now resumed its full activities. No meetings were held during the war, but the central organisation has been maintained intact. Now that Peace has come again, reconstruction is occupying its attention, and in order to make quick progress, in spite of the difficulties of transport, it was decided to hold a meeting in London. This meeting was opened last Monday at the Institution of Civil Engineers by Mr. Maurice Leblanc, the President of the Commission, 18 countries being represented by some 52 delegates.

Sir Richard Glazebrook, C.B., in welcoming the foreign delegates on behalf of the British National Committee of the Commission, of which he is Chairman, regretted the fact that Mr. A. J. Balfour, who had addressed the delegates in 1908, was most unfortunately unable to be present on this occasion; he had, however, written expressing the keenest interest in the work, and it was Sir Richard Glazebrook's hope that he might yet be with the delegates before the close of their meetings. Sir Richard then referred to the pioneer work in electrical standardisation carried out by the Electrical Standards Committee of the British Association, of which for many years he had acted as Secretary. This work had been international in its character and had laid the foundation for the industrial superstructure which the Commission was now endeavouring to complete. In Great Britain the British Engineering Standards Association was responsible for electrical standardisation, and overlapping of effort was entirely avoided by the fact that the Sectional Electrical Committee of the Association was, *ipso facto*, the British section of the International Commission.

Mr. Roger Smith (President elect of the Institution of Electrical Engineers) also extended a very hearty welcome to the foreign delegates, and Mr. A. R. Everest, on behalf of the British Electrical and Allied Manufacturers' Association, joined with the previous speakers in offering the industry's cordial greeting to the eminent electrical engineers present.

MR. MAURICE LEBLANC.
President of the I.E.C.

Mr. Maurice Leblanc, the President of the Commission, then gave an interesting address, in the course of which he referred to the fact that the Commission owed its inception to the Chamber of Delegates at the St. Louis Congress in 1904, at which Col. R. E. Crompton, C.B., had initiated the movement. He mentioned the fact that the late Lord Kelvin had been the first President. He also referred to the losses which the world of science and electrotechnics had sustained through the passing away of Dr. Silvanus Thompson, F.R.S., Prof. Eric Gerard, of Belgium, Mr. W. Duddell, F.R.S., Prof. Jona, of Italy, and Mr. Von Krogh, of Norway. He also spoke of the great problems of reconstruction which lay before the electrical industry of the world, and mentioned the surprise it had been to him to realise how quickly his beloved country, France, had, during the war, become a national workshop, and he felt sure that they would be able to turn the experience they had gained through the manufacture of munitions to the manufacture of the engineering appliances required in every-day life. He referred to the tremendous sacrifices which had been made by the Allied Nations to obtain this great liberty, and hoped that in the future those who had suffered would, in some proportion obtain the freedom and better conditions for which they had fought. He wished the Commission every success in the work which lay before it, the most important of which was the establishment of an agreed basis for the comparative rating of electrical machinery and apparatus.

Mr. C. H. Wordingham, C.B.E., President of the Institution of Electrical Engineers, replied to the address and expressed the pleasure they felt at having as their President an honorary member of that Institution. He remarked that while the Allied Nations had suffered most grievously in the war, the neutral nations, a number of whom were represented at this meeting, had also suffered very severely. He felt sure that the glorious nation of which the President was the honoured representative, would be unsurpassed in the period of reconstruction as it had been unsurpassed in the war.

Mr. Guida Semenza, past President of the Italian Association of Electrical Engineers, and one of the founders of the Commission, in thanking the British Committee for their welcome, expressed on behalf of the foreign delegates the pleasure it was to them all to be present at this meeting, and take part in what he felt was of immense importance to the future welfare of the electrical industry of the world.

Dr. C. L. Mailloux, President of the United States Committee, who through his linguistic ability, had from the very inception of the Commission been of the greatest service to the movement, acted as interpreter during the proceedings. At the close of the meeting, on behalf of the American delegation, he suggested that the next meeting of the Commission should be held in the United States of America, where he knew the delegates would, one and all, be certain of receiving a very hearty welcome.

Mr. Brylinski, President of the French Committee, supported Dr. Mailloux's suggestion, and it is probable that at the Plenary Meeting, which is to be held on Wednesday next, this proposal will be adopted.

A whole day is to be taken up in the consideration of questions of reconstruction. In addition to this, a special Committee on the rating of electrical machinery is meeting continuously in order to push forward this work, which is considered of the highest importance to the electrical industry, more particularly to its export trade, and in regard to which the definite proposals of the Commission are eagerly awaited. It is interesting to note the increasing attention which is being given to the work of the International Electrotechnical Commission by the manufacturers of the world who are now co-operating in the preparation of standards which are certain to be of immense utility to international commerce.

The following is a list of the delegates present at the meeting:—

Australia	Mr. G. H. Knibbs, C.M.G.
Belgium	M. E. Gevaert, M. le Prof. A. Halleux.
Brazil	M. M. de Oliveira.
Canada	Mr. A. P. Trotter.
Chili	Eng. Com. Don Roman Suarez. Eng. Lt. Mgueles.
Denmark	Prof. Absalon Larsen.
France	M. E. Brylinski, M. Paul Boucherot and M. David.
Great Britain	Sir Richard Glazebrook, C.B., Mr. F. M. Chapman, Mr. J. E. Edgecombe, Mr. A. R. Everest, Mr. C. Rodgers, Dr. A. Russell, Capt. H. R. Sankey, C.B., R.E., Mr. C. P. Sparks, Capt. J. Slee, R.N., Sir Wm. Slingo, Mr. Roger T. Smith, Mr. A. J. Stubbs, Mr. C. H. Wordingham, C.B.E.
Holland	M. Barnet Lyon, M. le Dr. de Haas.
India	Mr. Maurice G. Simpson.
Italy	Signor Guido Semenza, Prof. Morelli.
Japan............	Mr. Motosuke Masuda, Mr. Motoo Uchisaka.

Mexico	Senor Ing. D. Arturo Pani.
Norway	Eng. J. C. Holst.
Poland	M. Czainomski.
Portugal	Colonel J. Lucas, Mr. E. S. Lane.
Switzerland ...	Mr. Huber-Stockar, Mr. A. de Montmollin.
U.S.A.	Dr. C. O. Mailloux, Messrs. Burke, Hobart, Chubb and Kemble.

The following members of the British National Committee were also present :—Lt.-Col. Robertson, R.E., Mr. J. H. Bowden, Mr. W. McClelland, Prof. T. Mather, Mr. W. M. Mordey, Mr. G. Scott Ram, Mr. W. R. Rawlings and Mr. P. F. Rowell.

On Tuesday the delegates were entertained to dinner by the British National Committee, the Council of the Institution of Electrical Engineers and the Council of the British Electrical and Allied Manufacturers' Association. The chair was taken by Sir Richard Glazebrook, C.B., President of the British National Committee, and the principal guest was the Right Hon. A. J. Balfour.

After the toast of "The King" had been honoured, followed by that of the "rulers of other countries" represented by the Commission, Sir **Richard Glazebrook** gave a brief outline of the work which the Commission had carried out. He remarked that the father of standardisation must be regarded as Sir. John Wolfe Barry, who was the first to put the subject on a satisfactory basis. This work was laid before the Congress at St. Louis by Col. Crompton, who thus started the present I.E.C. At Turin the British Government first gave the Commission recognition, and in 1913 important work was carried through at Berlin, and further work was to have been ratified in 1915 at San Francisco. Owing to the war this programme naturally fell through, and the delegates were now faced with the work of gathering the threads together once more so as to continue their activities. Various reports had been prepared which it was hoped would be adopted, but in his opinion the really great work of the Commission was in the drawing together of representatives of all countries to aid in the common progress. It was perhaps sometimes forgotten that only general principles could be adopted in matters of this kind, and that freedom should be left to the various countries to elaborate details as befitted best each indiviual country concerned. Sir Richard then asked Mr. Balfour to be so good as to express a welcome to the delegates as he had done once before in 1908.

Mr. A. J. **Balfour** remarked that it was 20 years ago when, as Prime Minister, he met Sir John Wolfe Barry, to discuss the question of standardisation, and this was the beginning of any support of this great and useful movement on the part of the British Government. He had been fortunate enough to have another opportunity of meeting those interested in the problem in 1908. Since then a world tragedy had been upon us, but their meeting this week was a most successful attempt to do something to reknit the broken threads of the Association's work. Standardisation was a great labour-saving movement, having for its object the elimination of waste and unnecessary individualism. It might be objected that standardisation would do away with individual originality, on the development of which progress very largely depended. This danger must be guarded against, and nothing must be permitted to prevent the progress of human ideas. If this danger were kept in view, then standardisation must mean an immense saving of unnecessary effort. In electricity particularly it was most important not to hamper individual ingenuity. In his opinion standardisation had a great bearing on the distribution of the product of human industry. He expressed the firm conviction that the distribution of what was annually produced—for it was on what was produced annually we lived from day to day—was nothing compared with the amount there was to distribute. If the products of the industries of the world could be increased more would be obtained by making human industry efficient, than by individualistic effort, however good, if undirected. If men of science could increase production in this way they would do more to increase the well being of mankind than those who filled the newspapers were usually ready to admit. In his opinion this was the great panacea. The work done by societies like the I.E.C., unaccompanied by much public attention, would do much more for mankind than many other efforts which were receiving great attention. In conclusion, he wished success to the Commission and congratulated them heartily on what had been accomplished.

Mr. **Maurice Leblanc**, President of the Commission, in expressing his thanks for the way in which they had been received, felt it was a great honour to be present on that occasion. He remarked that Mr. Balfour was as popular in France as in England.

Mr. G. **Semenza** said he felt so much at home that it was difficult to find suitable terms in which to express their thanks. As Chairman of the Italian Committee, and as one of the oldest members of the Commission, he referred to the early scepticism with which the proposals to form the Commission had been met, and the original faith in which Col. Crompton felt certain that good results would be realised.

Remarks were also made by Mr. E. **Brylinski**, President of the French Committee, and Mr. **Huber-Stockar**, President of the Swiss Committee. The latter remarked that he was indeed thankful that it was possible to meet once again under normal conditions. During the war it had been difficult to express opinions without the fear of being misunderstood. Now, however, there need be no longer any fear of opposing the opinion of a friend if that appeared the proper course to take.

Col. R. E. **Crompton** remarked that the object of such meetings as the present one was to undo the great shell shock of Babel and to bring the nations together instead of having them separated. War would be impossible if nations were on sufficiently intimate terms, and thus the remedy was very simple, namely, all round friendship and each man doing his best for all concerned. Standardisation was international camaraderie. It was a means of doing service to others and was, therefore, of the greatest importance.

Dr. C. O. **Mailloux** (President of the American Committee), who, as usual, had a very busy time in translating the various speeches for the benefit of those who were restricted in their knowledge of English and French, expressed great appreciation on behalf of the delegates of the way in which they had been received. He felt that Mr. Balfour's words were inspiring, as they had been in 1908, and as they were also in 1916, when he (Dr. Mailloux) was privileged to be a member of the Committee to receive the Anglo-American Commission, of which Mr. Balfour was one of the members.

A brief response by Sir **Richard Glazebrook** and an expression of thanks to the Chairman by Col. **Crompton** brought the proceedings to a close.

Gattie Transport Scheme.

At the sitting of the Departmental Committee on the 15th inst., Sir Francis Dent, general manager of the South-Eastern & Chatham Railway Company, said that the result of the present system, as it affected the London & North-Western Railway, was that normally 90 per cent. of the wagons for London from that line arrived in London on the day of dispatch or the day after. The figures to-day were very nearly as good as they were before the war. Generally speaking, the greatest cause of delay in railway traffic was not in transit, but arose from the fact that the railway companies could not get rid of the traffic quickly enough after it had arrived. The New Transport Company's estimate for road-cars was £1,600,000, but the railway companies' estimate was £7,000,000. Over 14,000 motor-lorries would be required and a large London private carrier estimated 27,000 motor-lorries. He thought the estimate of 30,000 containers much too low. The calculation of London traffic was 64,000 tons. Although the container would be nominally a 3-ton container, the average load would be $1\frac{1}{8}$ tons. On the basis of $1\frac{1}{8}$ tons, 57,000 containers would be required to deal with 64,000 tons of traffic in London. He also challenged the estimate of £855,360 for the construction of tubes. The railway companies' estimate for such tubes, including service lines, was £10,000,000. The total capital required would be £33,000,000.

In cross-examination, the witness agreed that while alteration of the law relating to railways would be desirable in some directions, he thought it would be unreasonable to alter it, because it would alter the habits and customs of traders. The British railways were the only railway organisation which survived the war. That was to say that in every other country engaged in the war, and in some neutral countries, the administration of the railways had to be entirely altered during the war.

The inquiry was adjourned till to-day, (Friday).

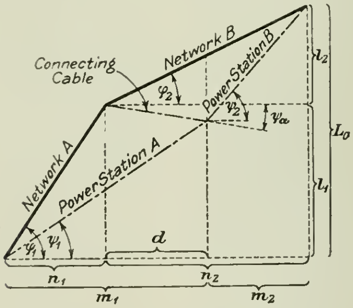
State Electricity.

The Home Secretary (Mr. E. Shortt), who gave an address on "State Electricity" at a meeting of the Eighty Club last week, stated that electricity was required in this country more than any other power. Electricity was wanted for the development of agriculture, and in all the problems of industrial competition with other nations, as well as in those of transport and housing. Very few people who were engaged in industrial pursuits really thought out the agricultural question. The country must be made self-supporting, not by artificial means and State bounties or by means of tariffs, but by making the system of agriculture more efficient and more complete. And that largely depended upon the cheap and organised production of electrical power. Complete and efficient transport could only be run by means of electricity, and the housing of working men in decent neighbourhoods was also a question of transport. One of the great objects was the generating of power for a smaller consumption of coal than at present. For the development of 1 H.P. per hour at present $7\frac{1}{2}$ lb. of coal was required. With proper organisation and with proper use of all the scientific knowledge that the country possessed it ought to be possible to generate that amount of energy for something like 2 lb. The water-power of this country could be used to a much greater extent, and the fact that many of the great industrial nations of the world were able to make use of water-power, and so to produce more cheaply than England could was an important consideration in the question of future competition. The Bill at present before the House of Commons would deal with the whole question of electrical development, but there was no desire whatever to take away local control, enterprise and energy.

The Working of Power Stations in Parallel.*

By G. BRECHT.

If power stations work in parallel and are joined by connecting cables to one another there are, generally speaking, differences in loads and power factors. Let us suppose there are two such stations, of which A generates 4,000 kw. and B 2,000 kw., while the load on A is 2,000 kw. and on B 4,000 kw. Then the connecting cable carries 2,000 kw. Let the power factor in the network of A be 0·554 and in that of B 0·894. Nothing is therefore fixed about the power factor in the connecting cable. In practical work the distribution of the load between two stations generally depends on the capacity and efficiency of the available generators, and similar considerations involving the availability of fuel, the convenience of the attendants, the peaks of the load, &c.; and it may be remarked that questions of general efficiency are apt to give way to convenience in working. But these things are not the immediate point under consideration. A vector diagram shows that, according to the excitation, there are various ways in which the needs of A and B can be met; but the different methods of distributing wattless current are not all equally desirable. It may be said in quite general terms that the phase displacement in the connecting cable decreases if the excitation in the station which furnishes the excess of power is decreased, or in the station which receives the power, is increased. The one station can improve its own power factor at the expense of the other station by weakening its excitation. This can be done by either station, intentionally or unintentionally. The one station may run with a power factor of unity and leave all the wattless current for both networks to be supplied by the other.



When two stations work in parallel under contract, it is usual to determine the wattless current and to make agreements with respect to it beforehand. Thus, if the one station supplies to the other an excess of wattless current over the corresponding power current at an agreed power factor—say 0·7—it is compensated accordingly at a rate agreed on. This plan sounds fair and seems to be in the general interest. It is impossible to determine on any scientific basis what is the precise value of a wattless kilowatt-hour; the compensation must thus be fixed on some arbitrary basis. The question, however, arises as to the power factor which can be taken as a datum time. It has been suggested that it should be taken as the average power factor of the network to which the power is supplied: but the author proposes to investigate the matter, holding this view to be wrong.

Let us consider the conditions shown in Fig. 1. Here the power stations A and B have capacities m_1 and m_2 in power-kilowatts; the respective networks absorb n_1 and n_2 in power-kilowatts; the wattless outputs are l_1 and l_2, and the apparent outputs are

$$\frac{n_1}{\cos\varphi_1} \text{ and } \frac{n_2}{\cos\varphi_2} \text{ in kilovolt amperes.}$$

The connecting cable carries $m_1 - n_1$. Over the whole system the total wattless output is $m_1 \tan\psi_1 \quad m_2 \tan\psi_2$. How ought the wattless output to be divided between the two stations? How, in fact, are we to reduce the losses in the two stations and in the connecting cable to a minimum? In the generators the following losses depend on the power factor—viz., the losses in excitation, the losses due to hysteresis and eddy currents, and the ohmic losses in the armature. So long as the machine is not so excited that the current leads, then all these losses increase with the current given out by the generator. With the transformers and the connecting cable, only ohmic losses are to be considered. The ohmic losses are, therefore, the deciding factor. Let w_1, w_a and w_2 be the ohmic resistances in the station A, in the connecting cable and in station B. Then the losses are

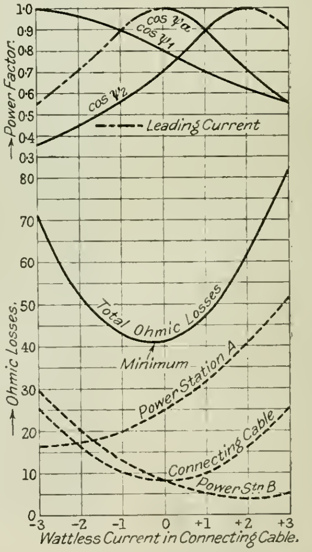
$$w_1(m_1^2 + m_1^2 \tan^2\psi_1) + w_2(m_2^2 + m_2^2 \tan^2\psi_2) + w_a(d^2 + (l_1 - m_1 \tan\psi_1)^2)$$

And it can be shown that, if these losses are to be a minimum,

$$\tan\psi_1 = \frac{\beta L_0 + \gamma l_1}{m_1}; \qquad \tan\psi_2 = \frac{\alpha L_0 + \gamma l_2}{m_2};$$

$$\tan\psi_a = \frac{\beta l_2 - \alpha l_1}{d},$$

where α, β and γ are the ratios of the respective resistances to the total resistance of the system. The connecting cable must, therefore, carry a wattless output of $\beta l_2 - \alpha l_1$ in addition to the power output d. The wattless output of the two stations is also given by the above equations. This, of course, solves the problem theoretically; it remains to consider it from the practical standpoint.



The coefficients α, β, γ are constants which can be calculated under known conditions, their values being positive and less than unity. If the two power stations are similar, then $\alpha = \beta$, and both are less than 0·5. The connecting cable generally carries a fairly heavy current in relation to its size, so γ is usually greater than α. If $\gamma = 2\alpha$, and $\alpha = \beta$, then α and β will be equal to 0·25. This gives a general insight into the probable magnitude of the various constants. The above equations show that when the losses are a minimum the

Wattless current.			Power factor.			Ohmic losses.			
Connecting cable.	Station A.	Station B.	Connecting cable.	Station A.	Station B.	Connecting cable.	Station A.	Station B.	Total.
+3·0	6·0	−1·0*	0·554	0·554	0·894*	26·0	52·0	5·0	83·0
+2·0	5·0	0	0·707	0·625	1·0	16·0	41·0	4·0	61·0
+1·0	4·0	1·0	0·894	0·707	0·894	10·0	32·0	5·0	47·0
+0·33	3·33	1·67	0·986	0·768	0·768	8·22	27·11	6·78	42·11
+0·25	3·25	1·75	0·992	0·776	0·753	8·13	26·56	7·06	41·74
0	3·0	2·0	1·0	0·8	0·707	8·0	25·0	8·0	41·0
−0·25*	2·75	2·25	0·992*	0·824	0·664	8·13	23·56	9·06	40·75
−1·0*	2·0	3·0	0·894*	0·894	0·554	10·0	20·0	13·0	43·0
−2·0*	1·0	4·0	0·707*	0·970	0·447	16·0	17·0	20·0	53·0
−3·0*	0	5·0	0·554*	1·0	0·371	26·0	16·0	29·0	71·0

Note.—An asterisk is attached to leading currents.

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* Abstracted from the "Elektrotechnische Zeitschrift," No. 12, 1919.

phase displacement in the connecting cable will decrease as the load along it increases; it will also depend on the ratio of its resistance to the other resistances. This result is at variance with the ordinary view. The equations also show that a leading current in the connecting cable will be an advantage if βl_2 is greater than αl_1. This case may often arise. A consideration of the particular case mentioned in the first paragraphs of this article may, perhaps, further explain the matter. Let us suppose the watt-currents to be $n_1=2$, $m_1=4$, $n_2=4$, $m_2=2$; the wattless currents $l_1=3$, $l_2=2$; the resistances $w_1=1$, $w_2=1$, and $w_a=2$. Then the following table gives the ohmic losses arranged according to the wattless currents carried by the connecting cable, with a power factor 0·554 in network *A* and 0·894 in network *B*.

The minimum ohmic losses are 40·75, as shown in the last line but three of the table; the power factor in station *A* is 0·824, in station *B* 0·664, and in the connecting cable 0·992, with a leading current in the connecting cable. This is shown graphically in the vector diagram in Fig. 1. The case is also shown in the curves of Fig 2. Under other conditions of load, naturally there would be a different solution. With a set of conditions in which the loads were constantly changing, exact results in attempting to reach the minimum losses would, of course, be impossible; but a good deal would be known from experience. If an attempt were made to keep the power factor in the connecting cable equal to the mean of the power factors in the two networks, then the total ohmic losses would be 55, which is 35 per cent. above the minimum. If the power factor in the connecting cable were made equal to that in the network to which power is transferred (which is the view held by some authorities), then the losses would be 47, which is 15 per cent. above the minimum. Practically it is advisable to keep the average wattless output in the neighbourhood of the average value of $\beta l_2 - \alpha l_1$; small differences in the exactitude of the balance have little effect on the result.

The author adds a note as to methods by which two power stations, supplying power to one another under contract, may adjust their accounts by a comparison of readings on sine meters and wattmeters. This would have to be done by reckoning the number of wattless kilowatt-hours which the one had supplied to the other, and an instance is given of the way in which these adjustments could be made. The working of power stations in parallel has been much developed in late years, and is likely to be further extended. And in this case the question as to the most suitable division of the wattless current is likely to become a matter of importance.

Should Wages Be Reduced?*

By E. J. P. BENN.

A broad survey of the present industrial and commercial position does not appear at first sight to justify optimism. Stagnation, hesitancy, uncertainty, inaction are the leading characteristics of the industrial world at the moment. Prices are outrageous. On the one hand there are a million people out of work, and on the other employers who complain of the difficulty of getting labour. No long contracts are being made, and this is, perhaps, the most striking difference between the industrial world of 1914 and that of to-day, as industry depends to a larger extent than is generally known upon forward contracts. Different people place the blame for this in different quarters; some talk of labour unrest, others complain of profiteers, others again put the major blame upon the new scheme of Government control, which has paralysed industrial activity. More important than any of these is, however, the attitude of mind into which we have allowed ourselves to sink. The individual is most to blame for the absence of that fresh start of industrial activity. There is in all quarters a feeling of grievance about, and so long as this exists we shall not be in a position to put forward our best in industry or in any other walk of life. We seem to have lost that will to work which is essential to the birth and maintenance of the new world. It is necessary to bear these considerations in mind in approaching the problem of wages, because wages and work and service are things which bear a very definite relation one to another.

The theory now is that the cost of living will go down. Labour, therefore, feels the need to start out on a new agitation, either to standardise wages at their present money level, or to go one better and push them still higher while there is yet a chance. Labour is also well aware that there are amongst us a good many short-sighted, old-fashioned people who are secretly hoping that wages will go down, and who will miss no opportunity to bring that result about. There is certainly sufficient proof of the existence of such a party in the recent negotiations with respect to railway wages. Those people who imagine that wages are going down as the cost of living goes down overlook the fact that the cost of living will not go down until Labour makes up its mind to tackle the problem of production, and Labour is unlikely to tackle that problem seriously if its only reward is going to be a reduction in the rate of wages. The only salvation for Labour and for the rest of us is now recognised to lie in higher production, and it would be a thousand pities if the awakening interest of Labour in the problem of production was dampened down at the start by the fear of vanishing wages. There are four elements in industrial success which are inseparable from one another, and which alone can give us success. These four elements are high wages, high production, high profits and low prices. One of the most dangerous and widely held of the many fallacies which are floating around at the moment is the idea that limitation of output or low production is a preventive for unemployment and makes work for others.

Take some common manufactured article, say a chair, and suppose that it is marketed at the moment at a price of £3. Further, assume that this £3 is made up as follows: Materials, £1; rent, rates, taxes, machinery, carriage, selling costs, and all the other charges of a factory, including profit, £1; labour, £1—total £3. The chair is made under trade union rules, with labour going slow, limiting output. Imagine that this workman proceeds to do a full hour's work in an hour, with the result that his output is doubled. The doubling of output would mean that twice the material would be used—cost £2; but rent and all the other charges named would remain stationery; and for the moment it is assumed that wages would remain at £1. Two chairs are therefore produced for £4. Now, there are five times as many people able and willing to buy a chair at £2 as there are at £3, so that by doubling his output, instead of causing unemployment the labourer actually makes work for 2½ men where there was previously work only for one. Coming back to my main argument, I am of opinion that under no ordinary circumstances should any wage be lowered, whatever may be the cost of living.

If a job will not stand a decent wage then that job should not be done. For instance, a very large percentage of work done on our railways never ought to be done at all. Why is it that American railways are, in some respects, so much in advance of our own? The answer is to be found in the wages conditions here and there. America has never had low wages, and is, therefore, driven to adopt every labour-saving and mechanical device that human brain can conceive. There is no more powerful hindrance to progress than low wages.

Suppose it were possible to secure the whole-hearted co-operation of the complete industrial army on the question of production. There are ten millions of us in these islands who have to work for a living, ten millions of us, consciously or unconsciously, operating on the ca'canny principle. It is almost impossible to conceive the power that would come to us if we could reverse our point of view, could suddenly be made anxious to see how much we could do. It would not then be necessary to talk of capturing foreign markets, especially at this juncture. Foreign markets would be throwing both arms around us, in order to secure some of our products. We could not only save this country; in the course of a few brief months we could confer an untold and much needed benefit upon the whole of humanity. This is, indeed, an ideal to keep before us, an ideal which in its entirety is no doubt unattainable, but it is, perhaps, worth stating in the endeavour to get the people thinking along the right line.

We must engender the spirit of progress and enterprise in the minds of the workers, and if that can be done the future is assured. It is a good deal harder to slack at a job than to do it with a will and with an interest. When a man does twenty minutes' work in an hour, he wastes forty minutes, not only of his own but of everybody else's time, and forty minutes of all the overhead charges associated with his business. If that man is getting a shilling an hour it would be better to pay him 1s. 6d. for twenty minutes' work and send him home to make room for others to come and work during the other forty minutes. The first need is to make the mind of Labour easy on this matter of wages, and there should be an honourable understanding among employers that a wage, once given, is never withdrawn. From that simple understanding would arise more caution on both sides in asking and giving further increases, and the first effect of such an understanding would be a cessation of these constantly recurring demands which are the chief difficulty in making long-term contracts.

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* From a lecture delivered before the Industrial League and Council.

Tramway Workers' Wages.

The recent awards of the Interim Court of Arbitration, increasing the wages of employees of all tramway, light railway and omnibus undertakings, has increased the difficulties of a situation which was already far from easy. In an official statement on the award by the Municipal Tramways Association it is pointed out that "every transportation undertaking, whether municipal, company or privately owned, now finds itself faced with immense arrears of work, both for renewal and reconstruction, which must be immediately undertaken if its system is to continue to be efficiently used for public traffic. Not only has this work accumulated in the years of the war, but now the cost of this work has advanced to twice or even three times the pre-war cost. As a consequence, the financial provision for it, in the shape of reserve funds established on a pre-war basis, is now wholly inadequate for its execution. Whilst during the war difficulties of providing urban transportation have increased, the public urgency of the transportation services has grown in a much greater degree. There has never been a time within municipal experience when every important urban community more manifestly stood in need of adequate facilities of transit, within its central districts and between the latter and its suburbs. The solution of the housing problem in every great city pre-eminently depends on the provision of new urban railways, further tramway extensions or additional omnibus routes. Locomotion is essentially a key industry, on the efficiency of which the progress of modern commercial life and health and convenient housing is contingent. It is a public utility, without which industry cannot commence or continue on any large scale. No industry, no matter in whose hands it is, whether a company, a municipality or a private person, can possibly provide efficient services or extend its operations or develop its activities when placed in such a position of financial embarrassment as that in which the urban transportation now stands. The cost of extensions or improvements is exaggerated by the poor credit which the undertakings afford, reflected in the high rates of interest payable, or in the discounts under which the needful money must be raised.

"The present award will (it is stated) add close on a million sterling to the annual wages bill for the industry. The employees were previously receiving 30s. per week in war bonus. In March last the working hours were reduced to 48 a week, at a further heavy financial cost. This raises the cost of transportation wages to a level which it is hard indeed to justify, either having regard to the financial ability of the undertakers or to the general level of wages in other industries. The effect on the transportation industry, crippled by the financial aftermath of the war, of this last advance is of the utmost gravity. On the present basis the revenue, which depends, of course, on the present standard of fares, few undertakers, if any, whether municipal or privately owned, can carry on if they are to maintain their undertakings in a sound financial state. Immense increase of fares will be necessary up to the statutory maximum, where the fares are not fully up to the legal powers at the present time, and in very many instances higher charging powers must be conferred upon the undertakers. The result will be that the price of transportation must rise with the rise in the cost of labour and materials represented in its services, just as much as the prices of other commodities have risen for the same reasons. The fact that the price of transportation is governed by statute must not prevent an equitable adjustment in the rates of charge allowed. But even increase of fares will not prevent some of the weaker transportations from having to cut their losses and go out of business. Municipal undertakings can have recourse to the local rates, but it is hardly likely that the local ratepayers will allow a subsidy to be drawn from the whole community, through the rates, in favour of, among other things, an advance in wages to transportation employees until fares have been raised to their utmost practicable limit. The existing rates of fares, so far as limited by Acts of Parliament, were fixed many years before the war, when much less costly conditions prevailed in regard to construction, maintenance, renewals and working. As against the present much-increased cost of operation and the great expense to-day of renewals and reconstructions, they are totally inadequate. This has been recognised by Parliament, and in the Statutory Undertakings (Temporary Increase of Charges) Act, 1918, in which provision is made for the authorisation of increased charges. This can, however, only be done within narrow limits and for a temporary period. That Act does not meet the case of transportation undertakings now the war is past, and new conditions are relatively permanent, any more than it met the case of the dock authorities, who had to obtain in each individual case special power from Parliament earlier in the year to raise their charges. Therefore, the problem before transportation undertakers and before the Government must be to recognise and reconstruct the financial basis of the industry to meet the new economic level of costs and charges. The immediate need is to lift the basis of fares to this new economic level. This is essential if the country is to be assured efficient urban transportation, and the recent wages award has made this necessity a matter of extreme urgency for transport undertakers."

The award will involve an extra expenditure of £47,000 in the current financial year and £94,000 a year subsequently for the tramways department of the London County Council. At Manchester the increased charge is put at £40,000 a year, at Liverpool £30,000, at Sheffield £26,000, at Birmingham it is £25,000, at Edinburgh £16,000, at Salford £11,000, at Oldham £4,000, at Burnley £4,000, at Blackpool £3,150, at Rochdale £3,600, at Ashton-under-Lyne £1,000 and at Darwen £600. Other municipal and company-owned undertakings are affected in a similar way.

Electrical Contractors' Association Peace Dinner.

This function, the first of a social nature held under the auspices of this Association since 1914, took place at the Imperial Restaurant, Regent-street, W., on Wednesday, October 15th. In furtherance of the desire of the Association to foster mutual interest and co-operation with allied associations, several guests were present, amongst whom were Mr. C. H. Wordingham (President of the I.E.E.), Mr. Roger T. Smith, and Mr. P. F. Rowell (I.E.E.), Mr. Cramb (I.M.E.A.), Mr. J. W. Beauchamp (E.D.A.). Mr. L. B. Atkinson (C.M.A.), Mr. A. C. Cramb (Croydon), Mr. A. P. Trotter, Mr. J. S. Highfield, Mr. H. G. Purchase, M.P., Mr. T. Roles (Bradford), and Mr. Leon Gaster (Illum. Eng. Soc.); Mr. D. N. Dunlop (B.E.M.A.) was unfortunately unable to attend. Whatever troubles may be pressing on electrical contractors in these times, it was quite evident that those gathered together on this occasion could put care aside for a few hours to indulge in social intercourse. After the President had proposed "The King," Mr. Wansborough proposed the toast of the "Electrical Contractors' Association," referring to the growth and development in the size and power of the Association since it was established some 16 years ago. Latterly great strides had been made in promoting a better feeling between contractors, and the growth of a desire to be of mutual assistance to each other, to allied associations and to the industry as a whole.

Mr. R. Tweedy Smith responded on behalf of the Association, and stated that out of the original Association three associations had come into being—the E.C.A., which was the body; the N.E.C.T.A., which represented the spirit; and the N.E.F.A., the soul. The first tended to remove trade jealousy and promote a co-operative spirit; the second safeguarded the economic side of the contracting industry; and the third aimed at promoting a better understanding between employers and employees.

Mr. Cross proposed the toast of the "Allied Associations," touching on the need for co-operation between all associations which were working for the good of the electrical industry. He expressed, midst applause, the Association's approval of the work that had been done by Mr. C. H. Wordingham during his term of office as President of the I.E.E. He recommended all contractors to join the I.E.E., the senior institution of the electrical industry. He also advocated that contractors should study the proceedings of the Illuminating Engineering Society. Greater co-operation was required between contractors and supply authorities. The latter acted as the salesmen for the product of the former, and is deserving of all possible help and assistance. He hoped the B.E.M.A. would influence manufacturers to give contractors a fair deal, then the contractor could help the B.E.M.A. to overcome the effects of foreign competition. The Cable Manufacturers' Association were to be congratulated on the effort they had made to maintain a high standard of quality. A cable was urgently needed which would fulfil the I.E.E. rules and which could be sold at a competitive price. They were pleased to welcome the E.D.A as the "baby" association of the industry, and looked for great things from this the youngest child.

Mr. Roger T. Smith, in reply, said that Peace had been signed and ratified, and the country was in the position of a man who had undergone a very serious operation and expected a quick recovery without allowing due time for convalescence. He wished he could give a lead to the industry which would help to the solution of the many troubles of to-day. He felt that a spirit of sportmanship was one which would help toward the betterment of industrial affairs. Sportsmanship helped this country through the war, through the railway strike, and he believed that this country could count on the assistance of a spirit of sportsmanship from the majority of the wage earners.

Mr. J. W. Beauchamp also replied, and expressed his appreciation of the spirit of co-operation which the E.C.A. had developed. He strongly realised that the supply men make "juice" and contractors find the "outlets." He was in favour of supporting the contractor, and had not been suddenly converted to this view. After experience as a supply engineer, both with and without a trading department, he had come to the conclusion that whilst a trading department greatly helped at the start, the day was rapidly passing when it could be said that the contractors in a district could not give the support and assistance needed in finding consumers. Contractors had become more firmly established and were better able to employ skilled assistance than previously. Mutual unity must exist between supply authority, manufacturer and contractor. On that unity the consumer depends, and all depend in turn upon the consumer.

The "Electrical Trades' Benevolent Institution" was toasted by Mr. H. J. Cash, who appealed to the members to support him as president of the forthcoming festival. The Institution afforded the best possible means for employees to provide against a future rainy day, and no one was in a position under existing conditions to foretell whether misfortune would come his way or not. Therefore all should prepare themselves in case of adversity.

Mr. F. B. O. Hawes, secretary of the Electrical Trades Benevolent Institution, in reply, explained the objects of the Institution and the benefits which accrued to subscribers.

The toasts were interspersed with enjoyable musical items, and at the conclusion of the evening one felt that it was good once again to be able to resume the social functions hitherto not held due to war conditions.

There can further be no doubt that the pleasurable evening spent, and the high character of the entertainment provided, will help to further those aims of the Association which, as we mentioned above, was one of the objects of the gathering.

The Glasgow Housing Exhibition.

Like all municipal undertakings at Glasgow, the Housing and Health Exhibition, which was promoted by the Corporation, shows evidence of progressive enterprise and good organisation. In fact it has proved the most popular and most successful industrial exhibition ever held in Glasgow. There is no doubt that the housing question is one of the most important social and economic problems of the day. In the past, architects and builders have been far too conservative, and the designs of dwellings have shown a striking lack of originality. Realising this fact, and that economy of cost, combined with the maximum of space and comfort, was the ideal to be aimed at, the Glasgow Corporation, which proposes to build several thousand houses, conceived the happy idea of holding a housing exhibition in order to give its citizens an opportunity of viewing modern, up-to-date methods of building and furnishing houses, &c. There are a number of interesting electrical exhibits on view, and one of the best stands is that of the Corporation electricity department. A great variety of electric light fittings, motors, cooking and heating apparatus and domestic and labour-saving appliances are on view. Among the exhibitors are the following: The Electric Suction Cleaner Company (for whom Messrs. Scholey & Company are Glasgow agents) show the Premier electric suction cleaner and the Kutmore electric drills; the Hoover Suction Sweeping Company an electric suction sweeper; Messrs. Wm. McGeoch & Company the Elliot electric woodworker and a variety of electric domestic and laundry irons, electric fires, soldering irons, cookers, electric fittings, fans, lamps, vacuum cleaners and other household appliances; Electric Appliances Company the Imperial electric vacuum cleaner; Doby Machine Mfg. Company electric vacuum sweepers; Falkirk Iron Company the "Falco" electric fires and cookers; Glasgow Corporation electricity department vacuum cleaners, clothes washing and ironing machines, laundry irons, sewing machine motors, electric cookers and fires, dining-room specialities, &c.; Malcolm and Allan electric irons, fans, heaters, vacuum cleaners, "Klydo" signs, &c.; C. E. Black & Company the "Thor" washing machine; Pinchin, Johnson & Company paints and varnishes; Carron Company a variety of electric cooking and heating stoves and labour-saving devices. Gem Labour-Saving Device Company, vacuum cleaners, &c.; Falk, Stadelmann & Company, electric lighting fixtures, electric lamps, &c.; Western Electric Company the Quead fires, electric dish-washers and washing machines, vacuum cleaners, &c.; Britannia Lamp & Accessories Company metal and carbon filament lamps, "Britannia" electric fires, reflectors, lighting accessories, pocket batteries, porcelain insulators and ironwork for overhead distribution, &c.; Rex Import Company, electric vacuum cleaners, &c.

The practical demonstrations of electric cooking given at some of the stands proved a great attraction, as did the ideal "St. Mungo Cottage," which was lighted electrically throughout by the Corporation electricity department. In addition, the Kearney high-speed railway was on view in the annexe. The manager of the exhibition, which was opened on the 8th inst. and will close on Nov. 1, is Mr. J. M. Freer.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

14,148 Siemens & Halske Akt. Ges. Variable electric resistance or rheostats. (15/2/17.)

132,284 Compagnie General de Magnetos. Magnetos. (1/10/17.)

118,600 Naamlooze Vennootschap de Nederlandsche Thermotelephoon Maatschappij. Wireless telegraphy or telephony. (12/7/17.) (Addition to 3954/15.)

132,315 Elphick. Electrically-ignited lighting device. (6/2/19.)

132,324 Coulson. Electric arc lamps. (6/9/18.)

132,354 Boorne. Electrodes for electric arc welding and metal-cutting purposes. (12/9/18.)

132,362 Higgs & Rayner. Alternating-current motors. (17/9/18.)

120,553 Monard. Apparatus for electrically operating and controlling railway points. (8/11/17.)

132,391 Robinson. Electro-magnetic wave reception systems. (4/11/18.)

A variable condenser is connected directly across the control element and filament of a thermionic device used as a detector or amplifier of the electro-magnetic waves.

132,413 Stott. Electrically-driven vehicles. (9/12/18.)

132,417 Wade. (Fabbrica Isolatori Livorno.) Insulators for high-tension electric cables. (19/12/18.)

132,429 Cohen. Telephone systems. (23/1/19.)

132,434 Reginald de Bellescize. Receiving circuits for wireless telegraphy. (26/6/17)

Comprises a closed receivnig circuit for wireless telegraphy which is exactly symmetrical as regards electrical actions, for the purpose of improving syntony, particularly with respect to the inconvenience caused by very near emissions, of obtaining exact radiogoniometric direction, and of reducing to a negligible value the effect of electrical disturbances of atmospheric or telluric origin.

132,435 Reginald de Bellescize. Receiving circuits for wireless telegraphy. (29/4/18.) (Addition to 3355/19.)

Comprises an improvement in the apparatus covered by above patent 132,434 according to which the potential of the primary circuit is stabilised by connecting a suitably selected point thereof to earth or to a Faraday's cage.

126,278 Akt.-Ges. Brown, Boveri, et Cie. Multiple-control apparatus for electric railways with motor-driven main switch drums. (3/5/18.)

132,460 Joyce & Park Royal Engineering Works. Apparatus for electrically igniting miners' safety lamps. (10/4/19.)

132,479 Sclater. Junction boxes for electrical conduits. (11/6/19.)

132,480 Rabinovitch & Mond. Electric batteries. (8/7/18.) (Divided Application on 1181/18.)

132,482 Collie. Means for making temporary connections with electric supply cables. (13/8/18.) (Divided Application on 13,104/18.)

Legal Intelligence.

A. & A. Electrical Company, Ltd. v. Lighting Accessories Company & J. Boehm.

Last week Mr. Justice Lush heard this action. There were two actions originally, but they had been consolidated. In the first plaintiffs claimed the repayment of about £500 in respect of a dishonoured cheque and bills of exchange in part payment of goods supplied under contracts between the parties for the supply to defendants of a large number of electric batteries. The second action was in respect of bills of exchange for £273. 8s. 4d., drawn by plaintiffs and accepted by defendants. Plaintiffs alleged that defendants, through Boehm, guaranteed due payment of the sums owing. The defence was that the bills of exchange and cheque were given for the supply of goods, but said the goods were bought by defendants by description, and they alleged a breach of warranty, and counterclaimed for damages.

In opening plaintiffs' case, Mr. Thomas, K.C., said the parties were competitors in supplying the trade with batteries and flash lights and electric torches. Plaintiffs were a limited liability company, but defendants were not. Early in 1918 the A. A. Company sent out their trade circular, and they entered into two contracts to supply defendants with batteries and lamps and other similar goods. Defendants practically admitted the claim, but alleged fraudulent misrepresentation. Owing to the fact that defendants were not a registered company, plaintiffs got the defendant Boehm to guarantee the payments of the acceptances, &c. Most of the goods sold by plaintiffs had been imported from America, but at the time of the contracts it was impossible to import further supplies or to make the goods in this country. Defendants were therefore anxious to get the remainder of plaintiffs' supplies. Batteries and lamps kept for a time became defective. When the second contract was entered into in June, 1918, plaintiffs made it clear that they would allow 5 per cent. to defendants to cover defectives, but said they could do no more than make that allowance, as the prices charged were so low. Plaintiffs never gave any other undertaking as to defectives. Counsel then read the correspondence on which the contracts for sale were based.

Mr. B. R. Agazar, plaintiffs' manager, said he made no statement to Mr. Boehm as to the quantity of defectives to be allowed. He explained that the smaller batteries were much more likely to become "dead" than the larger ones. Defendants complained that he had sold some 1,500 batteries of the "Bright Star" battery to a customer, who had sold them to one of defendants' customers. Those were batteries which had a reputation for being better than the smaller ones.

Mr. J. Boehm was called for the defence, and stated that plaintiffs' deliveries were of defective batteries, and witness told Mr. Agazar that if they accepted the 5 per cent. allowance, defendants must see how they fared when they tested the goods.

His Lordship said there was not a shadow of a defence to the action. The contracts were perfectly clear. There was no misrepresentation, and there must be judgment for plaintiffs for £814 odd and costs.

Electrical Trade Union Rules.

On the 16th inst. Mr. Justice A. T. Lawrence heard an action by Mr. Ernest Hy. Keeley, foreman of Messrs. Campbell & Isherwood, Ltd., electrical engineers, for a declaration that since April 20, 1918, he had been a member of the Electrical Trades Union, and for an injunction restraining the Union from acting on a resolution expelling him.

The reason for plaintiff's expulsion was that he, as foreman of the firm, allowed a fitter named Grint, who was not a member of the Union, to work on board H.M.S. "Melampus." Plaintiff was not told under what rule he was expelled. In 1915 a rule of the Union was made that "no man be allowed to work aboard ship in the Port of London unless he has held a ticket for at least three months." Plaintiff employed the fitter to work on the "Melampus," although he did not hold such a ticket, and it was for the alleged breach of that rule that plaintiff was expelled. For plaintiff, it was contended that under the rules there was no power to expel except for breach of a rule approved of by the council, and the rule never was approved of. The only rule authorising expulsion which was applicable to plaintiff was Rule 41 (*g*), which dealt with the case of a man who by his conduct "brought discredit on the union." The District Committee had no jurisdiction to expel a member. Only the branch committee could do that.

For the Union it was argued that there was jurisdiction in the district committee to expel members for breach of the rules.

Mr. Muir, an official of the Union, said that the point was most important. Most disputes and strikes, before the war and since, turned upon it, and plaintiff would give no undertaking in the matter.

Mr. Justice Lawrence, in giving judgment for the plaintiff, said that the plaintiff was told by Grint that he was a trade unionist, but that he had not a provisional ticket, and the plaintiff believed that Mr. Cox, the shop steward, who thought a ticket was not a provisional licence to work at that time, was not satisfied, and Grint was dismissed. Mr. Muir said that as officials they had to consider the men, and to work without friction they did not admit non-unionists. The plaintiff seemed to have acted on the same principle. It was clear that only the branch committee could expel. The district committee had no jurisdiction, and they acted against all justice in expelling plaintiff when he believed the statement of Grint about being a unionist. Under Rule 41 there would have been jurisdiction, and the branch could have heard the complaint, but they did not. As to the hearing by the Executive Council, the plaintiff was not informed of it, and was not bound by it; he was not summoned. There was no hearing at all by any tribunal which under the rules had power to expel, and he granted the declaration and injunction asked for.

Commercial Topics.

The Anglo-French Trade Agreement.

It is announced that the Agreement made in 1917 between the British and French Governments respecting the application of the French import restrictions to goods of United Kingdom origin or manufacture and of the United Kingdom import restrictions to French goods will terminate on the 27th inst. Applications for British import licences for all import-prohibited goods coming from France will therefore have to be made, after that date, by the importer of the goods, the present arrangements under which import licences can in certain cases be obtained by the French exporters being abolished.

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The Profiteering Act.

A new schedule of articles to be brought within the operation of the Profiteering Act has been issued, and the following (among other) articles have been added to those given in the first two schedules :—

All articles used for fuel and lighting (except coal), medical and surgical appliances, engineering and other tools and implements, and weighing and measuring instruments.

The allegation against the Metropolitan Electric Supply Company of having charged an excessive price for six 30-watt Ediswan lamps (3s. 6d. each) has been investigated by the Acton Tribunal, but the inquiry has been adjourned in order to obtain technical evidence.

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A British Empire Exhibition.

We learn with pleasure that arrangements are being made for the organisation of a great Imperial Exhibition, which will be held in 1921. Already some progress has been made with this important project, which is being welcomed in all parts of the Empire, and particularly in the Dominions and India. Even appplications to participate have already been received. Some of the most influential of the Ruling Princes of India have consented to join the Council, and among the recent additions are H.H. the Rajah of Cochin, the Lord Mayor of London, the Lord Mayor of Norwich, Sir Auckland Geddes, Lord Ampthill and Lord Desborough. It is said that the exhibition will include an interesting historical section, which will illustrate by means of exhibits and practical demonstrations, the development of different industries.

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The Bolivian Market.

Like other countries in South America, efforts are being made to develop the resources of Bolivia, and to attract foreign capital, &c. The country is rich in minerals, rubber and other natural products, and British manufacturers should study its future possibilities. It is stated that there are no British houses in the capital (La Paz) who import electrical supplies, tools, mining machinery, railway materials or motor cars, yet there is a great demand all over the country for hardware and ironmongery. Bolivia is mainly a mining country, and is in need of capital and machinery to develop her mineral wealth. Fuel is imported : coal from Australia, Wales and the South of Chile, and oil from the north of Peru. Last year the Legislature discussed a Bill for securing surveys and estimates for the development of water-power in the Republic. With the development of cheap power, many manufactures could be undertaken with every prospect of success. Power, light and heat are required in all the cities, towns and mining centres, while many local transport systems would be started if a cheap supply of electric current were assured This applies particularly to the western or mining half of the country, where a cheap supply of power for industrial, municipal and domestic purposes, including the supply of current to railways, could be obtained from the development of the available water-power. It will thus be seen that in Bolivia electrical engineers and manufacturers have a very promising field for their enterprise.

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Depreciation, Obsolescence and Wasting Assets.

Important evidence has been given on behalf of the Federation of British Industries before the Royal Commission on Income Tax in regard to the allowances for depreciation and obsolescence of machinery. The present allowances are, as we have frequently pointed out, totally inadequate, and, owing to the importance of the subject, we append a brief summary of the views submitted by the Federation.

Depreciation allowances should be permitted for the annual reduction in value of all property which contributes to the earnings of profits assessable for income tax. On plant and machinery the allowance should be on the prime cost, and not on the written-down value ; but it is pointed out that the allowance of one-sixth the annual value on buildings, mills, factories, &c., has been in practice curtailed, as far as possible, by the Inland Revenue authorities. When administered in this way it falls far short of what is reasonable. Depreciation allowances should be permitted on foundations which carry plant and machinery, on fixtures, office furniture, cost of removals, the cost of acquisition of leaseholds and expenditure for adapting premises, and on patents.

It was pointed out that insufficient depreciation allowances give rise to a heavy *obsolescence* allowance, and that this gives no encouragement to manufacturers to replace machinery by new types. Obsolescence allowances should, where necessary, be capable of being carried forward in a similar manner to that adopted in the case of depreciation. It is not proposed that the existing renewal system should be superseded.

Deductions on an equitable basis should be allowed for the exhaustion of all *wasting assets*, particularly in mines and similar undertakings, acquired by manufacturers for their business. Suggestions were also made as to the method of assessment, deductions from profits, &c.

Electricity Supply.

Bury (Lancs) Electricity Committee has decided to become a member of the Electrical Development Association.

Clacton Urban Council has applied for sanction to a loan of £5,500 for cable extensions and for 145 house services.

Coun. W. T. Dagnall, chairman of the Manchester Electricity Committee, has been appointed an alderman.

Edinburgh Cleansing and Lighting Committee recommends that electric lamps be provided for the streets on the Gorgie housing site.

Athy (co. Kildare) Urban Council proposes to appoint an electrical engineer to prepare an electric supply scheme.

Liverpool Tramways and Electric Power and Lighting Committee has submitted a supplementary estimate of £7,500 for public lighting.

An application is to be made by Duncan's Electricity Supply Company for provisional orders for Kincardine and other towns in Scotland.

A canvass of Louth ratepayers is to be made by the local tradesmen's association in order to ascertain the probable demand for electrical energy.

An inquiry has been held into the application of Tunbridge Wells Corporation for authority to borrow £30,000 for extensions of the electric supply undertaking.

The London County Council has sanctioned the following loans for electricity supply purposes : To Battersea Borough Council £10,666 for plant, and to Bermondsey Borough Council £2,000 for mains.

There was a failure of the Accrington electricity supply on Saturday. This was the third failure within a comparatively short period. The Electricity Committee attribute it to the poor quality of coal available for the generation of steam.

Pembroke Urban Council has increased the salary of the electrical engineer (Mr. Price) from £550 to £600 per annum. The charge for electric current for lighting has been increased by ½d a unit (to 8d.), and for heating, cooking and power by ¼d. a unit.

Wimbledon electric supply consumers have been notified that as from the September quarter the price charged for current for lighting will be 8d. per unit, an increase of 2d. on the existing charge, and 100 per cent. more than the 1914 charge.

Rathdrum (co. Dublin) Urban Council has been considering the question of electricity supply, and a London firm have intimated that, before undertaking the formation of a company, they would require half the capital to be subscribed locally.

Smethwick Corporation has consented to the application of the Shropshire, Worcestershire & Staffordshire Electric Power Company for permission to increase the price of electricity for lighting purposes from 4½d. to 6d. per unit for a period not exceeding two years.

Newport (Mon.) Electricity Committee recommend that the Corporation become a member of the Electrical Development Association. The borough electrical engineer reports that the suggested tramways extension in Corporation-road and the dry docks would entail a heavy annual loss.

The Bureau of American Manufacturers, which has offices in Dublin, and whose representatives are Dr. J. Tennant Byrne and Major Sir Wm. Longfield Brady, Bart., will send its engineer (Dr. Paul Hersch) to Tullow in order to advise the Urban Council on the cheapest and best plan to light the town by electricity.

Nuneaton Council has referred back a report of the Electricity Committee recommending certain concessions to large consumers of power – to consumers of 50,000 units and over. At present the municipal undertaking does not supply 50,000 units per quarter to any customer, but it was stated that the revised scale might induce new firms to take their power from the Corporation.

Hackney (London) Borough Council is recommended by its Establishment and General Purposes Committee to increase the salary of the borough electrical engineer (Mr. L. L. Robinson) from £750 to £1,050 per annum as from April 1 next, with increments of £50 per year until a maximum of £1,200 is reached. The revised annual salary is to include any war bonus or other grants now made or which may subsequently be made.

The report of Mr. E. M. Lacey on the Burnley electricity undertaking has been considered by the Electricity Committee, who recommend the Council to proceed as quickly as possible with the proposals suggested by Mr. Lacey. These include the erection of a 3,000-kw. turbo-alternator at a cost of £62,000. The applications for electric current are reported to be "pouring in," and extensions are absolutely essential if the Corporation is to meet its statutory obligations.

The accounts of Peterborough electricity department for the year ended March 31 show revenue £12,169 (compared with £11,282 in previous year), and working expenses £8,325 (£6,343). Loan charges were £4,586 (£4,761), and the net result was a deficit of £1,227 (compared with a profit of £141). Total cost per unit sold was 3·049d. (2·666d.). Units generated were 1,293,403 (1,782,519) and sold 1,016,376 (999,541). Total maximum supply demanded was 633 kw. (599 kw.) and load factor 18·33 (19·05) epr cent.

The Engineer and Manager of the Pontypridd Electricity Works has reported on the necessity of revising the charges for electricity supply. The working costs for 1918-19 were £9,926, and the estimate for 1919-20 is £12,100. No new plant has been put down for some 10 years, but the lamp connections have increased by over 30,000. It is suggested that for lighting the charge be increased to 73 per cent. over the pre-war figure, and for power an increase of 25 to 50 per cent. (according to quantity used) is recommended, while for heating the increase would be 25 per cent.

The accounts of the Hove Corporation electricity department for the year ended March 31, 1919, give the following particulars: *Hove Section*: Revenue £22,984, working expenses and special charges £13,963, gross profit £9,021, interest, instalments of loans, and income tax £11,046, net deficit £2,025. Units generated 1,054.832 and sold 845,754. Total maximum demand 639 kw. *Aldrington Section*: Revenue £1,548, working expenses £941, gross profit £607, capital charges and income tax £1,104, net deficit £497. Units purchased 54,978 and sold 48,189. Total maximum demand, 37 kw.

The accounts of the Stepney (London) electricity department for the year ended March 31 show revenue £175.834 (compared with £150,432 in previous year), and working expenses £110,154 (£104,393), leaving gross profit £65,680 (£46,038), and, after providing for capital charges, &c., the net profit was £22,245 (£3,642). Cost per unit sold was 1·017d. (0·993d.) exclusive and 1·437d. (1·415d.) inclusive of capital charges. The maximum supply into feeders was 9,720 kw. (9,757 kw.). Units generated were 28,811,770 (29,659,586), purchased 2,087,262 (678,920) and sold 25,383,085 (24,880,717). Units supplied for power and heating were 11,022,312 (11,032,137). A profit of nearly £950 was realised on the Council's motor-hiring business.

The Shropshire, Worcestershire & Staffordshire Electric Power Company recently asked Kidderminster Council to agree to a further increase in the charges for electricity for power and lighting. The company stated that during the war, owing to heavy increases in cost of labour and materials, they had to increase their charges by 25 per cent., bringing the total charge per unit for lighting to a fraction below 6d. Since then there had been even greater advances in the cost of production, and they asked to be able to have a flat rate of 8d. per unit. The Council considered the proposed charges excessive and the application was refused.

When it was reported to the Skegness Council last week that the Board of Trade had agreed to extend the provisional electric lighting order for a further period of six months from Aug. 7 last, it was decided to ask for an extension for 12 months. Dr. Sweeten was of opinion that steps should be immediately taken to supply electricity. He considered it would have been far better to have gone in for electric light instead of gas, but if they allowed their order to lapse a private company would come in. Mr. S. Moody pointed out that the purchase of the gasworks meant an additional 2s. rate for 35 years, and they ought to be careful before going in for another "paying" concern like the gas.

Hull Electricity Committee has applied to the Board of Trade for an order to enable it to supply electricity to the Humber cement works at Welton and Melton. There is also a demand for current for lighting at Hessle, and as soon as Board of Trade sanction for the existing order to come into force the Committee will give a supply.

The city electrical engineer (Major H. Bell) reports that there is a shortage of meters throughout the country, and owing to the enormous demand at present delay is being occasioned in connecting up new consumers. They had 300 odd people wanting to be connected up at Hull, but they were doing all they could under the circumstances.

All the new houses on the Hessle-road housing site are to be wired, and a report recommending the adoption of electric lighting in the principal streets has been forwarded to the Works Committee, with the suggestion that the tramway routes and all main roads should be lighted electrically.

An accident to a 5,000 kw. Westinghouse turbine set has interfered with the supply of electricity at Bradford. At the meeting of the Corporation last week, Mr. J. Haley, chairman of the Electricity Committee, explained that the committee had instructed the engineer and manager (Mr. T. Roles) not to connect up any new consumer of current for lighting or power. He said "The largest turbine at Valley-road had burst, and was out of commission, thus placing the department in a very precarious position." In the emergency, and with the view of partially meeting the shortage of current, a link-up had been effected with the system of the Yorkshire Power Company. During the war the department suffered from Government control, and the Electricity Committee was refused plant year after year. The engineer had done everything possible to get further plant. The maximum capacity at present and for the next three months would be 18,000 kw. Last winter they had wanted 21,000 kw. and the winter before 23,000 kw. The situation was a very serious one. They relied upon three vertical turbines, and all were running at full speed. For five years one or other of the turbines had always been under repair, but no matter what steps they had taken they had been unable to get plant.

As we go to press we learn that at 11.25 p.m. on Saturday, Oct. 11, after No. 4 turbo-alternator had been taken off the 'bus bars and steam shut off from the turbine, dull heavy sounds emanated from the alternator, accompanied by violent vibrations, the machine coming to rest within 10 minutes. After removing the alternator end shields, it was discovered that one of the bronze end rings supporting the steel end cap ring on the rotor had ruptured, and that fragments of the bronze ring had ploughed the stator iron and stator conductors to such an extent that a complete re-wind of the stator would be essential. Repair work is now being carried out by the makers with all possible speed.

Notwithstanding the unfortunate breakdown, there has been no interruption of the supply whatever, and Mr. T. Roles and his staff are to be congratulated upon the manner in which they surmounted their difficulties.

Electric Traction.

Llanelly Council has been authorised to borrow £5,750 for the purchase of electric vehicles for refuse collection, &c.

Ilkley Urban Council has applied for sanction to a loan of £1,250 for the purchase of an electric vehicle for refuse collection.

Ald. T. Baker, chairman of the Plymouth Tramways and Electricity Committee, has been presented with the freedom of the borough.

Paisley Town Council has agreed with the Paisley Tramway Company to sanction certain increases of the tramcar fares on weekdays, provided the company withdraw the proposal to charge double fares on Sundays and holidays.

Mr. H. P. Stokes, of Bexley, who was recently appointed tramways manager at Plymouth, has been presented with a clock and a set of bronzes, a silver cup and other articles by the members of the staff and other friends at Bexley.

The Dundee, Broughty Ferry & District Tramways Company, which obtains electrical energy from Dundee Corporation, and is paying 1¾d. a unit plus 10 per cent., has intimated that it will terminate the present arrangement in December.

The old International Tramways Union has been dissolved, but it will be reconstituted, and its members confined to the Entente and neutral countries. The London County Council has voted £24 for the maintenance of the Union for the years 1918 and 1919.

The claim of the employees of the Glasgow Corporation tramways department for a minimum wage of £4 a week and for other demands as to hours of employment, &c., was before the Arbitration Court last week, but the matter was adjourned to enable the Corporation and the Municipal Employees' Association to reopen negotiations.

Though the recent award of the Arbitration Court will increase the annual expenditure of the Salford Corporation tramways department by £11,000, the Tramways Committee has decided not to increase the tramway fares at present. In the next Parliamentary Bill to be promoted by the Corporation the Committee will include a clause to authorise the running of motor omnibuses.

Some changes have been made in the staff of the operating department of the Underground Electric Railways Company of London. Mr. J. P. Thomas has been appointed assistant operating manager of the company's railways and omnibuses, and Mr. J. Thornton becomes superintendent of the line to the District and Tube Railways, in place of Mr. W. E. Blake, deceased. For the past 14 years Mr. Thornton has been chief inspector of the District Railway.

In the Bill which is to be promoted by Manchester Corporation in the next session of Parliament powers will be sought to (inter alia) construct additional tramways and to give the Tramways Committee authority to borrow over £1,100,000 for the purpose. A sum of £500,000 will be required for 200 tramcars (at £2,500 each), £200.000 for new car shed. £55,000 for car sheds extensions, £50.000 for garages and works extensions, £20,000 for shelters. £125.000 for new lines. and £15.450 for overhead equipment.

It is anticipated that the recent award of the Court of Arbitration on the application of tramway and omnibus workers for an advance of wages will affect about 4.000 employees in Manchester. In March last an additional £70,000 a year was given, and the annual cost of bonuses and war advances to the tramways department is £436,128. The latest award will increase this to £475,225. The general manager (Mr. J. M. McElroy) has been asked to prepare a report on the financial position of the department, with special reference to the effect of recent awards.

At the meeting of the Liverpool Tramways Committee last week the chairman, Ald. Russell Taylor, announced that the result of carrying out the agreement of March last was to increase the wages bill by £92,000, and a further £30,000 would be added to the annual wages bill by the recent arbitration award. In the last five years expenditure had increased by 114 per cent., of which labour was receiving 81 per cent. Despite the carrying of 10,000,000 passengers more than last year and the takings being £120,000 more, the surplus had decreased £60,000.

At the meeting on Tuesday the London County Council unanimously adopted a recommendation of the Highways Committee to apply to Parliament for powers to own and run omnibus services to link up tramway dead-ends, provide overlaps to traffic points, and to provide auxiliary services in connection with housing schemes and tramway extensions.

The recommendation of the Local Government Committee to ask the Government to institute an inquiry into the question of the unification of the administration of Greater London was also adopted.

In recognition of the services rendered by the motormen, conductors and other employees of the London County Council tramways department during the recent railway strike, the Highways Committee have granted them two days' leave with pay, at a cost approximately of £9,000. The Committee desire to place on record their appreciation of the loyalty and co-operation of the staff of the tramways department during the strike. It is recognised that a heavy strain was placed on the traffic staff, and all classes of employees who came into contact with the public did their utmost to cope with the emergency. The traffic receipts for the two weeks ended Oct. 1 and 8 amounted to £183,000, subject to adjustments, and the average weekly receipts for the previous four weeks were about £80,000, or £160,000 for two weeks, showing an increase of £23,000 during the period covered by the strike. The additional expenditure in connection with the strike will not exceed £5,000.

The Committee have also authorised the General Manager to take steps to terminate the employment of women tramcar conductors.

Imperial and Foreign Notes.

Mr. T. W. Bridges has been appointed to report on a hydro-electric scheme for Stawell and Ararat (Victoria).

Mr. R. Gibson has been appointed to be a member of the Electricity Commission of Victoria, to fill the vacancy caused by the resignation of Mr. A. McKinstry.

An inter-State conference, which met in Melbourne recently under the auspices of the Institute of Science and Industry, fixed standard specifications for tram rail sections. Engineers of State departments, municipalities and private companies controlling tramway systems were present at the conference, over which Prof. Lyle presided. At a previous conference the standardisation of rails for railway lines was dealt with.

Attempts are being made by estate owners in Jamaica to develop the water power of the island for the purpose of generating electrical energy for lighting and industrial purposes. A sugar manufacturer is utilising a fall of a stream on his estate and electrical energy will be supplied not only for operating sugar-making machinery, but also for an electric tramway for transporting the sugar to the port of shipment.

The Municipal Committee of Simla is extending its electricity generating plant by a further 500 kw. Soon after the armistice an order was placed with Messrs. Siemens Bros. & Company for the supply and laying of some 6 miles of h.t. underground cable, and orders will be placed for the supply of a 500 kw. alternator and turbines, switchgear, &c., shortly. It is intended to erect four new sub-stations to meet a local demand of 500 kw.

Mr. H. R. Harper, chief engineer and manager to the Victorian Electricity Commission, states that the conclusions reached by the Committee appointed in 1917 to report on the suggested use of Morwell brown coal for the generation of electrical energy are being generally adopted. The advisability of making use of the various water schemes in connection with the power house at Morwell will be considered. Sufficient details to enable Parliament to vote the necessary funds will be ready by the end of the year, and current should be available in Melbourne in three years from that time. It is estimated that 400,000 tons of brown coal per annum will be required to meet the demand in Melbourne.

An important report by Mr. C. H Merz (Messrs. Merz & McLellan). has been presented to the South African Government on the subject of Electrifying the South African Railways. The report deals with four sections of the railways, viz. : (1) The main line from Cape Town to Touws River and suburban lines in the Cape Peninsula, (2) the Natal main line from Durban to Glencoe Junction, (3) the Witbank-Germiston-Randfontein line, and (4) the Delagoa Bay line from Witbank to Komati Poort. We hope to give a full abstract of the report in an early issue, but we learn from "The Times" that it deals fully with the economies to be effected by the adoption of electric traction. It is suggested that preliminary steps for converting the Durban-Glencoe Junction section of the Natal main line (about 250 miles of track) be taken immediately. Then the Rand lines, the Vryheid branch of the Natal line, the Cape Peninsula and Cape main line to Touws River, and finally the Witbank-Komati Poort sections should be successfully electrified. The direct current system with overhead transmission is recommended; the average voltage of supply being placed at 3,000. For main line traffic goods locomotives with a tractive effort of 48,000 lb., and passenger locomotives with a tractive effort of about 30,000 lb., capable of hauling a 600-ton load up a gradient of 1 in 60, are proposed. For suburban trains multiple unit cars would be employed. For the Natal line the erection of power stations at Durban and Tayside, near Glencoe Junction, is suggested, Generating stations for the other sections would be required at Cape Town, Touws River, and Komati Poort. A hydro-electric station at Olifants River and the utilisation of the Victoria Falls Power Company's net-work are proposed in the case of the Rand area.

* * *

Imports into Finland of railway and tram rails are now free of duty.

It is announced that the registration of trade marks has been resumed by the Rumanian Government.

The Danish prohibition against the export of various articles, including the following, has been withdrawn:—Mica, motor vehicles, platinum and platinum wire, vulcanised fibres, X-ray apparatus, &c.

The Electric Welding Company (Cia de Soldaduras Electricas), of Argentina, and the Cia Telefonica y Luz Electricas del Chubut have recently been authorised by Argentine National Government Decrees to commence operations.

The restriction upon the importation of the following articles into Finland has been removed : —Vulcanised fibre, aluminium and its alloys, railway and tramcars, asbestos, manganese, bauxite, insulators (whether combined with metal or not), glass insulators, mercury and mercury alloys, &c.

The French Chamber of Deputies is considering a scheme for developing the Water-power of the Rhone from the Swiss frontier to the sea and developing it for navigation, &c. It is estimated that the cost will amount to £90,000,000, and it is proposed to appeal to small investors of the cities of Paris, Lyons and Marseilles and the chambers of commerce and the manufacturers in the Valley of the Rhone to create a national company, which would be managed not by officials, but by manufacturers, merchants, consumers of electric power, and by representatives of the State. The harnessing of the Rhone will yield about 800,000 h.p. of electrical energy for lighting, traction and industrial purposes.

The official opening of the first section of the Madrid Underground Railway took place on Friday last in the presence of King Alfonso. This is the first tube railway to be constructed in Spain; it is 4 km. (2½ miles), runs north to south (from Cuatro Caminos to the Puerta del Sol), the central part of the metropolis. Practically the whole of the material and rolling stock are of native manufacture, and the enterprise has been financed by purely Spanish capital. The directors and engineers are Spanish, while the first name on the list of shareholders is that of King Alfonso, after whom the concern is called "The Metropolitan Company Alfonso XIII." The cost of the first section has been about 8,000,000 pesetas (about £320,000). There is a double electric track, capable of running a three-minute service both ways, each train conveying up to 500 persons if necessary. It is reported that the line is proving very popular, and work on the second section will be commenced immediately.

Miscellaneous.

It is announced that the Tungsten and Molybdenite Order, 1917, is suspended from the 18th inst.

The Corporation of Glasgow are promoting a British Science and Key Industries Exhibition, which will take place in the Kelvin Hall of Industry a fortnight after the closing of the present highly successful Housing Exhibition.

The September issue of the "Electric Power Engineer," the official organ of the Electrical Power Engineers' Association, contains the conclusion of the discussion on the Advantages of Amalgamation with the Society of Technical Engineers, articles on demobilised engineers and superannuation, reports from sections and other matters of domestic interest.

An association has been formed of members of the Signal Company, R.N.D., who were at Oxney Bottom, in order to meet once a year and dine together to celebrate members' service with the colours. The dinner will be held on Nov. 5 of each year. Tickets will be half a guinea. Evening dress will be worn with a small white ensign in the buttonhole. The hon. secretary is Mr. Ernest A. Gordon, 9, Finchley-road, St. John's Wood, N.W.8.

A public lecture on "Recent Developments in Public and Private Lighting" will be delivered by Mr. W. C. Clinton, B.Sc., M.Inst.E.E., at University College to-day (Friday), at 5 p.m. The lecturer will deal with the new sources of light that have become available within the last 10 years, and the increased efficiency and convenience due to their introduction. Tickets of admission from the Publication Secretary, University College, Gower-street, London, W.C. 1.

At Preston Quarter Sessions last week, Thos. A. Smith was sent to hard labour for three months on a charge of stealing 6 cwt. of copper cable and 18 cwt. of scrap lead, the property of the Blackpool Electricity Committee, and Jos. Regan, an army pensioner, was sentenced to four months in the second division. Richard Smith was found not guilty, and discharged.

The Committee appointed by the Board of Trade to consider and report upon Non-ferrous Mining in the United Kingdom held its first meeting after the recess on the 13th inst., under the chairmanship of Mr. H. B. Betterton, M.P. It has decided to deal in the first instance with tin mining, and subsequently the Committee will take up the question of zinc and lead mining. Evidence was given last week by Mr. C. A. Moreing, M.Inst.C.E., who stated that in his opinion the mines on the Redruth and Camborne line of lodes should be amalgamated and worked on a large scale, a plan which held out the only hope of economic success in the future. He pointed out the importance of the mining industry of Cornwall not only to those actually employed in the mines, but also to the country at large. This week the committee heard further evidence from Cornwall.

Tenders Invited and Accepted.

Manchester Tramways Committee invites tenders for the supply of permanent way special track work. Tenders to chairman by Nov. 11.

The time for the receipt of tenders by Invercargil (N.Z.) Council for the supply and erection of a steam turbo-alternator is extended from Oct. 9 to Oct. 30.

Walsall Corporation want tenders for tramway stores, including motor grease, oils, castings, trolley wheels, &c. Tender forms from the manager, and tenders to the Town Clerk by Nov. 1.

Merthyr Tydvil guardians require tenders for supply and erection of X-ray apparatus at their infirmary. Tenders to the Clerk (Mr. F. T. James), High-street, Merthyr Tydvil, by Oct. 31.

Manchester Waterworks Committee require tenders by Oct. 31 for a set of electrically-driven high-pressure centrifugal pumps. Specifications and tender forms from the Secretary, Waterworks Offices, Town Hall, Manchester.

Bolton Electricity Committee require tenders by noon Nov. 11 for the supply of an 8,000 kw. turbo-alternator, condensing plant, and four water-tube boilers. Specifications and tender forms from the Borough Electrical Engineer.

The Redding Co-operative Society require tenders for electrical and other work in connection with a new bakery and shops at Redding Muirhead, Polmont (Stirlingshire). Schedules from Messrs. Wilson & Tait, architects, Grangemouth.

Sydney (N.S.W.) Electric Lighting Department require tenders by 3 p.m. Jan. 19 for the supply of sub-station equipment (except power transformers) (contract 558). Specifications from the City Electrical Engineer.

Aberdare Tramways Committee invite tenders for the supply of 12 tramcars. Specifications from Mr. E. M. Lacey, 12, Victoria-street, London, S.W., and tenders to the Clerk of the Council (Mr. W. R. Morgan), Town Hall, Aberdare, by Nov. 1.

Johannesburg (Transvaal) Council require tenders by noon Nov. 24 for the supply of tramcar spares (contract No. 531), and by noon Dec. 1 for the supply, &c., of a 500-kw. converter, or, alternatively, a 750 kw converter, and spare parts (specification No. 114).

Rhondda Electricity Committee invite tenders for the supply and erection of two sets of sub-station switchgear. Specifications from the Engineer and Manager, Electricity Works, Porth, and tenders to the Chairman of the Committee, Pentre, Glam., by Nov. 5.

The directors of the North-Eastern Railway Company require tenders by 9 a.m. Oct. 27 for the supply of (1) telegraph apparatus and (2) telegraph wire and line stores for six or 12 months. Forms of tender from Mr. C. H. Ellison, Telegraph Superintendent, York.

The directors of the North-Eastern Railway Company also require tenders by 9 a.m. Oct. 27 for six or 12 months' supply of various stores and materials, including electric lighting sundry fittings, electric wires and cables, signal wire, &c. Forms of tender from the Stores Superintendent.

Tenders are required by Jan. 20 for the supply, &c., to the Australian Commonwealth Postmaster-General's Department, State of Victoria, of Automatic Telephone Switchboards at Collingwood, as per schedule 1,583. Tender forms, &c., from the High Commissioner, Room 406, Australia House, Strand, London, W.C.

Leeds City Council invite tenders for single phase, 2,000 and 6,600 volts, and Scott connected transformers, with a total capacity of 14,000 k.v.a., for early delivery, and also for further supplies of similar transformers as required for a period of two years. Specifications, &c., from the manager of the electricity department (Mr. C. Nelson Hefford), 1, Whitehall-road, Leeds. Tenders to the town clerk (Sir Robert E. Fox), 26, Great George-street, Leeds, by 11 a.m. Nov. 13..

Walthamstow Urban Council has ordered 20 tons of steel tramway rails from Messrs. Walter Scott, Ltd., at £21. 10s. per ton.

Belfast Corporation has accept ed the tender of the English Electric Company for the electrical equipment of 50 tramcars at £31,770.

York Corporation has authorised the Tramway Committee to accept a tender for the supply of material for the construction of an overhead trackless trolley line to Heworth.

Hackney (London) Borough Council has accepted the tender of Ransomes, Sims & Jeffries, Ltd., for the supply of two 2-ton electric vehicles at £1,195 each, and two 3½-ton vehicles at £1,364 each. Tenders were also received from the following firms: Richard Garrett & Sons, £1,090 and £1,245; General Vehicle Company, £1,120 and £1,310; Electromobile Company, £1,330 and £1,390; and Edison Accumulators, Ltd., £1,307 and £1,607 respectively.

Appointments Vacant and Filled.

A head of the physics department is required at Clifton College. Applications to the Headmaster by Nov. 8.

A meter tester is required by the Accrington Corporation Electrical Engineering Department. Salary £104 per annum, plus E.P.E.A. award of 20 per cent. and £90. Applications to Borough Electrical Engineer.

Telegraph inspectors and electrical mechanicians are required by the Posts and Telegraphs Department of the occupied territory of German East Africa. Applications to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1.

Applications are invited for the position of lecturer in electrical engineering at the University of Cape Town. Commencing salary £350, rising after three years' service by annual increments of £25 to £450, plus war bonus. Applications to the Secretary, High Commissioner for the Union of South Africa, 32, Victoria-street, S.W., by Nov. 30.

The Madras & Southern Mahratta Railway Company require an assistant on the staff of the Electrical and Telegraph Engineer. Salary from 400 to 650 rupees per month. Applications to Mr. H. Bonham-Carter, 25, Buckingham Palace-road, London, S.W. 1, by Oct 27.

Liverpool Tramway and Electric Power and Lighting Committee require a qualified engineer, with civil and electrical experience, to act as superintendent of the overhead line equipment, &c. Salary £500 per annum. Further particulars from the General Manager, Corporation Tramways, 24, Hatton-garden, Liverpool, to whom applications must be sent by Nov. 12.

The Corporation of the city of Cape Town invite applications for the position of station engineer. Salary £600 per annum. Applications by noon Jan. 3, 1920, to the town clerk, Mr. J. R. Finch, City Hall, Cape Town. The Corporation also invite applications for the position of temporary assistant engineer in the electricity department, salary £60 per month. Applications to the town clerk (Mr. J. R. Finch) by noon of Jan. 10, 1920. In both cases British candidates must send in applications to the London agents, Messrs. Davis & Soper, Ltd., 54, St. Mary Axe, E.C., by Nov. 15.

Major G. Thorp, O.B.E., R.E., has been appointed chief instructor of electricity at the School of Military Engineering, Chatham.

Mr. Alfred Smith, formerly superintendent of the Pacific Cable Board at Fanning Island and Vancouver, and recently of Auckland, has been appointed superintendent of the Pacific Cable Board at Sydney.

Business Items.

It is announced that the engineering firms of Messrs. Stothert & Pitt, Ltd., of Bath, and Torrence & Sons, Ltd., have agreed to amalgamate.

The proprietors of patent No. 21,783/1911, relating to "A process of making the active material for storage battery electrodes," desires to sell the patent or to grant licences. Further particulars from Messrs. Boult, Wade & Tennant, 111-112, Hatton-garden, London, E.C.

The proprietors of patent No. 24,392 of 1914, relating to "Signalling systems for controlling street traffic," desires to enter into arrangements for the Sale of the Patent Rights or for Granting Licences thereunder. Applications to Messrs. D. Young & Company, Patent Agents, 11, 12, Southampton-buildings, London, W.C. 2.

The Westinghouse Morse Chain Company, Ltd., has been recently formed in order to take over the Rocker Joint Chain Drive Department of the Westinghouse Brake Company, and a factory has been acquired at Letchworth. Mr. Edward Flex will act as general manager of the new company.

An eight-page pamphlet recently issued by Messrs. C. A. Vandervel & Company, of Acton, London, W., is devoted to a brief description of the C. A. V. standardised electric lighting and starting equipment, with diagrams of connections and notes on the maintenance of accumulators, &c. The equipment is described in semi-technical but clear language, and should prove useful to the many motorists who are called upon to use C. A. V. apparatus.

The General Electric Company, Ltd., 67, Queen Victoria-street, E.C.4, has issued a neat 10-page booklet which gives particulars of prices of the automobile type of Osram G.E.C. lamps. Headlight, sidelight, tail and dashboard lamps suitable for all kinds of motor cars, as well as lamps for interior lighting, &c., are listed. Tables of ratings and prices and of lighting-up times are included. Although specially designed for automobile and aeronautical work the lamps can equally be used for other purposes.

Owing to the greatly increased demand for their paper pinions the British Insulated & Helsby Cables, Ltd., of Prescot and London, have been compelled to issue a new catalogue which gives full particulars of, and the data necessary for placing orders for Prescot paper pinions. If customers prefer to cut their own wheels the company quote for the paper blanks built up and machined ready for cutting, and a special graphite lubricant is supplied for use with the pinions. The catalogue gives tables of standard keyways and of circular and diametral pitch.

The British Insulated & Helsby Cables, Ltd., of Prescot and London, have also issued a number of pamphlets dealing with other branches of their manufactures. Catalogue P.155 is devoted to Prescot porcelain insulation for the overhead equipment of electric tramways and railways. A number of Prescot green glaze insulators, hangers, shackles, &c., are described and illustrated. Leaflets P.156 and 157 deal with Prescot anti-acid and insulating varnishes; while H.82 relates to the Helsby condenser and points out the advantages of the Helsby condenser series system in cheapening and simplifying the electric lighting of the many new houses which are about to be erected all over the country. The Helsby condenser system can only be used on a.c. supply and a wiring diagram is included.

The very appropriate title of "The Henley Telegraph" has been chosen for the staff magazine of Messrs. W. T. Henley's Telegraph Works Company. The September issue of the magazine, which will be published quarterly in future, is brightly written and well edited. Apart from domestic news items, staff changes, social club notes, &c., there are some contributions of distinct literary merit. The right note is struck in the editorial, which states that "we want 'The Henley Telegraph' to be an organ of good feeling. We want it to knit closely the best interests of the staff and the Company. It is to be essentially a *staff* magazine, but we hope and feel that its varying features of gravity and gaiety will find much interest among many another good man and woman outside the staff."

From Batteries, Ltd., of Redditch, we have received a catalogue which contains an illustrated description of the "Ni-Fe" accumulator. The inventor of the accumulator, which is of the nickel-iron-alkaline type, is Dr. V. Jungner, a Swedish electrical engineer and scientist, and Batteries, Ltd., have secured the patent rights for the United Kingdom and the colonies. The "Ni-Fe" battery has been manufactured since 1911 in Sweden, and it is used extensively in that country for electric locomotives in factories and mines, on railways, for pleasure cars and commercial motor cars, and also for country house lighting and various other purposes. The accumulator, which has no lead or acid in its construction, is claimed to be unusually strong and light, and to have other advantages over the lead type of battery. We hope to publish further particulars of the battery in an early issue.

We have received a copy of the first issue of "Business Organisation and Management," a monthly magazine intended for the accountant, the secretary, the manager and all engaged in commerce and industry. The reading matter in the present issue covers a wide ground. Matters of moment relating to the industry and commerce of the country are ably discussed, while such subjects as the Registration of Companies, Indian Trade, Income Tax, Transport, Commercial Law, Costing, Office Management, Office Lighting, &c., are dealt with, each by a writer well qualified in every respect to contribute to the literature of the subject on which he writes. The article on Office Lighting is by Mr. Leon Gaster, and other contributors are Sir Charles W. Macara, Bart., Sir Edward Braybrook, Mr. Wm. Schooling, C.B.E., Mr. F. D. Head, B.A., and Mr. P. D. Leake. The magazine is published by Messrs. I. Pitman & Sons at 1s. 6d.

Companies' Reports, &c.

The United River Plate Company, Ltd., has declared an interim dividend of 3 per cent. (3s. per share), tax free, for the half-year ended June 30.

Callender's Cable & Construction Company, Ltd., has declared an interim dividend of 5s. per share, less tax, on the ordinary shares, payable Nov. 1.

The directors of the Electrical Utilities Corpn., Ltd., have declared a dividend of 1¼ per cent. on the preferred stock for the quarter ended Sept. 30.

At the meeting of the Parsons Marine Steam Turbine Company, Ltd., on Tuesday, a final dividend of 15 per cent. was declared, making 25 per cent. for the year.

An interim dividend at the rate of 6 per cent. per annum has been declared by the Shanghai Electric Construction Corporation, Ltd., compared with 5 per cent. last year.

The directors of the Indo-European Telegraph Company, Ltd., have declared an interim dividend for the half-year ended June 30 at the rate of 5 per cent. per annum, tax free.

The directors of the Shanghai Electric Construction Company, Ltd., bave declared an interim dividend at the rate of 6 per cent. actual (12s. per share), less tax), in respect of the year 1919, compared with 5 per cent. (10s. per share) in 1918.

The report of Automatic Telephones (Australia), Ltd., for the year ended June 30, shows a profit of £6,375. A dividend of 10 per cent. was recommended, payable in half-yearly instalments of 5 per cent., the next instalment being due in February, 1920.

In a circular issued by the Nairobi Electric Power & Lighting Company, Ltd., it is stated that it is now possible to procure further machinery and plant required to meet local needs at Nairobi. The goods are in course of shipment, and the directors anticipate an expenditure of approximately £10,000. Part of this is being paid for out of revenue, but the directors have decided to make a further issue of shares, not to exceed £5,000, in part payment of the plant.

The report of the Compania Marconi de Telegrafia Sin Hilos del Rio de la Plata for the year ended May 31, 1919, states that, with the termination of hostilities, it became possible to proceed with the construction of the company's station. The company's rights are no longer limited to the exploitation of the Marconi system of wireless telegraphy. The company recently called for tenders for the erection of towers and machinery. The transmission station will be on the north-west of the city of Buenos Ayres and not at Veronica as originally proposed.

Extraordinary general meetings of the shareholders of Brotherton Tubes & Conduits, Ltd., have been convened for approving a conditional agreement which the directors have entered into with Edison Swan Electric Company, Ltd. The agreement provides for the change of the Company's name to "Brotherton Ediswan Tubes & Conduits, Limited," and the increase of the capital from £13,000 to £51,000 by the creation of 65,000 further ordinary shares and 25,000 cumulative participating preference shares of £1 each, which latter the Edison Company agree to take up and pay for in full. The agreement also contains provisions defining the interests of the preference shareholders and providing for their representation on the board, &c. The Edison Swan Company will take from the Brotherton Company exclusively such goods as it manufactures, and two of the Edison Swan Company directors will join the board of the Company. It is proposed to offer the 65,000 new ordinary shares to existing shareholders at 8s. per share.

New Companies.

ELECTRO-METALLURGICAL EXTRACTION, LTD. (159,732).—Reg. Oct. 17. Capital £30,000 in £1 shares. To manufacture, produce, refine, sell and deal in all chemical elements, compounds, products, &c., and to enter into an agreement with J. J. Collins. Solicitors: Herbert Smith & Co., 62, London Wall, E.C.

EVANS, DEWHURST & COLLEY, LTD. (159,568.)—Private company; reg. Oct. 14, capital £5,000 in £1 shares. Objects: To carry on the business of electricians, mechanical engineers, manufacturers, and workers of and dealers in electricity, &c. First directors are W. J. Thomas (chairman), D. J. Evans, W. B. Dewhurst and A. H. Colley (all permanent). D. J. Evans and W. R. Dewhurst are joint managing directors. Solicitor, T. John, 1, Castle-street, Cardiff.

FEUERHEERD'S ROTORS (BRITISH EMPIRE), LTD. (159,606.)—Private company; reg. Oct. 16, capital £240,000 in £10 shares. Objects: To take over an invention relating to rotary engines and pumps, air compressors and the like, for use within the British Empire, and to enter into certain agreements. First directors are E. M. Feuerheerd and C. F. K. Quack. Reg. office, New Bridge-street House, E.C.

FOX BROTHERS (SWANSEA), LTD. (159,569.)—Private company; reg. Oct. 14, capital £1,500 in £1 shares. Objects: To carry on the business of motor, mechanical, electrical and general engineers, &c. First directors are T. Tyrrell, G. R. Griffiths, C. W. Fox, C. W. Clements, W. H. Fox and G. W. Fox (all permanent). Secretary, C. W. Clements. Reg. office, Burrows-place, South Dock, Swansea.

HOLLINWOOD ELECTRIC LIGHT & POWER COMPANY, LTD. (159,575.) Private company; reg. Oct. 14, capital £3,000 in £1 shares. Objects: To take over the business of an electrical engineer and supplier carried on as "S. Stapleton," by S. L. Stapleton at Hollinwood, Oldham. S. L. Stapleton is permanent director. Reg. office, 205, Manchester-road, Hollinwood, Oldham.

MICA MFG. COMPANY, LTD. (159,410)—Private company. Reg. Oct. 8, capital £25,000 in £1 shares, to carry on the business of manufacturers, importers and exporters of and dealers in mica, micanite and insulating materials, paints, varnishes, papers and paper cloths, electric, chemical and other machinery, &c. First directors are P. Freeman (managing director), T. J. Sack (works manager of micanite department) and G. H. Hadder (works manager of mica department), all permanent. Reg. office: 22½, Cazenove-road, N.16.

NEWCASTLE ENGINEERING COMPANY, LTD. (159,077)—Private company, reg. Sept. 24, capital £25,000 in £1 shares; objects, to take over the business of engineers and machinery merchants carried on at Tyne Dock Entrance, Corsterphine Town, South Shields, as "Reed and Foggin," and to carry on the business of manufacturers and repairers of internal combustion and other engines and electrical and other motors, &c. First directors are J. C. Gunn, W. T. H. Foggin, S. Gunn, W. R. Potter and J. H. Reed and one other.

NEWMAN TRADING COMPANY, LTD. (159,296)—Private company. Reg. Oct. 3, capital £5,250 in 5,000 ordinary shares of £1 each and 5,000 deferred shares of 1s. each, to carry on the business of manufacturers' agents, manufacturers, merchants, exporters, importers, dealers in manufactured goods, &c. First directors are: R. C. Boin and A. Marque. Reg. office: 1, Newman-street, W.1.

NORTH BRITISH TOOLS COMPANY, LTD. (10,646)—Private company. Reg. in Edinburgh Oct. 2, capital £6,000 in £1 shares, to carry on the business of mechanical, motor and electric engineers, tool makers, &c. Reg. office: 198, St. Vincent-street, Glasgow.

VICKERS-ORIENT, LTD (159,684.)—Private company; reg. Oct. 16, capital £10,000 in £1 shares. Objects: To carry on the business of manufacturers of and dealers in steel, iron, brass and metals of all kinds, shipbuilders, electricians, &c. Reg. office, Vickers House, Broadway, Westminster, S.W.

VICKERS (NEW ZEALAND), LTD. (159,523.)—Private company; reg. Oct. 11, capital £5,000 in £1 shares. Objects; To carry on the business of manufacturers of and dealers in steel, iron, brass and metals of all kinds, shipbuilders, &c. Reg. office, Vickers House, Broadway, Westminster, S.W.

Prices of Metals, Chemicals, &c.

Tuesday, Oct. 21.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£115 0 0	£1 0 0	—
Electrolytic bars ...	,,	£121 0 0	—	—
H.C. wire basis......	per lb.	1s. $4\frac{1}{16}$d.	—	—
Sheet	,,	1s. 4d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. $8\frac{1}{16}$d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 11½d.	⅛d.	—
Sheet, basis	,,	1s. 2⅝d.	—	⅛d.
Wire, basis	,,	1s. 2½d.	—	⅛d.
Iron—				
Cleveland Pig	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	£33 10 0	£1 0 0	—
Lead Pig—				
English	,,	30 0 0	£1 0 0	—
Foreign or colonial	,,	29 10 0	£1 15 0	—
Tin—Ingot	,,	282 0 0	—	£1 15 0
Wire, basis	per lb.	0 3 6	—	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £21.

,, (Roll Brimstone).—Per ton £21.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6d.

Shellac.—470s. December delivery 455s.

Rubber.—Para fine, 2s. 6d.: plantation 1st. latex 2s. 3¾d. lb.

Thirty-Seven Years Ago.

[From The Electrician, Oct. 21, 1882.]

Rates to Valparaiso.—We are informed by the Direct Spanish Telegraph Company that their rate to Valparaiso and other stations in Chili has been reduced from £1. 4s. to 14s. 8d. per word.

Electric Light in Shipbuilding Yards.—The extensive shipbuilding yard, shops, and sheds of Messrs. Pearce Bros., at Dundee, are to be lighted by means of arc lamps, supplied by the Northern Electric Light Company, of Dundee.

A Conference on the Electric Light.—The Camberwell Vestry have decided to invite all the vestries and boards of works in the south of London to hold a conference on the provisions of the Electric Lighting Act, and the question of electric lighting generally.

Undertakers and Electricity.—A member of the Kensington Vestry asked the somewhat pertinent question, "What has electricity to do with undertakers?" at a recent meeting. Unfortunately the lugubrious term has become law, and is to be found at every turn in the Electric Lighting Act, 1882. We confess that we are in accord with Mr. William Griffith when he prefers the old term "promoter" to that of "undertaker."

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ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

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Notes.

Breakdowns at Generating Stations.

THERE is no question that the breakdown of plant at generating stations is becoming a far too frequent event at the present time. We need only mention Accrington, Bradford, Sunderland and the Greenwich power station of the L.C.C. tramways as recent examples. In the first named we understand that the cause of the trouble was inferior coal. This, of course, may reduce the steam that is available very materially, and may thus render it impossible to carry the full load. Failure from this cause, however, is a very different matter from the breakdown of turbine plant or of electric generators, for such occurrences are independent of the steam supply. It is these which are really the serious features of recent difficulties. During the last two or three years we have repeatedly called attention to the absolute importance of maintaining sufficient reserve plant. It is not realised by the lay official that generating plant cannot be run day in and day out with the certainty of giving a continuous supply. Overhauling is necessary, and consequently it becomes essential to carry out extensions sufficiently in advance of the load that is to be supplied, and thus to enable overhauling to be effected with regularity. The electricity supply industry is, no doubt, at present reaping the bad effects of an enforced policy of restriction ; but now that the war is over it might be thought that new plant could be readily obtained. Unfortunately, in practice this is not the case. Indeed, the conditions are in some respects worse than during the war. In those days it was at least possible to obtain priority certificates, but at the present time such certificates are not available, and consequently orders for new plant must take their chance. The general experience is that manufacturers have their hands full of orders, and have, indeed, more work than they can carry through in a reasonable time. Consequently it follows that orders for new plant, even though very urgent, may be very considerably deferred. It is difficult to know what remedy can be adopted. We think, however, that something might be done if the various associations which are particularly interested in electricity supply and power supply were to come together and were to represent to the manufacturers concerned the extreme importance from every point of view of giving priority to plant for extensions of electricity works. It seems to us that something in the nature of a priority certificate might be arranged in this unofficial way, which would be helpful to the industry, and thus avoid increasing the difficulties to which we have alluded.

The Electric Heating of Water.

ALTHOUGH the heating of water by electrical methods makes no very notable headway, we do not doubt that it will come in the course of time. The methods at present in vogue for heating water are often of the crudest possible kind, especially in the kitchen of the ordinary house. Moreover, such methods, especially under present conditions, often suffer from serious inconvenience, and therefore the convenience of an electric water heater would be worth paying for so long as the extra running costs were not too serious. At the moment, electricity supply tariffs are unfavourable owing to numerous war charges, but we all hope that this is only a passing feature. There are, however, other aspects of the question. For industrial purposes a supply of hot water is often necessary, either occasionally at stated intervals, or steadily over a known period of the day. An interesting example of this kind is reported from Germany, where a dairy was provided with hot water for its purpose. The installation replaced a boiler and steam pump, which required a good deal of repair. The local company for the supply of electric energy in rural districts, of a kind common in Germany, advised on the matter, and agreed to supply the power at certain hours of the day. The whole installation was completed for £60 at pre-war prices, and has worked perfectly satisfactorily since 1913 without the need for any repairs whatever. It has taken about 5,000 units a year, though this has varied somewhat, partly from causes due to the war. In normal times the load might be expected to be fairly steady, and appears to last about six hours a day. And as the hours of consumption can be regulated by agreement, the load appears to be on a profitable basis for the supply company. Plainly, the whole installation is quite on a small scale, but it may be taken at a type of the industrial application of the heating of water by electricity, which might become fairly common if only sufficient brains and energy were put into the development of this field of activity.

The Demand for Condensed Information.

A feature of the scientific literature of the present day, which is commented upon in a recent issue of "The Engineer," is the demand for brevity. Few scientists and engineers are now able to do more than glance over abstracts, except, possibly, in the branch in which they specialise. They are obliged to take in tabloid form what their forefathers took in doses, and there has been a steady tendency towards abstracting scientific literature. The recent departure of the Institution of Civil Engineers in issuing their Abstracts as a separate publication is an instance in point. We fear that this tendency is inevitable, though we do not think it is wholly good. A very short abstract, even if skilfully prepared and with judicious selection of material, is commonly only useful to an expert as an indicator; it points the way to sources of detailed information. This is, in general, the chief value of abstracts from the standpoint of serious study, and it is for this reason that we lay stress on the judgment and ability of the abstractor. The secondary use of abstracts is to give a bird's-eye view of progress, necessarily superficial, unless supplemented by study of the original source; but yet of value as a means of disseminating general scientific knowledge. This function is, however, to some extent impaired by the fact that abstracts are, very properly, prepared by experts for experts, and are therefore not always capable of easy assimilation by the casual reader. The chief problem of the present time, and it is admitted not easy of solution, is to correlate all these sources of condensed information which are now coming forward, and prevent undue overlapping of effort. From this point of view, we should have liked to see the new series of abstracts, dealing with civil engineering, issued as an additional section of "Science Abstracts."

The Energy Component in Industry.

The three chief elements required for the production of any commodity are raw materials, labour and energy. The engineer is specially interested in the last named item, and it is most instructive to survey industry as a whole and to ascertain in what field the use of energy, especially electrical energy, is most evident. We observe in the "Electrical World" some statistics derived from the American census of manufactures for the year 1914 which are of interest in this connection. The figures relate to about 275,000 plants, and the most striking fact is that in the period 1909 1914 the installation of power as a whole increased by 20·7 per cent., although the cost of energy advanced by only 17 per cent. The horse-power per wage earner advanced from 2·8 to 3·2. A 20 per cent. increase in power equipment was thus accompanied by a 10 per cent. increase in the average wage, and by a 3 per cent. decrease in the cost of energy per horse-power. These figures deserve attention at the present moment as showing how increased use of power not only increases production, but also wages. In regard to electrical equipment, the figures are equally striking. In 1909 25·8 per cent. of manufacturing power was electrical, in 1914 39·5 per cent. There was an increase of 84 per cent. in motor installations and of 52 per cent. in the degree of electrification. Much interesting information is also to be derived from the detailed statistics for individual industries. We notice, for example, that iron and steel heads the list in the installation of power, and that 45 per cent. of this was electrical. But lumber, which comes next, used only 6·8 per cent. of electrical power. So far as the installation of motors is concerned, iron and steel is easily first, with 30 per cent. of the total, and textile next (11·3 per cent. of total). It would be interesting to make a comparison with similar figures for this country, and we commend this matter to the notice of bodies concerned with electric development. Such a comparison would, of course, reveal a smaller use of power in this country per wage-earner, and it might also be found that in certain industries the percentage in electric power was unduly low, and that these industries should, therefore, be specially catered for by propaganda.

◆

The Dynamicables.—A dinner of the Dynamicables will be held on Wednesday next, at 6.45 p.m., at the Trocadero Restaurant, when the chair will be taken by Mr. A. A. Campbell Swinton.

Industrial League and Council.—On November 4 a lecture will be given at the Guildhall by Dr. Russell Wells on "Higher Commercial Education and the Universities," and on November 5 there will be a lecture at the Institute of Journalists by Mr. W. J. Grosert on "Standard Factory Organisation."

Institution of Civil Engineers.—The 101st Session of the Institution of Civil Engineers will be opened on Tuesday, November 4, at 5.30 p.m., when Sir John Purser Griffith, President, will deliver an address, and will present awards made by the Council for Papers dealt with during the past Session.

A "Strike Issue" of "Chemical and Metallurgical Engineering."—In our last issue we gave an account of how the printers' strike in New York had effected the issue of the "Electrical World." A similar strike issue of "Chemical and Metallurgical Engineering" has now come to hand. This issue also consists of a single type-written sheet. In their case, however, the strike is the more unfortunate, as a weekly issue instead of a monthly issue was to have been begun on October 1.

National Employers' Convention.—We are informed that a convention with this title, organised by Mr. H. N. Casson, will take place at the Central Hall, Westminster, on Thursday, November 6. In the morning the subject for discussion will be "What We Can Do Ourselves," and in the afternoon "What the Government Can Do." A prominent business man will introduce each subject, and committees will be appointed to discuss and draw up resolutions. Admission will be by ticket only. In the evening a mass meeting will be held, when the committees will present their reports and Mr. Casson will deliver an address on "The Rights of British Managers and Employers." Those wishing to attend latter are also asked to apply for tickets.

Institution of Electrical Engineers.—The opening meeting of the Institution of Electrical Engineers for the forthcoming Session will take place at the Institution of Civil Engineers, Great George-street, London, S.W., on Thursday, November 13, at 6 p.m., when the president, Mr. Roger T. Smith, will deliver his Inaugural Address. Light refreshments will be served at 5.30 p.m.

A reunion dinner of the Midland Centre will be held at the Grand Hotel, Birmingham, on November 5 at 7 p.m., a reception previously taking place from 6.30 p.m. to 7 p.m. The cost of the tickets is 12s. 6d. each, exclusive of wine. The Chairman and Committee trust that this dinner will be largely attended as it is felt it will provide an opportunity for meeting friends who have been scattered during the war. The time table has been so arranged that the speeches will be concluded by 9 p.m., with a view to allowing members who have come from a distance to return to their homes the same night.

The Transition from War Work to Peace. The experience of the New England Westinghouse Company (U.S.A.) in re-adapting its machinery to peace work, is no doubt typical of many large concerns at the present moment. It was formerly chiefly occupied on a large order for Russian rifles, and was also turning out large quantities of machine guns. The whole equipment has now been re-modelled for the production of small motors, special attention being devoted to washing-machine motors and ignition sets. The "Electrical World" contains an interesting account of the new arrangements. The plant was originally built without crane equipment, so that the change to the manufacture of relatively small motors was a natural one. Group driving is still employed, and there are now in use about 700 motors, ranging from ¼ h.p. to 100 h.p. with an aggregate capacity of about 2,500 h.p. Electric automatically controlled coil-drying ovens are also largely employed. We observe that energy is received from a hydro-electric station at 5,500 volts, and distributed at 440 volts to the working secondaries.

Industrial Councils for the West of England.—A meeting of representatives of the electricity supply undertakings both of local authorities and companies and of trades unions representing employees in the electricity supply industry, was held at Bristol, on Monday last, for the purpose of forming a District Council for Herefordshire, Gloucestershire, Somersetshire, Wiltshire and the part of Devon including Barnstaple, Ilfracombe and Lynton, in connection with the National Industrial Council for the Electricity Supply Industry set up under the Whitley Report. The constitution setting out the functions and conduct of business of the District Council which had been circulated was approved and adopted. The officers elected to serve on the Council were :—*Hon. Chairman*, Mr. H. Faraday Proctor ; *Hon. Vice-Chairman*, Mr. G. W. Betteridge (District Secretary of the Gas and Municipal Workers) ; *Joint Hon. Secretaries*, Mr. Thos. H. Gait (Bristol Corporation Electricity Department) and Mr. A. Hawker (Local Secretary Union of General Workers). The address of the Council is : The Electricity Department, The Exchange, Bristol.

A Research Association for Fuel Oil.—Members of the Diesel Engine Users' Association and others interested in the work of the Association met at a dinner at the Connaught Rooms, London, on the 23rd inst. In proposing the toast of the Association, Sir Frank Heath, K.C.B., Secretary to the Department of Scientific and Industrial Research, referred to the proposal that an Association should be formed for carrying out research work on liquid fuels for Diesel and Semi-Diesel oil engines under the Government scheme for industrial research. He understood the whole question had been considered at the meeting of the Association which had been held that day. He thought that, in dealing with the fuel problem, if the user and the fuel producer could combine and obtain an interchange of knowledge, then success would be far more easily attainable. He noted with approval that it was the intention of the Association to invite the co-operation of fuel producers and oil engine makers in connection with research work for fuel oils best suited to their purpose. His Department would be pleased to assist them in this matter in a substantial way. The Fuel Research Board were now working on the question of treating coal in such a manner as to produce a fuel oil suitable for use in internal combustion engines, and he thought that the work which they were carrying out ought to be of great assistance to the Diesel Engine Users' Association.

Recent Developments in Public and Private Lighting.—A public lecture on the above subject was delivered at University College, London, by Mr. W. C. Clinton on Oct. 24. The lecture was illustrated by numerous exhibits and lantern slides, all the typical modern electric lamps being shown. Among other demonstrations Mr. Clinton showed the marked alteration in tint of a series of coloured plates when the mercury tube light, the quartz tube mercury lamp, and the gas-filled lamp were switched on in succession. A demonstration of the " Pointolite " lamp was also given. A series of slides illustrated the comparative thicknesses of actual carbon and tungsten filaments, and also of spiralised tungsten filaments as used in gas-filled lamps. The chief systems of lighting, direct and indirect, cornice lighting, &c., were discussed by the aid of illustrations of well-known installations, and the development in public lighting from 1882 (when only 0·2 c.p. per watt was obtained from glow lamps and 0·5 c.p. per watt from arc lamps) to 1914 when the corresponding figures were 2·0 c.p. and 3·5 c.p. per watt respectively. It was also shown that on the Embankment the actual cost of lighting increased from 3s. to 10s. per hour during this same period, but the cost per 1,000 c.p. hours fell from 1s. to 3s. 4d. Another feature of interest was the display of some early French prints showing how the central suspension system of street lighting, regarded as a modern development, was employed with oil lanterns in Paris as early as 1720.

Association of Mining Electrical Engineers.—The annual meeting was held at Edinburgh on Friday and Saturday, Mr. C. A. Carlow presiding. The report of the Advisory Committee stated that at June 30th last the membership had risen to 1,288, and of that total 439 belonged to the three branches in Scotland. Mr. Carlow was reappointed President ; Dr. W. M. Thornton, Newcastle-on-Tyne, and Mr. C. F. Alexander, Nuneaton, Vice-Presidents ; and Bailie A. Anderson, Wishaw, Treasurer. The first gold medal awarded by the Association was presented to Mr. Gay, of South Wales, the most successful student of the past year.

In the course of his presidential address, Mr. Carlow said it was obvious that Britain's industrial supremacy was bound up with her coal supply. Great economies must be introduced in the consumption of coal which had been wasted in a most serious manner in the past because of its cheapness and plentiful supply. Their methods of producing power, and, to a lesser extent, light, had admittedly been very extravagant. During the near future and for many years to come the export of coal was bound to be greatly reduced, and further restriction of output might render export altogether impossible if this country was to be adequately supplied. In 1913 the coal trade provided more than 10 per cent. of the total exports of the country. A nation, like an individual, must get richer or poorer according to the difference between income and expenditure, and to cut off 10 per cent. of income in the face of rising expenditure might well make one pause to think. In regard to education and other matters he was of opinion that some good would result from periodical intercourse between representatives of the workmen and the local management at the mines. Referring to systems of payment, he said that as much as possible of the work should be done on piece-work, and any tendency to increase the proportion of shift work was to be deprecated. It was the duty of mining and electrical engineers, by assiduously applying themselves to present difficulties and courageously facing the unknown, to bring the industry to the highest possible point of efficiency, remembering always that the interests of the country and the Empire were at stake.

Personal.

Sir John A. F. Aspinall has resigned his position as a director of the Lancashire & Yorkshire Railway Company in consequence of his appointment as Consulting Mechanical Engineer in the Ministry of Transport.

The President of the Board of Trade has appointed Mr. Andrew Rae Duncan to be Controller of Coal Mines in place of Sir Evan Jones, Bart., M.P., resigned.

Sir Henry A. Miers, D.Sc., F.R.S., Vice-Chancellor of the University of Manchester, has been appointed a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

Lieut. A. H. Desforges, late R.A.F., has returned to Messrs. Siemens Brothers & Company, Ltd., Woolwich, after an absence of about three years on active service.

Sir Richard Glazebrook, late director of the National Physical Laboratory, is to be presented in December by the staff with his portrait in oils, the work of his cousin, Mr. H. Glazebrook.

Arrangements for the Week.

FRIDAY, Oct. 31st (to-day).

Junior Institution of Engineers.

7.20 p.m. At 39, Victoria-street, London, S.W. Social Evening.

TUESDAY, Nov. 4th.

The Institution of Civil Engineers.

5.30 p.m. At Great George-street, Westminster, London, S.W. Address by the President, Sir John Purser Griffith.

Rontgen Society.

8.15 p.m. At the Medical Society of London, 11, Chandos-street, Cavendish-square, London, W.1. General Meeting. Description and demonstration of Apparatus.

WEDNESDAY, Nov. 5th.

Liverpool Engineering Society.

8 p.m. At the Royal Institution, Colquitt-street. Inaugural Address will be delivered by the President.

FRIDAY, Nov. 7th.

The Technical Inspection Association.

7.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Paper will be read on "The Spectroscope in the Science of To-day," by Prof. Baly, C.B.E., F.R.S.

SATURDAY, Nov 8th

Birmingham and District Electric Club.

7 p.m. At the Grand Hotel, Colmore-row, Birmingham. Paper to be read on " Automatic Telephones," by Mr T. Pettigrew.

Improvements in the Starting and Controlling of Rotary Converters.

(a) *Self-Synchronising Converters.*

As is well known, it is usually required nowadays that rotary converters shall be of the self-synchronising type. The use of these machines facilitates the running of the sub-stations, and it can be taken that this practice is now standard.

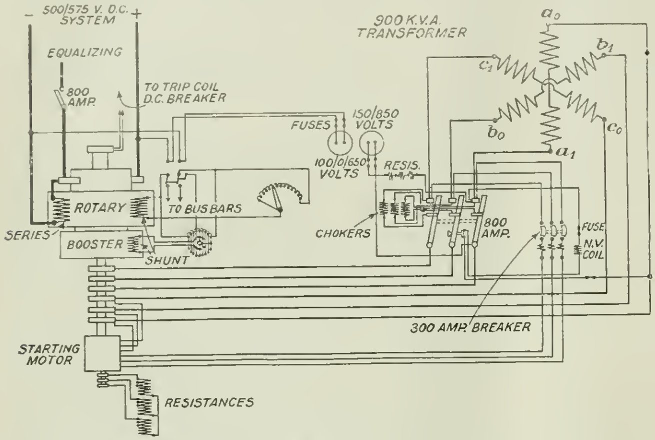

Fig. 1.—Diagram of Connections for Self-Synchronising Rotary Converter. (General Electric Company, Ltd.)

Fig. 1 illustrates the scheme of connections of the self-synchronising converters as now supplied by the General Electric Company, Ltd. The essential features are the synchronising switch shown in greater detail in Fig. 2, and the choking coils indicated in Fig. 1. A complete panel for controlling a self-synchronising rotary converter is shown in Fig. 3, from which it will be seen that the gear required is of the simplest possible character.

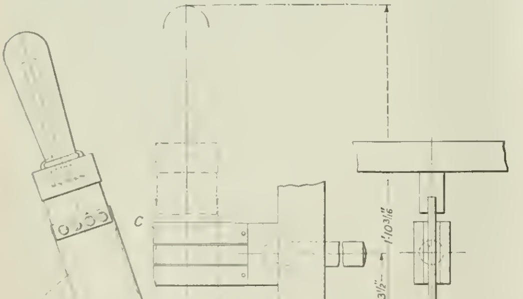

Fig. 2.—Front View Showing Switch in Synchronising Position.

The rotary converter is provided with a starting motor, which is set into rotation by closing the triple-pole circuit-breaker shown at the top of the panel in Fig. 3. This brings the set up to approximately synchronous speed. Meanwhile the starting switch, shown in Fig. 2, is closed into its starting position, where the blade *A* makes contact on to the long synchronising contact *B*. Reference to Fig. 1 shows that under these conditions the slip-rings of the rotary are connected to the source of alternating-current supply through the choking coils which limit the current taken by the machine. This current, however, is sufficient to pull the set into synchronism. When this has happened the synchronising switch is pushed right home, so that the blade *A* goes into the full-on contacts *C*.

Fig. 2 shows the mechanism which prevents the attendant accidentally closing the synchronising switch straight away on to its fully-closed position. It will be seen that the steel pin *G* is fixed to the blade *A*. On closing the switch, *G* is led, by means of *D* and the hinged piece *E*, to impinge against *F*, which arrests the movement of the blade *A* in the starting position. It will be understood that *F* and *D* form part of one slotted piece of steel, which is hinged at *H*. On slightly pulling *A* towards the "off" position the pin *G* releases the slotted bar, which falls under its own weight, allowing the pin *G* to pass along the slot and permitting the synchronising switch to be pushed right home. When this happens an interlocking contact is operated which opens the no-volt coil of the starting motor circuit-breaker, tripping the latter, so that the converter set is left in synchronism with the starting motor disconnected.

At the bottom of Fig. 1 a resistance will be seen connected to the slip-rings of the starting motor. This is a fixed resistance, and is adjusted once and for all when the set is first put into use, so as to give the best value of slip to the starting motor and so as to necessitate the minimum value of synchronising current.

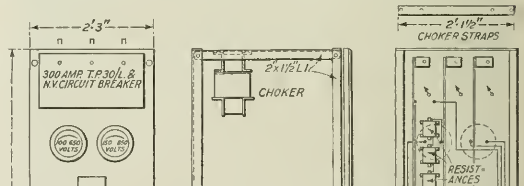

Fig. 3.—750 kw. 500/575-volt Rotary Self-Synchronising Panel for Plymouth Corporation.

(*b*) *Rotary Converters in Parallel.*

It is well known that if it be attempted to run two rotary converters in parallel on both the continuous-current and alternating-current sides, difficulties are experienced in that the load divides itself unequally between the two machines, depending upon slight differences in resistance on the commutators and the like. When an alternator has been required, therefore, to feed directly two rotaries in parallel it has commonly been arranged with two separate and distinct windings, one for each rotary. The method adopted by the General Electric Company is illustrated in Fig. 4. It will be seen that a balancing transformer is used. This transformer consists of three cores upon each leg of which two windings are arranged, each winding being in series with the corresponding phase of either converter. It will be clear from this that when the currents are equal, the windings being reversed with regard to each other, no magnetism is induced in the core of the balancing transformer. Directly the currents become unequal, however, the magnetic balance is upset and a voltage is induced in the one winding of such a character as to restore the balance.

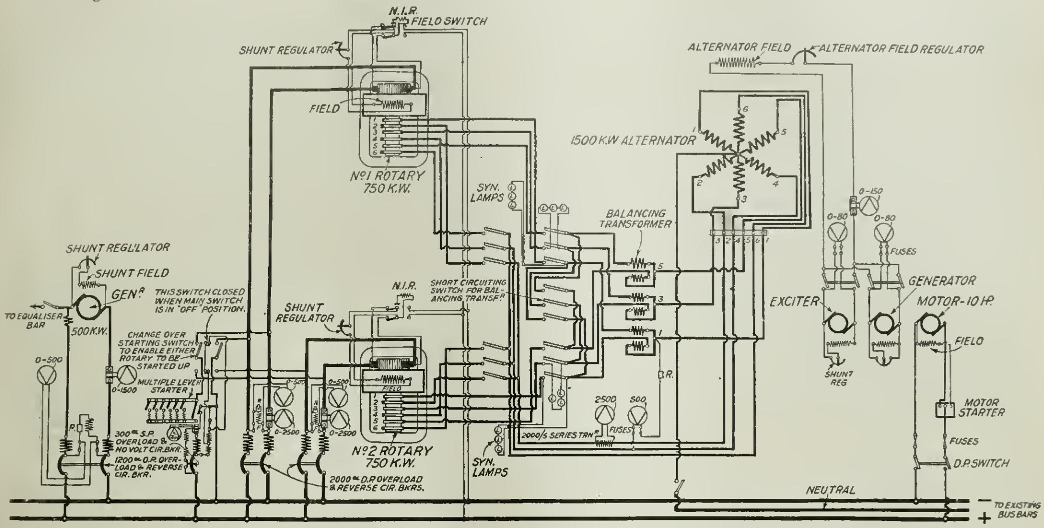

Fig. 4.—Diagram of Connections for the Parallel Running of Rotary Converters.

It is found in practice that quite a small balancing transformer is sufficient to balance large machines, and this scheme has been in successful operation in several places.

Fig. 5 shows a balancing transformer for two 750 kw. rotaries standing in a trench behind the switchboard. The size of this transformer is approximately 2 ft. 5 in. × 1 ft. 1½ in. × 3 ft. 0 in. overall.

These methods above described of self-synchronising rotary converters and for running two rotary converters in parallel form the subject of various patents granted to C. C. Garrard and the General Electric Company, Ltd.

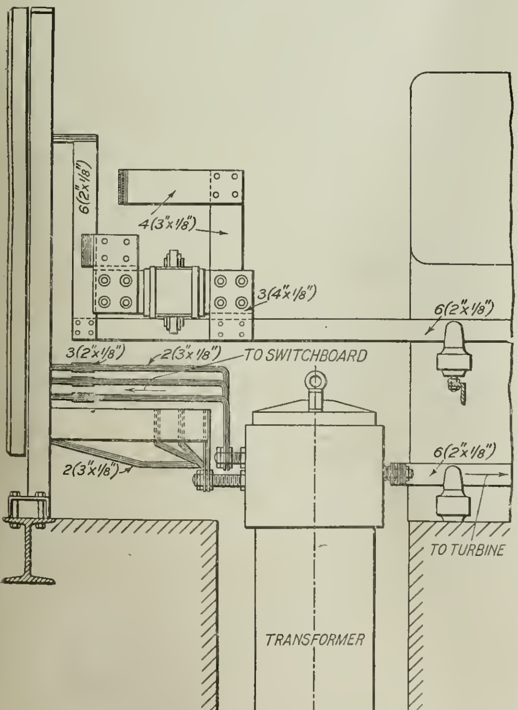

Fig. 5.—Balancing Transformer for the Parallel Running of Rotary Converters.

Telegraphy with Infra-Red Rays.—In addition to the experiments with thermopiles, connected to a galvanometer, for the detection of objects by the heat radiated from them, infra-red rays have been applied for signalling purposes during the war. In the "Génie Civil" an account is given of the arrangements devised by Messrs. J. H. Stevens and A. Larigairdie, which has enabled messages to be conveyed by heat rays for distances up to 20 km. The analyst uses a thermopile at the focus of a parabolic mirror as the receiver, and an electric arc projector, covered by a special black glass screen coated with manganese peroxide as the source. This screen diminishes the total radiation by 50 per cent., but completely blocks visible rays, thus rendering the signalling a secret process. The receiver is also recommended for use at sea in detecting approaching icebergs, and the authors have devised a special form of galvanometer, unaffected by rolling or pitching, for use in this case.

The Electrical Properties of Iron Alloys.*

By E. GUMLICH.

The committee appointed some years ago to investigate the magnetic properties of iron, in so far as they depend on chemical constitution and thermal treatment, soon discovered that very little systematic work had been done and very little was accurately known. A large number of persons and firms, therefore, interested themselves in the matter. The plan was to take commercially pure iron, and to add to it definite amounts of other chemically pure elements. The most important of these are carbon, manganese and silicon; secondarily, aluminium is, perhaps, less important; but this was also, included, though not sulphur or phosphorus. A muffle furnace, heated by gas, was used, which was capable of heating rings 30 cm. in diameter, weighing 10 kg. But it was later found more convenient to use an electrically-heated tube furnace, which would take rods or narrow bundles of sheet iron. This avoided the indirect effects due to the atmosphere of gas, and enabled experiments to be carried out more or less in a vacuum. The original Paper contains full particulars of the magnetic investigations, which were carried from 0·5 to 300 gauss. The coercive force and the saturation point were determined for each alloy. The initial permeability was also determined for very weak fields, and this point has lately become of technical importance in connection with certain types of galvanometer and transformer. The specific resistance, the temperature coefficient of the resistance between 20°C. and 100°C., and the density of the alloy, were also investigated.

As is to be expected, the so-called "change points" are of importance; taken in connection with the thermal treatment, they exercise an effect on the magnetic properties of iron. The first of the three first "change points" is the temperature at which the carbon is separated from the iron carbide, which is in itself slightly magnetisable, and is known by the name of cementite. If there is less than 1 per cent. of carbon, the separation takes a laminated form, which has a pearly appearance, and gives rise to the name "perlite," which is strongly magnetisable. The separation of the carbon can, under certain circumstances, be avoided by the sudden cooling of the iron from a high temperature; this generally forms a hard steel, known as "martensite." This has lately been regarded at the first decomposition-product of a non-magnetic component, called "austenite," which is very difficult to obtain in a pure state. The first "change point" at 700°C. is very important in alloys containing carbon—*i.e.*, in all commercial forms of iron. The second "change point," between 760 deg. and 770 deg., is the ascending temperature at which α iron, which is magnetisable, changes into β iron, which is not. The third is at 900 deg., when β iron changes into γ iron, also non-magnetisable, but which contains the carbon in solution. The three "change points" for ascending temperatures are called Ac_1, Ac_2, Ac_3; for descending, Ar_1, Ar_2, Ar_3.

Samples 1 to 5 were iron, used in dynamos, or black iron plate; sample 6 was cast steel, with 0·55 per cent. of carbon; sample 7 was an alloy containing 3 per cent. of silicon. Samples 1 to 5 were very similar in chemical analysis, and contained 0·05 per cent. of carbon, 0·3 to 0·4 per cent. of manganese, 0·05 to 0·1 per cent. of sulphur and phosphorus. Beside this, there were some strips, 3 mm. thick, of Fischer's electrolytic iron, which is of an extraordinary degree of purity. It was first the intention to determine from these samples, and by extrapolation from the series of carbon, silicon, manganese and aluminium alloys, the true density and resistance of pure iron. Thus this value was obtained by a number of different processes, which all gave results which agreed to a very remarkable extent. The mean of the values thus obtained for the properties of pure iron were as follows: viz., the density 7·876; the resistance per metre at 20 deg. of a bar, 1 sq. mm. in cross-section, 0·0994 ohm; the temperature coefficient of the resistance, 0·573 per cent.; the saturation value 21,620. The figure for the resistance agrees with that obtained by Yensen, who found 0·0996. Bennedick's figure of 0·076 is undoubtedly much too low. The saturation value of 21,620 agrees exactly with that obtained from Fischer's electrolytic sample. From the samples 1 to 5 the following values for the "change points" were obtained—viz., $Ac_1=732$ deg.; $Ac_2=765$ deg.; $Ac_3=896$ deg.; $Ar_1=673$ deg.; $Ar_2=763$ deg.; $Ar_3=886$ deg. There is a certain temperature hysteresis to be noticed—*i.e.*, the values for ascending and descending temperatures differ, though this is not the case for the second "change point."

The magnetising curves of the material before heating showed no peculiarities. The coercive force with samples 1 to 5 for rods lay between 1·4 and 2·4; the remanence was about 10,000 and the maximum permeability was between 2,000 and 4,600. The rolling process made these figures worse for plates, but subsequent heating improved things. The samples were next heated for 24 hours in an atmosphere of nitrogen at temperatures of 660, 735, 785, 840, 900, 950 and 1,000 deg., which include all the "change-points." It was found that the best temperature for this process was 785 deg.; up to that temperature the coercive force fell, while the remanence and maximum permeability increased; beyond 785 deg. the figures fell off. The hysteresis curve for sheets became excessively steep through the heat treatment, the remanence rose nearly to 15,000. This heating to 785 deg. was repeated. With rods 6 mm. in diameter a slight improvement was noticed for four heat treatments; with sheets the best result was reached after the second or third heating. after which the figures began to fall off. The changes or improvements were mostly noticeable for low values of the induction or field strength; for high values there is no perceptible change of any note.

It was now a question as to whether the presence of nitrogen in the furnace exercised any determining effect. A vacuum tube furnace was therefore employed, and tests at 785 deg. and 900 deg. were carried out. Naturally a good deal of gas was given off, but this was removed by the pump. The result was surprising: The samples 1 to 5 were very decidedly improved at 785 deg.; with the sheets the improvement was completed in 24 hours. The best sheet had a coercive force of 0·64, and a maximum permeability of 10,800; η, the Steinmetz coefficient, was 0·00108. With rods the improvement continued during the second treatment. They had a coercive force between 0·37 and 0·53; amaximum permeability from 14,800 to 7,800; η varied from 0·00054 to 0·0007. The values of η were determined for an induction of 18,000. Technically, the ordinary induction is about 10,000, and the value would be correspondingly altered. The heat treatment at 900 deg. produced worse results than at 785 deg. Later attempts were made for shorter periods at 1,100 deg. in a vacuum. The results were distinctly worse than those as 785 deg., but perhaps slightly better than those at 900 deg., which was probably due to the shorter length (12 hours) of the heating process.

As for hydrogen, it is known to exercise a very marked hardening effect on pure iron. Electrolytically deposited iron contains a great volume of hydrogen, and is magnetically very hard. However, in that case we are dealing with nascent hydrogen. It seemed, however, important to determine whether the presence of hydrogen in a furnace exercised any deleterious influence. The result of tests on samples which were heated 24 hours in an atmosphere of hydrogen at 810 deg. was to show that a marked improvement was effected, but not so marked as with nitrogen.

The cause of the beneficial effect of the heat treatment has generally been supposed to be that it removes a certain mechanical hardness and tends to alter the structure. If this were so, one would expect a progressive improvement from thermal treatment. As we have seen, a prolonged thermal treatment produces finally a poorer result than one less prolonged. We are, therefore, lead to the conclusion that thermal treatment from the magnetic point of view injures the structure of the metal; but this injury is at first more than counterbalanced by the improved softness of tbe metal. Oxygen is supposed to be the most harmful gas which is present in iron, and it can only be removed by oxidising the carbon. This decarbonisation takes place more rapidly and completely in a vacuum, and more quickly in sheets than in rods. It also takes place more rapidly if the thermal treatment is repeated for short intervals rather than if continued for long ones. The relative content of carbon and oxygen is mainly the cause of improvement due to heat treatment. There is an element of chance about the results. It was not found possible to produce the same results with different samples from the same source. Some micrographic photographs of sections are given which were taken from a rod before and after a thermal treatment of 17 hours at 975 deg. in a vacuum. The perlite, which corresponded to the relatively high amount of carbon—viz., 0·55 per cent.—gradually seemed to disappear. The photographs show that this took place more at the edge of the rod than in the middle

It seemed possible that a high temperature during the rolling process might injure the sheet iron used in the construction of dynamos. It was also possible that the water used on parts of the rolling machinery might be decomposed by the red hot iron and th gases partially absorbed. Experiments were carried out to test this point with the practical help of a firm of ironworkers; but nothing could be definitely traced to either of these causes.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," Nos. 26 and 27, 1919, which contains an abstract of the Paper read before the annual meeting of the Verband Deutscher Elektrotechniker in Berlin. A complete report of the Paper is contained in the "Wissenschaftliche Abhandlungen der Reichsanstalt," Band IV., Heft 3, 1918, published by Julius Springer, Berlin.

The tendency of iron to "age" in the process of time is a well-known phenomenon; but a general investigation of the problem would take us too far. It must suffice to draw attention to some points. The German Verband Deutscher Elektrotechniker defines the "ageing coefficient" as the percentage change in the losses in the iron, due to a maximum induction of 10,000 c.g.s. after being heated for 600 hours to 100°C. Proceeding on this basis, we may examine the results of some tests. There were five samples which had the same chemical analysis and very similar magnetic properties. After heating in an atmosphere of nitrogen, one of these samples, which had been made by the Thomas process, showed a very much higher "ageing coefficient" than the others. This amounted to something between 1·6 and 2·1. All the other samples were made by the Siemens-Martin process, and after heating in a vacuum at 785deg. they had a coefficient of about 1·01; after heating in a vacuum at 900 deg. the coefficient was between 1·2 and 1·4; while with the Thomas steel the coefficient was nearly three times its original value. In the making of the material by the Thomas process, a current of air is passed through the fluid mass. It therefore seemed probable that a certain amount of oxygen might be occluded in the metal. It was shown to be the case that with specially prepared samples of pure iron, into which oxygen was artificially introduced, the ageing characteristics were specially bad. Alloyed metal does not show the same tendency to age, and this points to the fact that the oxygen, dissolved in the metal, is a contributory cause, because a portion of the silicon or aluminium is used in deoxidising the metal, and is removed in the form of slag. It is, therefore, fair to assume that the highly alloyed metal is more free from oxygen than the ordinary type. But even this does not fully explain the matter, and it must be supposed that certain obscure molecular changes gradually take place in the course of time, about which at present very little is known.

The next section of the Paper deals with carbon alloys, and a number of curves are given showing results of tests on samples from different makers. These include a study of the magnetic properties after slow cooling from 930 deg., and also after sudden cooling, together with the influence of vibration and heat; but no general conclusions are given on the subject, the authors confining themselves to a study of particular cases. The same thing is true to some extent about the author's treatment of other alloys, such as those containing aluminium, silicon or manganese. The reader must be referred to the original Paper for full details, as it is only possible here to find space for the general outline of the work. With regard to silicon, after the alloy is poured out into the moulds and allowed to cool slowly, some part of the carbon-content seems to disappear; in certain cases the coercive force is almost as low as that of pure iron. If suddenly cooled, the presence of silicon seems to prevent the formation of large quantities of "hardening" carbon, which is known to be specially harmful. The carbon impurities take the form of the comparatively harmless perlite; but this also decomposes. The carbon may combine with the occluded oxygen and escape in the form of carbon monoxide, or it may change under the action of silicon into ferrite and carbon, and is then magnetically almost harmless; but in order to obtain this result there must be at least 3 or 4 per cent. of silicon in the alloy. If aluminium is present in the alloy, it acts indirectly like silicon in almost precisely the same way. Thus, it has the same tendency to convert carbon into some harmless form, in so far as the magnetic properties of the metal are concerned.

Turbines for Mechanical Drives.*

By R. R. LEWIS.

To meet the demand for a reliable and efficient steam turbine in small and medium sizes to drive centrifugal pumps, fans and other moderate speed apparatus, the "Type L" mechanical drive turbine was designed.

These machines have been on the market about two years, and hundreds of them are in successful service. Many such turbines are located in basements and in more or less inaccessible places where they receive the minimum of care and attention; but their ruggedness and simplicity have enabled them to perform their duties under adverse conditions.

The design has been made as simple as possible; the turbine consisting essentially of a bucket wheel mounted on a shaft and enclosed in a steel casing, a nozzle for directing steam into the buckets, and an opening for the escape of exhaust steam. One of the greatest difficulties met in the design of this type of turbine was to achieve moderate cost and at the same time to make the machines suitable for a wide range of operating conditions. In driving centrifugal pumps the speed depends largely on the head under which the pump is to operate, and turbines for this service must run at speeds from 800 to 3,600 revs. per min. The steam pressure may be from 75 lb. to 200 lb. or over, the back pressure may be from atmospheric pressure to 20 lb. or 30 lb., or the turbine may be required to operate with a vacuum. The capacity required may be 10 B.P. or 600 H.P.

It would be out of the question to develop a special turbine for each combination of conditions; but practically the same result is secured by designing certain standard elements, a number of which can be combined to form a complete turbine that will exactly fit any particular case.

The plan of construction adopted involves the use of one, two or three bucket wheels, a variation in the length of the buckets, and the arc of steam admission through the first-stage nozzles. The size of the steam and exhaust connections and the governor parts for regulation at different speeds are also varied.

Before assembling one of these machines for a particular duty, it is necessary to know the

1. Capacity in brake-horse-power.
2. Steam pressure.
3. Superheat or moisture.
4. Back pressure, or vacuum.
5. Speed of revolution.
6. Direction of rotation.

It is optional whether the turbine shall have one, two, or three stages; but the machine with the greater number of stages usually is more efficient but more expensive.

The turbine is of the Curtis impulse type, in which the steam is given a relatively high velocity by passing through a divergent nozzle. It then immediately enters the revolving buckets, and as its velocity becomes reduced it gives up its energy to the buckets, causing a rotation of the wheel and shaft. The steam in entering the turbine passes first through the emergency valve chest (if one is used), then through a steam strainer which prevents the entrance of scale or other foreign particles. It next passes through the governor valve and enters the turbine proper through the first-stage nozzles. After passing through the buckets of a single-stage turbine it passes out of the exhaust opening. In the case of a two-stage turbine, the steam after leaving the first bucket wheel would pass through an opening in the diaphragm between the stages and through the second-stage nozzle, then through the second-stage buckets and into the exhaust.

The wheel casing is made of steel and is split horizontally. To this are bolted the high and low-pressure heads. The heads support the main bearing brackets and are provided with feet on which the turbine rests. The high-pressure head also supports the steam chest and governor valve. The low-pressure head carries the exhaust flange.

The wheel discs are of steel and are keyed to the shaft. Each disc carries two rows of buckets made of bronze and dovetailed around the periphery. The diaphragms are held by grooves in the casing. The bearings are babbitt lined and ring oiled. The governor is of the centrifugal type and is mounted on the end of the shaft. It operates, through a bell crank, the governor valve, which is of the double balanced poppet type.

By means of a simple device the speed may be altered while the turbine is running, the governer continuing to exert full control at the altered speed. When desirable, an emergency governor may be fitted to the machine. This device is entirely independent of the governor proper, and in emergency shuts off the steam supply and prevents excessive speed. For operation at two different steam pressures, or whenever the best efficiency is required at various conditions of load or speed, one or two hand valves may be used. These valves modify the effective capacity of the nozzles.

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* Abstract of an article in the "General Electric Review" (U.S.A.)

"British Westinghouse Gazette." The current issue of the British Westinghouse "Gazette and Club News" contains articles on "A New Electrically-Driven Winding Equipment at Kilton Collieries," by Mr. C. E. Raeburn, and on "Electrically-Driven Reversing Rolling Mill at Jarrow." The "Club News" sections deal exhaustively with the social activities of the employees at Trafford Park, from which we gather that they are a very happy family.

Electrification of Main Line Railways.*

By W. B. POTTER and S. D. TODD.

The relation of electricity to electrification is much the same as that of steam to the steam railroad, but the manifestation is different. We have switches instead of valves, solid conductors instead of pipes, contacts instead of pipe fittings, rotary motors instead of reciprocating engines: but these are differences in kind rather than in function.

There are several methods by which electrification may be accomplished, but the choice of the method and type of equipment demands care to ensure the best economic results. The interest on investment and the maintenance in particular are among the perpetual expenses which are largely determined by this choice.

The subject is one of world-wide importance, but seems to have been recognised, especially in the United States. In spite of our great mileage, we have more actual main line electrification and a greater proportion of our total mileage electrified than all the rest of the world. The 265,000 miles in the United States represents about 400,000 miles of single track. To this must be added about 50,000 miles of trolley lines, making the total railway single track in the United States approximately 450,000 miles.

In considering heavy electrification, if we eliminate the electric roads which are devoted strictly to motor car service, and include under our category those tracks, both steamroad and trolley, which are handling freight and passenger service, with electric locomotives, we find in the United States approximately 675 electric locomotives operating over 4,875 miles of route, or 8,300 miles of electrified track. Compared with this, in all the rest of the world there are approximately 450 electric locomotives operating over 1,000 miles of route, or 1,750 miles of track. Thus the percentage of electrified route mileage in the United States is about 10 times as much as the percentage in all other countries combined.

Reasons for Electrification.—The reasons justifying a change in motive power from steam to electricity on main line railroads have been often discussed. They include freedom from smoke and cinders, increased carrying capacity of track, decreased expense of operation, elimination of delays due to grades and other conditions, increased safety and reliability, and other similar advantages. Probably the freedom from smoke and cinders has been the most influential argument in the past. To-day, however, there are other special factors such as the conservation of fuel; 25 per cent. of the coal mined in the United States is used on its railroads.

To-day, however, there are other special factors such as the conservation of fuel. Twenty-five per cent. of the coal mined in the United States is used on its railroads.

During the year 1914 (including the estimated tonnage of cars and locomotives) the railway traffic amounted to about 1,000,000,000,000 ton-miles. Of this, the movement of coal for railway purposes, together with the coal cars and locomotive tenders carrying the same, amounted to about 12 per cent.

It will be of interest to estimate the electric power which would be required to move this tonnage exclusive of the railway coal haulage. The energy demand per 1,000-ton miles for railroad service varies widely under different conditions, but following tests on heavy railway service one may deduce an average of approximately 33 watt-hours at the power-house per ton-mile moved over the railroad. For contingencies we might increase this item approximately 20 per cent., and we have assumed in the following table 40 watt-hours per ton-mile as an amply conservative basis for estimating the electric energy:—

Power Demand for the Electric Operation of the Steam Railways in United States, 1914:—

Ton-miles, excluding tenders, but including 25 per cent. of railway coal cars ...	930,000,000,000
Watt-hours per ton-mile (assumed).........	40
Annual power	37,200,000,000kw.-hrs
Coal required at central steam power stations at 2·2 lb. per kw.-hour	40,000,000 tons
Average continuous load	4,250,000 kw

The actual fuel used on steam locomotives for 1914 was 128,400,000 tons of coal and 40,000,000 barrels of oil, or a total coal equivalent of 140,000,000 tons. The preceding table shows that the same tonnage could have been moved with electric locomotives by an expenditure of 40,000,000 tons—a saving of 100,000,000 tons per year.

We do not suggest that all railroads in this country will ever be operated electrically, certainly not within any reasonable time, but the figures presented emphasise the importance of considering railway electrification wherever the conditions admit. In the year 1914 the coal production for the country was 513,000,000 tons. Statistics for the last year are not available, but unofficial estimates have indicated that the coal production for 1918 was 685,000,000 tons. All the figures given in the preceding table would presumably be increased by 25 to 30 per cent. in order to represent conditions to-day. It is self-evident that the utilisation of water-power is of vital importance, as affording the only known means for effectually conserving our limited fuel supply. At the present time, the water-power development in the United States amounts to about 5,000,000 kw. Estimates as to the presumable ultimate development vary considerably, but are around 50,000,000 kw.

The relative amount of power required for complete railway electrification is less than is usually supposed. A number of power stations capable of delivering 37,200,000,000 kw.-hours per year, with an average 24-hour load of one-half the installed capacity, would have an aggregate installation of approximately 8,500,000 kw. In 1917 there were installed in central stations for lighting and power purposes, approximately 9,000,000 kw.; in railway power-stations 3,000,000 kw., and in isolated stations 8,000,000 kw., a total installed capacity of about 20,000,000 kw. Thus there is already installed in the country a power station capacity of over twice the requirements for operating all the railroads electrically. The power that would be required really is not excessive as compared with the electrical development which has already been accomplished.

The present tendency of modern power development, both steam and hydraulic, is towards the growth of large central power stations and inter-connected distributing systems, situated at points of cheap coal supply or of hydro-electric development. Besides power for cities and industries, the same systems could furnish power for the railways in their territory. The Montana Power Company may be cited for example. This company has 12 hydraulic power stations feeding into a common distribution system at 100,000 volts. The total installed capacity is approximately 175,000 kw. with possible extensions by future development of an equal amount. Power is furnished for lighting and industrial purposes to various cities throughout the State and also to the Chicago, Milwaukee & St. Paul Railway. The average 24-hour demand for the 440 miles of the Chicago, Milwaukee & St. Paul electrification is only in the order of 15,000 kw. with a maximum of about 28,000 kw.

Design of Locomotives.—A comparison of American electric locomotive development with European and particularly Continental, shows a characteristic difference in the method of transmitting the power of the motor to the driving wheels. In America the success attained with the many heavy high-speed motor cars, and the utilisation of these cars in many cases for hauling trains, led to the building of similar equipment for locomotive purposes only. This type represents the most economical design, but as the tractive effort is transmitted through the truck centre pin, it is commonly limited to a weight of about 60 tons. For heavier locomotives of this type, weighing from 60 to 100 tons, the two trucks are usually connected and the tractive effort transmitted directly through the trucks instead of through the locomotive frame. Continental designers, having had little experience with heavy motor car equipment, were sceptical of gearing and the practice of mounting motors directly on the axle. Their efforts have been mainly directed towards substituting the electric motor for the steam locomotive cylinder, retaining all of the side rods and adding a few more. There is a difference, however, between driving side rods from a steam piston and from a motor-driven crank. In a steam engine the maximum stresses and pin pressures, so far as driving power is concerned, may be predetermined from the piston area and steam pressure. In an electric locomotive having a motor-driven crank and side rods, the maximum stresses are influenced by variations in the wheel centres and the wear of bearings. The mechanical design must be strong enough to withstand the driving torque at an angle of 45 degrees from the centre, and at as much less angle as may result from the variations. The Continental locomotives show many variations. Out of nine European railroads operating 210 locomotives there are 28 different types, while out of 14 American railroads operating 364 locomotives only 21 types are represented.

The design of American locomotives for slow speed, freight and passenger service, has been influenced largely by the heavy motor car with motors geared directly to the driving axle. A gearless motor which could develop as tractive effort, a proportion of the weight on the axle comparable to the geared motor, would furnish a still simpler design. Recent developments indicate the possibility of such a gearless slow-speed locomotive.

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* Abstract of an article in the "General Electric Review." (U.S.A.)

The design of electric locomotives for high-speed passenger service at 60 to 80 miles per hour is a more complicated problem. A saving through the elimination of turn-tables, and incident delays, is obtained by designing the locomotive double-ended and capable of running equally well in both directions.

A problem in the design of a double-ended locomotive is to control the lateral oscillation and to minimise its effect on the track. The problem is to design a double-end locomotive with leading and trailing trucks having sufficient guiding force for the front end, and with such characteristics as to minimise the cause and effect of lateral oscillations. To minimise the cause of lateral oscillations the front and rear trucks should be restrained so far as possible from individual movement other than that essential to the proper guiding of the locomotive. A two-axle truck, with an articulated connection, accomplishes this result much more effectually than either a two-axle bogie or pony truck. To minimise the effect of lateral oscillations the truck will allow a time element during delivery of the thrust against the rail head, and any lateral thrust at the centre pin should produce a large vertical component at the outer guiding wheels. Raising the bearing point or centre plate of guiding trucks to 60 in. or 70 in. above the railhead enables these characteristics to be obtained.

For high-speed passenger service with speeds of the order of 60 to 80 miles per hour on a locomotive equipped with geared motors, the gear reduction approaches a small ratio if the armature is to be kept within practical rotative speeds. This presents the disadvantages of increased weight due to gears, with their cost of maintenance, without the compensating advantage of the increase in tractive effort usually gained by gear reduction. Consequently, for such speeds and for such service the gearless motor with the armature mounted directly on the axle appears to be the best solution.

Collection of Current.—The trolley pole and wheel which has so well served the electric railway is not well adapted for the heavy service we have been considering, nor is it a convenient device for movement in both directions. The pantograph collector, which requires no attention on reverse movement, has long been used, but it is only within the past few years that its capacity as a collecting device has been fully demonstrated. Rolling and sliding contacts have both been tried with results distinctly in favour of the slider. The wear of the working conductor, or trolley wire, is due more to the destruction by arcs at the point of contact than mechanical friction, hence the wire should be so supported as to eliminate any rigid spots which are the usual cause of this arcing. The wire should be lifted slightly and really supported by the collector rather than that the collector should run underneath a wire held in rigid relation to its support. Lubrication of the collecting surface not only reduces the wear but seems to slightly improve the contact, presumably because of less tendency to chatter than with bare metal. The amount of current that can be successfully collected is limited only by the current capacity of the working conductor. Tests have shown no arcing at the contact with 3,000 amperes at 30 miles, and 2,000 amperes have been collected with equal success at over 60 miles per hour. A copper conductor with copper wearing strips on the collector gives the best results. Measurements taken on the Milwaukee Railroad indicate the working conductor will have a life of over 100 years before it will have to be replaced because of wear.

Regeneration.—Regeneration as used in this connection implies the use of electric braking, and the utilisation of the energy in the train as electric power which is fed back into the distributing system. The train on a down grade drives the motors as generators, which is comparable to the action of falling water in a hydro-electric power station. Regeneration is of special advantage in the long grades encountered in mountain districts, and grades of 20 to 50 miles in continuous length are found on almost all the railway lines crossing the continental divide. It eliminates the surging in the train and the variations of speed which are encountered in holding the train by air brakes. In addition to this, the wear of brake shoes is eliminated and the delays which are often due to over-heated brake shoes on long grades are avoided. Electric braking takes place entirely at the front end of the train, taking up all slack, and permits the air reservoirs to remain fully charged in reserve for emergency. The power returned to the trolley by regeneration varies with the amount of the grade and the type of train. It has been shown that a train on a two per cent. grade has regenerated 42 per cent. of the power required to pull the same train up the grade. On a 1·66 per cent. grade 23 per cent. has been regenerated. The records for a particular month over the entire Rocky Mountain Division of the C. M. & St. P. for both freight and passenger trains show that the regeneration was equivalent to 11·3 per cent. of the total power used.

Conclusion.—We have attempted to give a broad survey of the field of railway electrification and some of the recent developments therein. Among the many reasons for considering railway electrifications, none stand forward so prominently as the possibilities in the direction of conservation of fuel supply. The fact that 140,000,000 tons of coal are used for railway service indicates that electrification will assume great importance in the conservation of fuel. On locomotives for freight and slow-speed passenger service it seems probable that the use of geared motors mounted directly on the axle will be continued. On locomotives for high-speed passenger work the motors will presumably have some type of gearing or preferably be of gearless design. The characteristics of the guiding trucks in their design and method of attachment are important for high-speed running. Incidental difficulties in connection with operation of heavy service electrically are being solved. The collection of any reasonable amount of current from an overhead conductor offers no difficulty; while regeneration solves the problem of braking on long grades and returning the available power to the power system instead of wasting it in brake shoes.

Presidential Address to the North-East Coast Institution of Engineers and Shipbuilders.*

By A. DOXFORD, M.A.

The point of most vital importance to us at the present time is the economic position. The situation is very serious and will require the co-operation of all classes to avert catastrophe, but this is surely not the time for pessimism. Prior to the war we were content to drift on a calm sea of optimism, and it is a lasting disgrace to those who were in power that they allowed such a state of ignorance to exist. Now, again, we are falling into the same error. Fears are expressed on all sides that civilisation itself is imperilled. But, after all, could one expect things to be otherwise? The evil that has risen must be skimmed off and not allowed to breed worse troubles for future generations. Let the people know what these evils are, and then the common sense of the nation will wipe them out of existence.

Two of the most important of these evils are greed and ignorance. The former has not been confined to one class, with the inevitable result that the cost of living has gone up, and the cost of production of goods for export is rapidly cutting us out of the world's markets and the balance of trade is becoming so adverse to this country that it will not take many years to make us bankrupt. Rumours were spread of the huge profits which were being made, with the result that the working classes rushed in to get their share of the plunder. Unfortunately, there was no plunder for anyone—the country was spending millions a day, not on the creation of wealth, but on instruments of destruction in the cause of civilisation. Much too little publicity has been given to the true economic position of the country, and this has given the extremist his opportunity to inflame the minds of the ignorant and lead the country perilously near to anarchy.

Both these great evils—greed and ignorance—can be overcome by education, and here the most important point to consider is the qualification of the teacher—he must be sound in first principles, sound in his facts, sound in his reasoning, and capable and willing to impart his knowledge to others. One would have thought that a common-sense nation would have seen the absolute necessity of paying well for such qualities, but, instead, we find that the teaching profession is one of the worst paid, with the natural result that we get either inferior or discontented teachers. This discontent is bound to be reflected, to a greater or less extent, in the mind of the pupil, and is the source of a great deal of our social unrest. If, in our reconstruction then, we put education foremost, we shall remedy not only many of the evils that existed prior to the war, but also the more virulent types that have arisen since. Let not only the teacher in our schools and the lecturer in our universities teach accurate facts and sound reasoning, but let also those whom we have chosen to guide and govern us state openly all the facts concerning our economic position and industrial unrest. Let them, from these facts, deduce a policy to remedy the truly critical position the country is in to-day, and they will find that, however drastic the remedies may be, all classes will loyally support them, if their deductions are in accordance with the facts.

The high cost of living, which is the chief cause of discontent to-day, can only be remedied by increased production per individual. Such a large increase in the output per man can be gained by payment by results, and the return to the workman is so much greater than when he is working on time that this method of payment is palpably the way out of our present difficulties, though here again education is needed to counteract the theory that the slower the work is done the more continuous the employment, and by increased production he will not only increase his wages but reduce the cost of living. He must also be educated to see the advantages of labour-saving devices.

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* Abstract. Delivered at Newcastle-on-Tyne, Oct. 24, 1919.

The question of education naturally brings one to the consideration of the *raison d'etre* of technical institutions. These are intended to disseminate knowledge by free intercourse and exchange of views and information. The great obstacle, of course, to obtaining this pooling of knowledge has been the competition to get work and make profits, but gradually the manufacturer is appreciating the fact that the cheaper an article can be produced the greater the demand, and therefore the less the difficulty in obtaining remunerative work. Technical institutions have gradually broken down trade secrecy, and it is in the earnest belief that in this direction we must work for the improvement of mankind, that your Council are endeavouring largely to increase the income of this Institution so that it may more adequately carry out the essentially necessary work it has undertaken.

An appeal has been sent out to the various Employers' Associations to assist in the establishment of institutions in the principal industrial centres of the North-East Coast and to inaugurate special annual lectures on those engineering and shipbuilding subjects with which the Institution is concerned. The work of research associations has been too little appreciated by manufacturers in the past, but, to anyone who heard Prof. McLennan's Paper read at the summer meeting of this Institution, I am sure the thought must have come that, if such marvellous progress can be made in four years of war our trades must enormously benefit if advantage is taken of the work of the scientific investigator. It is also proposed to establish a bureau of scientific intelligence.

Notes on the Localisation of Breaks or Faults in Submarine Cables.

By J. F. LLOYD.

There has been so much written in the past, by eminent electricians, on methods of localising breaks in submarine cables that the writer approaches the subject with diffidence, but at the same time feels that the following practical methods may prove useful in increasing the electrician's confidence in dealing with a subject in which there is always liable to be an element of doubt or uncertainty.

From observations made the following results were determined :—

(*a*) There is a natural current from the fault due to the E.M.F. set up by the proximity of the copper conductor and the iron sheathing wires of the cable, and the presence of salt water. This current assists the testing current.

(*b*) On applying a negative current (zinc to line) through a fault a polarisation E.M.F. is set up at the exposure. This polarisation E.M.F. predominates over the natural E.M.F. at the fault, the resultant effect being a current which opposes the testing current. That is (with no natural earth current present in the cable), the resistance measured on the bridge is too high by the amount of this apparent resistance due to polarisation of the break or fault.

(*c*) With earth currents present (that is, true earth currents induced in the cable due to varying potentials on the earth's surface) the resistance measured on the bridge may be too high, or too low, depending upon the direction of this earth current.

The combined apparent resistance due to polarisation and earth current may, for all practical purposes, be calculated direct from the bridge readings, in the following manner :—

1. Test to instrument, or scale zero, using a ratio of 2/1 with current to line of 20 milliamperes and 10 milliamperes.

Let result with 10 milliamperes $=A$.
Let result with 20 milliamperes $=B$.

2. Test to cable, or false zero, using Black's method with current to line of 20 milliamperes reduced to 10 milliamperes ; and 10 milliamperes reduced to 5 milliamperes.

Let result with 10 milliamperes reduced to 5 milliamperes $=A'$.
Let result with 20 milliamperes reduced to 10 milliamperes $=B'$.

In test 2 the difference $A'-B'$ may be taken to represent the fall d in the resistance of the fault or break, the apparent resistance due to earth current being eliminated, and the effect due to polarisation is practically negligible.

Now, taking test 1 and assuming—

$x=$Actual resistance to break or fault ;
$f=$Resistance of fault with lower current c.
$d=$Fall in resistance of fault due to larger current nc ;
$n=$Ratio of currents (in this case $n=2$) ;
$e/c=$Apparent resistance of earth current with current c ;
$e/nc=$Apparent resistance of earth current with current nc.
$A=$Resistance measured on bridge with current c.
$B=$Resistance measured on bridge with current nc.

Then, with a negative earth current

$$x+f=A-e/c=\text{I}.$$
$$x+(f-d)=B-e/nc=\text{II}.$$

Subtracting II. from I.

$$d=A-B-e/c\,.\,\frac{n-1}{n}$$
$$\therefore\ e/c=2(A-B-d),$$

and
$$e/nc=A-B-d,$$

and
$$x=A-(A-B)\frac{n}{n-1}-(f-2d)=\text{III}.$$

For all practical purposes e/c and e/nc may be taken as a measure of the combined apparent resistance due to polarisation and earth current which in the majority of cases (that is when the earth current opposes the testing current) is subtractive from the bridge reading.

It is now necessary to find a value for the factor $(f-2d)$.

Strictly speaking, the polarisation E.M.F. does not remain constant as the current is increased to nc, and therefore a slight error is introduced, but it is found that this error may be corrected by adding d to the resistance of the fault as determined by Kennelly's law.

The resistance of the fault with current c to line may then be taken as

$$f=\frac{\sqrt{n}}{\sqrt{n-1}}\,d+d,$$

which, with current ratio 2/1, is

$$f=4{\cdot}41d$$

and
$$f-2d=2{\cdot}41d.$$

Then
$$x=A-(A-B)2-2{\cdot}41d=\text{IV}.$$

Examples.—In the following examples the combined apparent resistance due to polarisation and earth current was measured in order to compare with the calculated value.

TEST 1.—Constant for measuring earth current and polarisation =6·57 milli-volts per scale division.

	INSTRUMENT ZERO			CABLE ZERO			
	Milli-amps.	Resistance measured.	Polarisation.		Milliamperes.	Resist. meas.	Difference d.
	Earth current before Test 81 divs. additive.						
B	20	2115	48 divs. subtractive	B'	20 red. to 10	2092	6
A	10	2139	45 divs. subtractive	A'	10 red. to 5	2098	

Polarisation (measured)—

$$\text{With 20 milliamperes}=\frac{48\times6{\cdot}57}{20}=15{\cdot}7\text{ ohms.}$$

$$\text{With 10 milliamperes}=\frac{45\times6{\cdot}57}{10}=29{\cdot}6\text{ ohms.}$$

Polarisation (calculated)—

$$A-B-d=24-6=18 \text{ ohms.}$$
$$2(A-B-d)= \quad 36 \text{ ohms.}$$

Then
$$A-e/c=2139-36=2103,$$
$$B-e/nc=2115-18=2097,$$
$$x=2103-(2103-2097)2-2{\cdot}41\times 6,$$
$$x=2076{\cdot}5 \text{ ohms to break.}$$

Or, taking IV. above—
$$x=2139-(2139-2115)2-2{\cdot}41\times 6,$$
$$x= \quad 2076{\cdot}5 \text{ ohms to break.}$$

Actual resistance to break was 2080 ohms.
Resistance of fault $=4{\cdot}41\times 6=26{\cdot}5$ ohms.

TEST 2.

	INSTRUMENT ZERO			CABLE ZERO		
	Milli-amps.	Resistance measured.	Polarisation and earth current.	Milli-amperes.	Resist. meas.	Difference d.
	Earth current before test 111 divs. subtractive (negative earth current).					
B	20	2185	233 divs. subtractive	B' 20 red. to 10	2094	} 5
A	10	2271	230 divs. subtractive	A' 10 red. to 5	2099	

Polarisation and earth current (measured)—

$$\text{With 20 milliamperes}=\frac{233\times 6{\cdot}57}{20}=76{\cdot}5 \text{ ohms (Subtractive).}$$

$$\text{With 10 milliamperes}=\frac{230\times 6{\cdot}57}{10}=151 \text{ ohms (Subtractive).}$$

Polarisation and earth current (calculated)—

$$A-B-d=86-5=81 \text{ ohms.}$$
$$2(A-B-d)= \quad 162 \text{ ohms.}$$
$$x=2271-(2271-2185)2-2{\cdot}41\times 5,$$
$$x= \quad 2087 \text{ ohms to break.}$$

Actual resistance to break was 2083 ohms.
Resistance of fault $=4{\cdot}41\times 5=22$ ohms.

TEST 3.

	INSTRUMENT ZERO			CABLE ZERO		
	Milli-amp.	Resistance Measured.	Polarisation and Earth Current.	Milli-amperes.	Resist. Meas.	Difference d.
	Earth current before test 229 divs. additive (positive earth current).					
B	20	2053	130 divs. additive	B' 20 red. to 10	2094	} 5
A	10	2012	132 divs. additive	A' 10 red. to 5	2099	

Polarisation and earth current (measured)—

$$\text{With 20 milliamperes}=\frac{130\times 6{\cdot}57}{20}=42{\cdot}7 \text{ ohms (Additive).}$$

$$\text{With 10 milliamperes}=\frac{132\times 6{\cdot}57}{10}=86{\cdot}7 \text{ ohms (Additive).}$$

Polarisation and earth current (calculated)—

$$B-A+d=46 \text{ ohms.}$$
$$2(B-A+d)=92 \text{ ohms.}$$

$$x=A+(B-A)2-2{\cdot}41d,$$
$$x=2012+(2053-2012)2-2{\cdot}41\times 5,$$
$$x= \quad 2082 \text{ ohms to break.}$$

Actual resistance to break was 2082 ohms.
Resistance of fault $=4{\cdot}41\times 5=22$ ohms

It is obvious that the calculation of the apparent resistance due to earth current and polarisation is not required in actual practice, the measurements being shown simply to prove the correction $2{\cdot}41d$.

When time permits it will be found advantageous to take three measurements to instrument and cable zero as follows :—

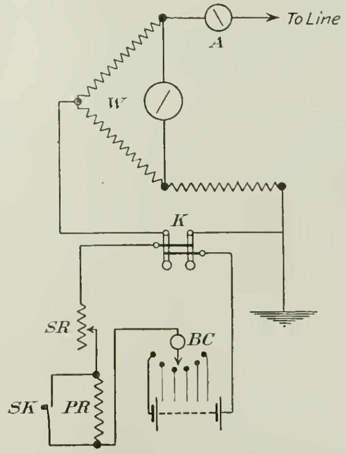
Instrument zero.	Cable zero.
With 20 milliamps. $=B$	20 milliamps. red. to 10 milliamps. $=B'$
„ 10 „ $=A$	10 „ „ „ 5 „ $=A'$
„ 5 „ $=C$	5 „ „ „ $2\frac{1}{2}$ „ $=C'$

On examination it should be found that $\frac{C'-A'}{A'-B'}$ is equal to or less than 2, it is certain that there is a good exposure and the higher current values with instrument zero (that is, 20 and 10 milliamperes) will give good results. On the other hand, should it be found that this ratio is greater than 2/1 either the exposure is very small or it is covered with mud. In these circumstances it is better to take the lower current instrument zero values (viz., 10 and 5 milliamperes), when d of course becomes equal to $C'-A'$.

It may seem awkward to always have to work to a determined current to line, but actually there is no difficulty, provided a battery commutator and a small variable slide resistance are included in the battery circuit. The number of cells should first be found, by means of the commutator, that will give approximately the current to line required (after obtaining an approximate balance on the bridge), it being then a simple matter to vary the slide resistance in order to obtain the actual current as balance is being approached.

To those who may be interested in Black's excellent reduced current method of testing the following observations may be useful :—

It was recognised by the writer that there was a law connecting the size, or in other words, the resistance of the exposure, and the difference between values obtained with two sets of reduced currents ; that is, the smaller the exposure the greater would be this difference, provided always that the same ratio of, and the same currents were used.



An endeavour was made to find a coefficient P, which is a function of this difference, and which when multiplied by this difference would give the resistance of the fault with the lower current.

Below is given this coefficient P for various differences $A'-B'$, when the currents to line are—

20 milliamperes reduced to 10 milliamperes $=B'$,
10 milliamperes reduced to 5 milliamperes $=A'$

P.	$A'-B'$.	P.	$A'-B'$.
3·45	2·5	3·29	10·0
3·44	3·0	3·28	10·5
3·43	3·0	3·27	11·0
3·42	3·5	3·26	11·5
3·41	4·0	3·25	12·0
3·40	4·5	3·24	12·5
3·39	5·0	3·23	13·0
3·38	5·5	3·22	13·5
3·37	6·0	3·21	14·0
3·36	6·5	3·19	15·0
3·35	7·0	3·17	16·0
3·34	7·5	3·15	17·0
3·33	8·0	3·13	18·0
3·32	8·5	3·11	19·0
3·31	9·0	2·99	20·0
3·30	9·5		

Then $$x=A'-(A'-B')P.$$

For reasons which have been stated previously it will also be found advantageous in this case to take three measurements, viz. :—

20 milliamperes reduced to $10=B'$,
10 milliamperes reduced to $5=A'$,
5 milliamperes reduced to $2\frac{1}{2}=C'$.

Should it be found that $\dfrac{C'-A'}{A'-B'}$ is equal to, or less than 2, then the higher current values will give good results, that is,

$$x=A'-(A'-B')P.$$

Should this ratio be between 2/1 and 3/1 it shows that the exposure is very small and in this case it is better to take the lower current values, that is,

$$x=C'-(C'-A')P.$$

If greater than 3/1 or 4/1 the gas is not escaping at the exposure, and any result determined on can only be in the nature of an approximation.

Examples.—

Milliamperes.		Resistance.		
20 reduced to 10	B'	1120	$d=7$	For $d=7$ $P=3{\cdot}35$
10 reduced to 5	A'	1127	$d'=9$	
5 reduced to 2½	C'	1136		

Then as $9/7=1{\cdot}28$

$$x=A'-(A'-B')P,$$
$$x=1127-7\times3{\cdot}35,$$
$$x=\quad 1103{\cdot}5 \text{ ohms to break.}$$

Actual resistance to break was 1104 ohms.

Milliamperes.		Resistance.		
20 reduced to 10	B'	1172	$d=6$	For $d=20$ $P=2{\cdot}99$
10 reduced to 5	A'	1178	$d'=20$	
5 reduced to 2½	C'	1198		

Then, as $20/6=3{\cdot}33$,

$$x=C'-(C'-A')P,$$
$$x=1198-20\times2{\cdot}99,$$
$$x=\quad 1138 \text{ ohms to break.}$$

Actual resistance was 1133 ohms to break.

It is advisable to use a fairly dead beat and not too sensitive galvanometer of the D'Arsonval type. For use on board ship the T. C. & M. Company's balanced galvanometer will be found very serviceable.

When the break is close in, insert 1,000 ohms in series with the line, and deduct from the result.

A diagram of connections is given on p. 499, in which

W is the ordinary Wheatstone bridge arrangement (a shunt and short-circuiting key should be included across the galvanometer, and a short-circuiting key across the milamperemeter *A*).
K Battery key,
SR Variable slide resistance,
PR Ordinary plug resistance inserted by means of *SK* when desired to halve the current,
BC Battery commutator.

Checking the Alignment of Diesel Engine Shafts.*

By GEO. E. WINDELER.

Experience shows that regular periodic overhauls obtain more efficient service out of engines with a lower average cost of upkeep. Engines overhauled only when they are on the point of breakdown are more costly in upkeep, and the user should realise that it is to his interest to keep his engine in first-class condition. Seeing that Diesel engine plants have had to run many hours owing to the extensive demand for electric power for war purposes, it may be assumed that many are in a state requiring considerable overhaul, and the present period is opportune for this work to be carried out.

One of the most important items is the question of alignment of the crankshaft, and I propose to refer to a simple and reliable method of detecting "out of alignment." The alignment of an engine is a most important factor. If the parts are aligned in a satisfactory manner there will be greater smoothness of working, less wear and tear and less tendency to break down at critical periods. It is not essential that an engine bedplate should be absolutely dead level, as would be indicated by a spirit level, but that when an engine bedplate is laid down its shaft should be lying in its bearings parallel with the top machined surface of the bedplate, and the shaft journals should be lying evenly and concentrically in the whole of the bearings in which they will work. From the top of the bedplate the whole of the superstructure and other portions of the engine will be erected. In the case of a vertical engine, these parts should stand correctly at right angles to the top of the bedplate, and therefore to the axis of the shaft. The crankshaft, formed with large intermittent gaps, produces a comparatively weak structure, which is liable to spring under ordinary handling; therefore great care must be exercised when bedding in a shaft to be sure that it is not strained in any way. Before proceeding to bed in a crankshaft precautions should be taken to observe that the bearing shells are bedded accurately, and without spring or slackness into the bedplate housings. The shaft should then be tried in its bearings and tested for concentricity and roundness of its journals. Neglect of this point is certain to produce unsatisfactory running results. If the journals of the shaft are not concentric with each other or are out of round they should be filed and lapped or re-machined. The former course is the one usually adopted. When these parts are fitted the shaft should then be bedded in its bearings, the bearings closed down to their normal running clearance and the caps screwed hard home. This may be accepted as the usual procedure for bedding in a crankshaft.

But the question arises how to determine when it is necessary that this work shall be carried out. We will assume that an engine has been at work for some time, and that the engine user is contemplating an overhaul or refit. The chief consideration is time, and naturally he wishes to determine beforehand the amount of work that requires to be carried out. The most important points to consider with the crankshaft are: (*a*) Is it being properly supported in its bearings? (*b*) Are the bearings in a satisfactory condition? (*c*) Are all the bearings, including the outboard bearing or bearings, in alignment with each other?

These important and difficult questions have not hitherto been easy to answer and decide.

The first indication of a shaft being imperfectly supported in its bearings is excessive end play on the shaft with the flywheel running out of truth. In most Diesel engine crankshafts the end movement of the shaft is limited by certain thrust collars, and it has been noticed that the end movement has often been seriously in excess of the actual mechanical clearance allowed. This excess led me to form the opinion that the excessive end movement was produced by the springing of the crankshaft for want of support, and that actually the shaft was being extended and contracted in length by the opening and closing of the gap between the crank webs. The difficulty was how to measure this distortion with the engine parts all erected, to decide the amount of want of support, and where the measurement should take place. The next step was to investigate whether the amount could be measured with the engine at rest and the whole of the reciprocating parts in position. It was decided to measure the distance between the crank webs when the crank pin was on the top centre and when the crank pin was on the bottom centre. It was found that a few thousandths difference in the dimensions between the crank webs when the crank pin was on the top and bottom centre indicated that the shaft was out of line. This method was especially valuable in checking the alignment of outboard bearings. It was proved that, if a shaft was not being supported at a particular point, by placing the crank pin of that particular line of parts adjacent to the unsupported bearings at (*a*) the top centre and measuring between the crank webs at a predetermined point, and then (*b*) placing the crank pin on the bottom centre and measuring as before, a distinct difference was noticed. If the bearing was low the crank webs would close in when the pin was on the bottom centre, and open out when the pin was on the top centre. If an outerboard was low the reverse was the case, the weight of flywheel causing the crank webs to open when the crank pin was on the bottom centre and close in when crank pin was on top centre. It can thus readily be determined which bearing or bearings are low, and the higher bearings can then be scraped down to suit. This simple method can be applied by anyone, and does not require any special skill or training.

The instrument first used for these tests was an inside micrometer, having telescopic rods so that variable lengths could be dealt with. This instrument required very skilful handling, and a device was produced which could be used by anyone, and would register correctly the amount of difference in the dimensions taken between the respective crank webs.

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*Abstract of a Paper read before the Diesel Engine Users' Association.

Electric Furnace Operation at Buffalo.*

Nine electric steel furnaces are served from the lines of the Buffalo (N.Y.) General Electric Company. Some were installed in 1914 and others in the latter part of 1918. They include four types, the Héroult, the Pittsburgh, the Snyder and the Greaves-Etchells, the sizes ranging from 2 tons to 10 gross tons. A table summarising electrical conditions during typical observations on these furnaces are presented. Thus for a Heroult furnace the load-factor for the heat was 62·3 per cent., based on a maximum peak of 2,700 kw. While a momentary peak of 4,000 kw. is registered, the demand during the melting process shows an average value close to 2,500 kw. During the refining operation the load ranges from 500 kw. to 1,000 kw. In one operation the furnace was melting for two hours and thirty minutes and refining for one hour. The load-factor for this heat was 70·3 per cent., based on a maximum peak of 2,700 kw. In both instances the load was entirely interrupted and re-established once during the heat.

Data on Electric Furnace Operation at Buffalo, N.Y.

Installation No.	No. of furnace.	Year. installed.	Size of furnace in tons per heat.	Type of furnace.	Type of lining.	Phase and frequency	Volts at arc.	Transformer rating.	Transformer rating for light & power.	No. of months which data cover.	Monthly average. Max. demand.	Kw.-hours.	Tons poured	Kw.-hours per ton.	Per cent. load-factor.	Hours per day operated.	Per cent. load factor per heat.
1	2	Oct., 1918	10 gross	Héroult	Basic	3–25	100 to 120	3,000 k.v.a. each 11,000/110-volt taps	250 kw	6	2,700	614,500	1,050·9	585	33·0	Continuously except for charging and pouring	60 to 70
2	1	Oct., 1918	3	Pittsburgh	Acid	3–25	110 to 120	1,000-k.v.a. 11,000/110-volt ½ voltage taps	25 kw	7	1,150	45,143	...	...	5·4	Varies	70
3	2	1914	2	Snyder	Acid	1–25	160	2,250 k.v.a. total * 60 per cent. p.f.	270 kw	12 (1917)	1,600	155,817	248·6	627	13·5	Night only (four heats per night)	80
4	1	Dec., 1916	2	Héroult	Acid	3–25	100 to 120	645 k.v.a. 2,200/1,980/107-volt.	105 kw	16	1,023	186,924	196·0	970†	25·5	Six to twelve hours	75
5	2	1918	6	Greaves-Etchells	Acid	3–25	110 to 70	1,300 k.v.a. each	300 kw	6	1,650	168,950	...	...	13·96	...	65

* These transformers have a connection equivalent to the Scott (or T) connection, as so to give approximately a balanced three-phase load on the primary when both furnaces are operating.

† Includes shop load of 100 kw. to 150 kw. Figure for furnace use only should be between 600 kw.-hours and 200 kw.-hours.

These Héroult furnaces are operating with a basic lining consisting of magnesite brick to the slag line and metalkase brick around the slag line. They were installed for melting and refining. While the average record in the table shows that over a six-month period they produced steel at an average rate of 585 kw.-hour per ton, the greatest consumption per ton occurred in December, 1918, when the monthly record was 656 kw.-hours per ton. A Pittsburgh 3-ton furnace is engaged in melting only, using high-grade scrap. A curve for a typical melting operation lasting two hours and fourteen minutes is shown in the original article. The load-factor for the heat was 70·4 per cent., based on a maximum demand of 1,125 kw. While this furnace is served from three 333 k.v.a. transformers, the load registered momentary peaks of 1,400 kw. For another a melting operation which lasted one hour and forty-two minutes the load-factor was 73 per cent., based on a maximum demand of 1,125 kw. The furnace is equipped with a Thury regulator.

Two Snyder single-phase 2-ton furnaces (installed in steel plant No. 3) were installed in 1914. The furnaces are both provided with an acid lining of silica brick. They are served from 2,250 k.v.a. of transformer rating for the two furnaces. The transformers are connected by a scheme equivalent to the T connection, which gives a balanced three-phase load when both furnaces are operating. They operate on a 220-volt circuit in which reactance has been permanently inserted between the transformers and the furnace. The power-factor of this load on account of the external reactance is about 60 per cent. The furnaces are used for melting only, the electrodes being hand-regulated. With one single-phase furnace melting for two hours and thirty-five minutes, the load-factor was 81·6 per cent. based on a maximum peak of 800 kw.

An especially complete record is available on a 2-ton Héroult furnace installed at steel plant No. 4. This is a furnace with an acid lining which is used for melting high-grade scrap. It is served by transformers rated at 645 k.v.a., 2,200/1,980-107 volts. In addition to this, two 7·5-k.v.a. transformers are installed to supply the furnace auxiliaries and three 30-k.v.a. transformers supply energy for the general shop power. The average consumption is between 600 kw.-hours and 700 kw.-hours per ton. During the sixteen months covered by these data this furnace never ran less than forty-eight heats per month, and in one instance poured 112 heats per month. The average for the sixteen-month period was seventy-nine heats per month. The practice was to run from two to four heats per day with approximately three hours per heat. In a melting operation lasting two hours and fifty-two minutes. Taking out the estimated energy consumption of the shop, the furnace used 1,555 kw.-hours, and had a maximum demand of 750 kw. This would give a load-factor of 72·4 per cent. The charge consisted of 5,000 lb. of steel scrap, making 622 kw.-hours per ton. While the average maximum demand shown is probably around 900 kw. there were many months when the measured maximum demand ran around 1,100 kw. and 1,200 kw. in spite of the fact that the transformer rating for the furnace installation is only 645 k.v.a. (These demands include the shop load.) The electrode control has been readjusted recently, and it is expected that the demand will be less.

The furnaces at steel company No. 5 are Greaves-Etchells 6-ton units, and have been used for melting only. Later they will be used for refining, when a basic lining will be installed. Thury regulators are used for electrode control. These furnaces now have an acid lining consisting of ganister and silica brick. Each furnace is served from a 1,300-k.v.a. transformer bank, and in addition 300 k.v.a. of transformers is installed for light and power service. In the six months these furnaces have operated the average maximum demand was 1,650 kw., and during two months the maximum demand was 1,800 kw. The load factor was for period lasting four hours and fifty minutes 64·2 per cent. The highest momentary peak shown is about 1,750 kw. The voltage at the arc, ranging from 110 volts to 70 volts, is somewhat lower than on some other three-phase furnaces. Their load-power-factor averages 90 per cent. or better, with one exception, *i.e.*, the Snyder single-phase furnace, which has installed in the circuit an external reactor which lowers the power factor.

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* Abstract of an article in the "Electrical World."

Engineering Golfing Society.—This Society held their postponed autumn meeting over the St. George's Hill course, Weybridge, last week. Mr. A. Valen won the "Hele-Shaw" scratch challenge bowl with a score of 88. Other prize winners were Walter Phillips, Mr. A. Patey, Mr. J. E. Spagnoletti, Mr. F. Bolton and Mr. A. P. Livesey. The foursomes competition for the Hadfield Challenge Cups was won by Major C. H. Hayward and Mr. J. B. Marr.

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Wages and Work.

A question which is agitating the mind of many an employer at the present day is the best method of encouraging employees to give increased output. In this connection, profit sharing may be set somewhat on one side, because that is a method of giving a share in prosperity, and is not necessarily a reward for increased output alone. What we have in mind is rather the various means of payment by results, of which ordinary piece work is the simplest example. The employer sees the advantage of such methods. This is not only because the labour charge per article thus remains constant, or may even be reduced, but because, in common parlance, the capital is "turned over" more quickly, and therefore the business becomes more prosperous. As far as the employer is concerned, it would be equally satisfactory to him if he could merely raise his prices. This, however, is generally an impracticable course, his action in this respect being governed by competition, over which he has no control.

On the other hand, the trade unions have an objection to piece work and, in general, to payment by results. Apparently, they would prefer that all such systems should be discontinued. In some industries, however, the piece-work method is strongly entrenched, as, for example, in textiles. In other industries, such as engineering, piece work is only used to a limited extent, and the employer may experience some difficulty in introducing it, if not already in use, although he may feel it is advantageous. In order to understand the position, it is well to have a book dealing with the subject of wages, such as that written by Mr. G. D. H. Cole.* Here we have a statement of the case from the labour point of view, for the author is with the unions in objecting to anything but the ordinary time rate of payment. For example, he does not like the premium bonus system, notwithstanding the fact that this system was welcomed by Mr. G. N. Barnes, who at that time was general secretary of the Amalgamated Society of Engineers; and it has also found favourable with many other people.

To understand the attitude of Labour in raising these objections, it must be realised that this attitude is largely the result of past experience with piece work. It is obvious that if the rate for piece work is gradually reduced so that a hard worker can obtain no higher wages than his fellow-workman on time rates, dissatisfaction must result. From this point of view employers in the past have only themselves to thank for much of the dissatisfaction that has arisen. The unnecessary cutting of piece rates has done a vast deal of harm. Another important consideration that weighs with the workman is the fear of unemployment through over-production. On the other hand, the employer is faced with the (by no means imaginary) difficulty of restriction of output. Mr. Cole remarks that "ca'canny" is not countenanced by any union; but on a later page he remarks that "ca'canny" would almost disappear if it became clear that employers and their representatives were prepared to play fair on the subject of earnings. We fear it is not so much a question of restrictive methods being countenanced, but rather that they are not being discountenanced, by the unions. Theoretically, a fair day's work is given for a fair wage; but at the present day there are many opinions as to the meaning of a fair day's work. The experience of many employers is that the output per employee is much less than it used to be, and yet the rate of wages is much higher. There is an unfortunate tendency to pay little attention as to what is a fair day's work, and consequently every employer feels it increasingly necessary to adopt some method of payment by results if such methods can in any way be applied. Where individual piece rates are no longer applicable, collective bargaining, whereby a whole shop or a whole works receives a premium in accordance with the time taken for certain work, presents a possible course, and apparently such a method is looked upon more favourably by trade unions than anything in the nature of premiums to individuals. As is well known, this method has been followed with marked success by Priestman Brothers, of Hull. It is not, however, universally applicable.

There are those in the Labour movement who fear that anything in the nature of payment by results or profit-sharing will impare the "solidarity of labour," and that if such methods bring about contentment they will result in less readiness to strike in those firms where such methods are in use. Contentment and well-being seem to be small matters in comparison with the possibility of overthrowing the capitalist system. And yet those who are familiar with the intricate working of industry know full well that there is certainty in one direction and merely a chimera in the other. The solidarity of labour is only a danger to the community if it is wrongly employed, as has been evident in quite recent events.

What is to be feared more particularly at the present time is the sinking of all effort to a dead level in any one grade, so that individual effort receives no reward. As Mr. Cole remarks at the beginning of his book, an employer does to some extent differentiate between more or less capable workers, even where payment is made by time; but this differentiation is "sometimes checked by trade union action." "The trade union by collective bargaining aims at establishing a standard rate for each class of work; and it may, in some cases, be as impossible for the employer to pay more than the standard rate for each individual as for him to pay less." We cannot imagine any system which gives less incentive to individual effort. Then, again, near the end of his book, Mr. Cole asks the simple question: "Why should a man who produces more be paid more?" The simple reason is, of course, that he is worth more, and in every other walk of life people are paid more or less what they are worth. In the opinion of Mr. Cole, the idea that a worker who produces more should get more money is "pure capitalist morality." This is a most unfortunate mental outlook, and we regret that it should be expressed by a responsible author like Mr. Cole, for if it becomes more general it will render the task of those who wish to maintain the commercial industrial position of this country extremely difficult. The economic laws of international competition are not going to be altered by any talk of capitalist morality, and therefore we hope that those leaders of trade unions who have had the advantage of analysing the complicated nature of industrial activity in various countries will do their best to eradicate doctrines of this kind, which, while very comforting to those who desire to do a minimum of work, must be finally destructive to our industrial position if they become in any sense general.

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* "The Payment of Wages." Published by the Fabian Research Department and George Allen and Unwin. Price 6s. net.

Reviews.

The Practical Telephone Handbook and Guide to the Telephonic Exchange. By J. Poole, A.M.I.E.E., Wh.Sch. Sixth Edition. (London: Pitman & Sons.) Pp. xxiii.+725. Price 12s. 6d. net.

"Poole's Book" and its author have won a regard amounting almost to affection from all who know them. The book with its quaint sub-title is a veritable encyclopædia of British telephone principles and practice, present and past. The learner uses it to unravel the mysteries of the circuits and apparatus which surround him, and the expert refers to it to seek information on some obsolete system or on a matter outside his specialised branch of telephone work. The edition now issued should meet with a hearty welcome, not only in this country but abroad, for it is by far the best account of British practice yet published.

The author has, more extensively than in previous editions, availed himself of the assistance of specialists to revise the important chapters dealing with sub-station apparatus, extension and P.B.X. working, switchboard apparatus, common battery exchanges, junction and trunk line working, line construction, transmission, loading and traffic studies. Numerous references to sources of further information greatly increase the value of the work.

The general arrangement of the book remains the same, but several new chapters have been added, including those on the Relay Automatic Telephone Company's system, military telephones, telephone speech relays and transmission tests. In common with the British telephone system and the historic Topsy, the book bears evidence of having "growed." Although in some places the matter has been re-arranged with improvement, there is room for a more methodical plan to be followed in a future edition. Some of the original figures, too, have been retained (for example, Figs. 116 and 307) and compare badly in style and clearness with those more recently introduced. Fig. 131 is indistinct and even inconsistent with the revised text. Fig. 305, on the other hand, is all that a reproduction of a circuit diagram should be. Some erroneous matter has been carried over from earlier editions. The C. B. instrument circuit in Fig. 132 is of no practical use; the circuit for the direct current is through the receiver. The circuits shown for the "Siemens" system in Fig. 133 and the electrolytic cells referred to on page 133 are not now in use by Messrs. Siemens Brothers & Company, nor as far as the writer is aware, by any other firm. Shunt machines are used for charging accumulators because they are not subject to reversal of magnetisation should a reversal of the current in the charging circuit occur, rather than for the reason stated on page 358. A few misprints and incorrect references to figures are noticeable, but all these are minor blemishes, almost inseparable from the "growing" process previously referred to.

The printing and binding are excellent. The index, a matter of some importance in a book of this nature, is also good.

Both as a text book and as a work of reference the book is undoubtedly the best description of British telephone practice available to the general public. The new edition contains so much modern information and has been so extensively rewritten that even those who possess previous editions will be amply repaid by the purchase of the new one.

W. H. Grinsted.

Sound, Light Electricity and Magnetism. By W. B. Anderson, Ph.D. (London: Hill Publishing Company, Ltd.) Pp. xiii.+457. 10s. net.

This work, which forms a companion volume to the author's "Mechanics and Heat," has been prepared chiefly for students of agriculture and engineering in the States Colleges of U.S.A. who wish to include in their curriculum a study of physical science. The book is divided into three parts, the first of which, following on the earlier volume already mentioned, is numbered Part IV. (pp. 337-391), and is devoted to the subject of sound. It consists of four chapters, subdivided into 41 sections, and deals with such matters as the nature, production, transmission and velocity of sound, quality, pitch, simple harmonic motion, interference, musical instruments, resonance, stationary waves and musical scales. Some of these subjects are thoroughly discussed, as for instance the consideration of the relation of musical sounds to one another; but in other cases, as in the study of the organ pipe, and the determination of the velocity of sound in gases, it is felt that the author has not been sufficiently explicit, and has sacrificed too much to brevity.

Part V. (pp. 395-518) deals with the subject of Light, and is divided into 10 chapters which are subdivided into 123 sections. The contents may be indicated by the following headings: Theories of the Nature of Light, Velocity, Refractive Index, Photometers, Reflection, Refraction, Dispersion, Lenses, Optical Instruments, Interference, Diffraction, X-Rays, Luminous Efficiency, Döppler Effect, Fluorescence, Colour, Polarization and Double Refraction. The formulæ for curved mirrors and lenses are deduced by the Sagitta method, and a distinct improvement over several text-books is seen in the fact that often the diagrams show the *waves* as well as the *rays* of light. A very good introduction is given to the more advanced part of the subject; Young's experiment is described with simple mathematical treatment, and the interference effects in thin films and Newton's rings are briefly discussed. The diffraction grating is considered in more detail, and the methods of wavelength determination pointed out.

Part VI. (pp. 551-780) is concerned with Magnetism and Electricity, and is divided into 197 sections, grouped into 12 chapters. The scope of this portion can be judged by the following: Magnetic Poles and Field Strength, Terrestrial Magnetism, Electrostatics, Potential, Condensers, Electric Currents, Ohm's Law, Electrolysis, Thermo-Electricity, Wheatstone's Bridge, Heating Effects, Electro-magnetism, Magnetic Circuit, Generators and Motors, Discharge Through Gases, Cathode Rays, e/m, X-Rays, Radioactivity, Electromagnetic Waves. The inclusion of remarks on the electron-tube detector for wireless waves and on radiotelephony, shows that the work is up-to-date, and the author constantly emphasises the practical aspect of the subject in hand as, for example, in the study of the telephone, telegraph, ammeter, voltmeter, wattmeter, dynamo, &c. Evidence of the same plan is found in the chapters on Optical Instruments, Photography and Kinematography.

The text is explained by the aid of some 220 diagrams and figures, and a considerable amount of importance is attached to the solution of problems and numerical exercises of which some 157 are provided. The volume concludes with a comprehensive index of 14 pages.

B. W. C.

The Payment of Wages. By G. D. H. Cole. (London: Fabian Research Department and George Allen and Unwin.) Pp. 155. Price 6s. net.

This book may be considered as a companion to the one by the same author on "An Introduction to Trade Unionism," which was reviewed a fortnight ago in these columns.

Mr. Cole deals first with certain general questions affecting industries and then gives a description of various wage systems now in use, such as piece-work systems, bonus systems, efficiency systems, scientific management and collective bargaining. Finally, he deals with profit-sharing, payment by results as compared with time work, and a final chapter is headed "The Problem of Trade Unionists." There are also appendices giving certain agreements, rules, price lists and similar information.

The book is distinctly interesting, and may be regarded as of value, chiefly in throwing light upon the Labour point of view in connection with these numerous problems. When we say the "Labour point of view" it must be understood that the author belongs to that section of Labour which does not look very favourably upon Capital. He does not specifically object to the payment of dividends; but, on the other hand, he certainly does not protest against the ideathat Capital is not entitled to any dividends at all. This, from the point of view of doing serious good at the present time, is the weak point of the volume. The author does not make any attempt to reconcile Capital and Labour. As an example of this attitude of mind we may take the question of the introduction of machinery to secure greater productivity, or the introduction of an invention for this purpose. The view is expressed that in the introduction of a labour-saving device the claim of Labour to a share "is as good as that of the consuming public, and far stronger than that of the employer." The view is also implied that an employer should not cut down his output when the market is falling against him, and that such restriction is on a par with the restriction of output by labour.

It is rather interesting to note the opinion expressed in the last chapter that "it is no use to deny the fact that in many centres of industry in which individual systems of payment by results are established the workers would at present oppose their abolition," yet the whole trend of the book is in opposition to payment by results. The object rather is to give the worker control. Ample leisure, for example, is not regarded as sufficient; it is necessary to go further in the direction of control, with the object of replacing the existing system in industry and politics by a "system of democracy."

We refer in more general terms to this book in our Leading Article.

Electro-pneumatic Device for Electrically Driven Air Compressors.

By GEO. J. DUCKETT.

In most modern workshops the electric drive for machinery has been generally adopted, and during the change over many peculiarities have been noticed which with all-steam group-driven machinery would not have come to light. For instance, I remember some time ago converting an air compressor from group to individual drive.

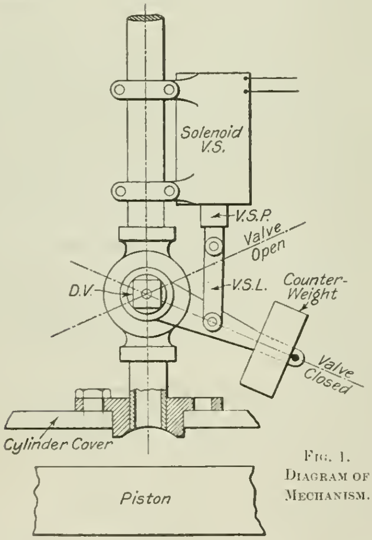

Fig. 1. Diagram of Mechanism.

The air compressor was of the single-cylinder type, and required 15 h.p. to drive it when under load; but if by chance the compressor was stopped with the piston half-way through the compressor stroke it required something approaching 30 h.p. to start it up again.

A 15 h.p. motor and starter was ordered, and the motor withstood the heavy short period overload; but the starter gave very considerable trouble, especially in view of the fact that it had sometimes to cut in as many as 12 times per hour. At first it was thought advisable to obtain a much higher capacity starter; the cost, however, was found prohibitive, and therefore the difficulty had to be overcome by other means. So I evolved an automatic arrangement in the form of a decompressor which released the cylinder compression on

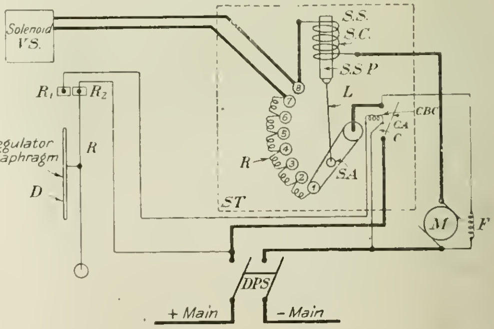

Fig. 2.—Diagram of Connections.

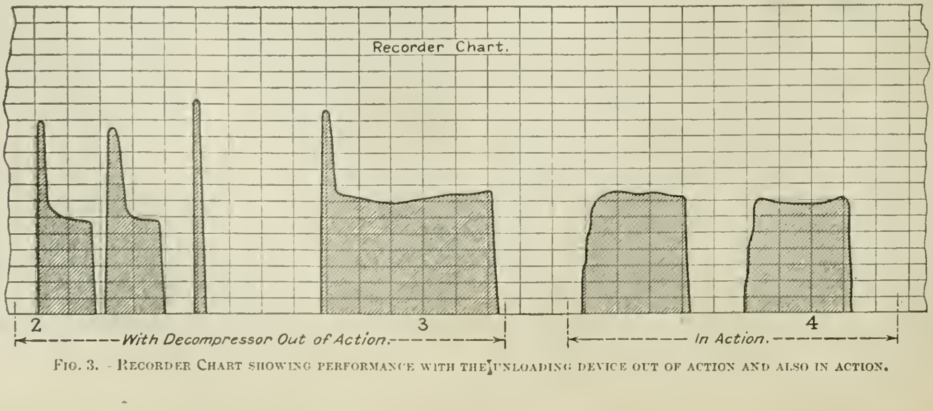

Fig. 3. - Recorder Chart showing performance with the unloading device out of action and also in action.

starting up the motor, allowing normal current to flow, thus saving the starter contacts, and at the same time we were able to retain the original starter without any alteration, except the removal of one resistance section.

Fig. 1 shows the decompressor valve. Fig. 2 is the wiring diagram, Fig. 3 is a recorder chart.

On starting up the motor *M* by closing the double-pole switch *DPS*, which in turn energises the solenoid *SC* of the starter *ST*, the starter arm *SA* is moved over the resistance contacts 1 to 8. On the top or side of the compressor cylinder, whichever position be most convenient, an electrically-operated cock is fixed, and is normally in the closed position, except during the starting of the motor. The solenoid *VS* of the cock or valve *DV* bridges across the last two steps (7 and 8) of the starter *ST*. Naturally it follows that on starting up the motor the solenoid *VS* is energised and the valve is opened, thus reducing the compression in the cylinder to a very low figure.

When the starter arm *SA* passes over No. 7 resister step the armature of the motor is revolving at something like its top speed, and therefore any sudden application of the load is overcome by the energy stored in the flywheel, and as No. 7 step is passed the solenoid *VS* becomes de-energised and the valve *DV* closes, after which the compressor acts in a normal manner. The circuit-breaker contactor *C* makes and breaks the circuit, and is in turn operated by a regulator, *R*, which opens the contacts *R*1 and *R*2 whenever the pressure exceeds the pre-determined amount.

Fig. 3 shows the effectiveness of the device.

An Electrically-Driven Letter Opener.

A small electrically-driven machine which has been placed on the market in America and which opens letters at the rate of 500 a minute, is proving a very useful instrument of efficiency and of economy of money, time and labour. It is claimed that with this machine one person can open the mail in less time than it took five or more persons by the old method, and with greater safety and accuracy. Not only is confusion thereby reduced to a minimum, but responsibility is unquestionably centred. The machine, built by the Bircher Company and known as the "Lightning" letter-opener, can be placed on any table, desk or counter, all litter thereby being confined to a restricted area.

Electric Letter Opener.

Attached to an ordinary lamp socket, it is set in motion by a mere snap of a switch, through the medium of a Westinghouse motor mounted within the case and consuming an amount of power so small as to be almost negligible. The machine is simple in construction, repairs being reduced to a minimum, and any person of ordinary intelligence, after two or three minutes' practice, can operate it proficiently. The envelopes are placed on a feed table in a stack of 40 or 50 at a feeding, and are conveyed automatically one at a time, by a feed belt, through two rapidly revolving circular knives which cut a very small shaving from the exposed edge of the envelope. The letters are then carried automatically into a stacker. It is asserted that as the typewriter replaced the steel pen in the commercial world, so the letter opening machine will take the place of the paperknife.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"The Thermionic Valve and its Developments in Radiotelegraphy and Telephony," by Prof. J. A. Fleming, F.R.S. (London: Wireless Press, Ltd.) Pp. xv.+279. 15s. net.

"Report of the Proceedings of the Municipal Tramways Association relating to the Application by the National Transport Workers' Federation of July, 5, 1919, for Further Increase in Wages, &c." (Gothic House, Accrington: J. Beckett.)

The International Electrotechnical Commission.

The plenary meeting of the International Electrotechnical Commission was held on Wednesday, October 22nd, with Monsieur Maurice Leblanc, President, in the chair.

It was unanimously decided to re-appoint the Advisory Committees (formerly called Special Committees) which were at work before the war, and appoint some additional Advisory Committees. These Advisory Committees were appointed as follows:—

Nomenclature.—The Advisory Committee on Nomenclature was reappointed with one delegate from the National Committees of each of the following seven countries:—

Denmark, France, Great Britain, Holland, Italy, Spain and United States of America.

The Advisory Committee was requested to consider the terms and definitions which were agreed in 1913, and to deal with those which were considered to require revision at the present time, the remainder to be published at once. The Committee were then invited to continue the work and also to prepare terms and definitions for automatic telephone apparatus.

Rating of Electrical Machinery.—The Advisory Committee was re-nominated with one delegate from each of the National Committees of the following seven countries:—

Great Britain, Italy, Sweden, Switzerland, Belgium, France and United States of America.

It was agreed to publish the rules relating to the rating of electrical machinery agreed upon at the last meeting and modified in accordance with recent decisions.

A cooling air temperature of reference of 40°C. (the figure already adopted in the British, American, French and Italian rules) has been adopted unanimously. It was also agreed to limit the scope of the present rules to machines up to 750 k.v.a., or 5,000 volts, or armatures in length 50 cm., also the use of thermometer methods of measuring temperature under certain conditions in cases where resistance methods only were formerly permitted has been agreed upon.

These international rules will shortly be published.

Symbols.—The Advisory Committee on Symbols was re-appointed with one delegate from the National Committees of each of the following 10 countries:—

Belgium, France, Great Britain, Holland, Italy, Denmark, Norway, Spain, Switzerland, United States of America.

The Advisory Committee, in addition to revising I.E.C. publication No. 27, on Symbols, has been invited to prepare a list of graphical symbols, including those for ordinary and wireless telephony and telegraphy.

Nomenclature of Prime Movers for Electrical Plant.—The Advisory Committee on the Nomenclature of Prime Movers for Electrical Purposes was re-nominated with one delegate from each of the National Committees of the following seven countries:—

France, Great Britain, Italy, Norway, Switzerland, Sweden, United States of America.

This Advisory Committee was requested to reach agreement in regard to nomenclature of steam-driven prime movers for electrical purposes.

Aluminium.—An Advisory Committee consisting of one delegate from the National Committees of each of the following eight countries,

France, Great Britain, Italy, United States of America, Norway, Sweden, Holland and Switzerland.

was nominated to study the question of the adoption of an international standard of resistance for aluminium, and it is desired that the lines adopted for the preparation of the standard of resistance of copper should be closely followed.

Screw Lamp Caps and Lamp-holders.—An advisory Committee consisting of one delegate from each of the National Committees of the following seven countries,

France, Great Britain, United States of America, Italy, Japan, Switzerland and Holland,

was nominated to study this question, and it is understood that the report of the Committee will deal only with the question of international interchangeability, the question of material not being dealt with.

Charging Plugs for Electrical Vehicles.—An Advisory Committee consisting of one delegate from the National Committees of each of the following six countries was nominated to deal with this subject:—

Belgium, France, Italy, United States of America, Great Britain and Sweden.

In this case, also, the question of interchangeability only is concerned, and it is understood that the charging plugs employed in the United States of America and Great Britain for this purpose are identical.

Pressures for Distribution.—An Advisory Committee consisting of one delegate from the National Committees of each of the following 10 countries was appointed to consider this question:—

Belgium, France, Great Britain, Italy, Switzerland,
United States of America, Holland, Spain and Norway, Sweden.

It was agreed to consider first of all a series of pressure steps for insulators, in accordance with the proposals of the Italian Committee, and subsequently to consider the subject more generally.

At a meeting of the Council of the I.E.C., Dr. C. O. Mailloux, President of the American National Committee, was unanimously elected the new President of the Commission. Previous Presidents have been :—

Right Hon. Lord Kelvin, O.M.
Prof. Elihu Thomson,
Prof. Dr. E. Budde.
Prof. Maurice Leblanc.

Dr. Mailloux was one of the founders of the Commission, and its success has been due in no small measure to his efforts on its behalf. His great linguistic abilities have been of the utmost service on many occasions.

The Council accepted the invitation of the American Committee to hold the next plenary meeting in America during 1920.

At the close of the meeting Dr. Mailloux, on behalf of all the delegates, presented a silver cup to Col. R. E. Crompton, the "father" of the Commission.

Hydro-Electric Survey of India.

An important preliminary Report on the Water Power Resources of India, based on a survey made in 1918-19 by the late Mr. G. T. Barlow, chief engineer of hydro-electric surveys, assisted by Mr. J. W. Meares, M.I.C.E., M.I.E.E., electrical adviser to the Government of India, has recently been issued, and supplies much valuable information on the water-power resources of India. The Report, which contains 108 pages, is divided into seven chapters and gives a number of tables, curves, maps and other data.

In the introduction, Mr. Meares gives a brief sketch of hydro-electric progress in India, some extracts from the preliminary Report of the Water Power Committee of the Conjoint Board of Scientific Societies (issued in London in July 1918 and abstracted in The Electrician for August 16, 1918), a list of the places visited, &c. Unfortunately Mr. Barlow died in April 1919, before the completion of the survey, but Mr. Meares carried on the work and compiled the present Report.

Chapter I. is devoted to water power in general, the basis and sources of water power, artificial water-falls, reservoirs, combined irrigation and power projects; Chapter II. deals with weather and water, seasonal rivers, rainfalls, the measurement of a discharge, &c.; and in Chapter III. there is an examination of geographical considerations and existing surveys. From Chapter IV., which is devoted to a census of power used in India, we learn that in 1917 the electrical power used was 215,000 kw. (285,000 E.H.P.), of which 36 per cent. was obtained from water power, and the total units generated amounted to only 550,000,000. Tables are given of the power of all kinds in use in certain parts of India, including Assam, Bengal, Bihar and Orissa, Bombay, Burma, the Central Provinces, Madras, Punjab and the United Provinces. It is estimated that in Bombay and Ahmednagar there is no less than 750,000 B.H.P. used and a considerable part of this power is supplied by the Tata Hydro-Electric Works. It is estimated that the total power used in the above-named districts is 1,153,638 B.H.P. After referring to some of the uses for which hydro-electric power could be employed, especially in electro-metallurgical and electro-chemical works, lighting, traction, &c., Mr. Meares points out that there are many other industries in which electric power would be welcomed if it could compete with other forms, and in any area where reasonably cheap hydro-electric development is possible within transmission distance this successful competition is simply a matter of relative costs. To take one instance, in a comparatively small area of the Duars, within easy reach of water power, it is estimated that fuel equivalent to a working load of about 100,000 H.P. is used in the tea factories; partly for the production of power from steam engines, but mainly for drying purposes with hot air and fans. Both the motive power and the hot air can be obtained electrically; it is merely a question of comparative costs. Other tea districts are similarly situated. Again, the cotton mills of Bombay are now mostly driven by electric motors fed from the Tata scheme, which have replaced steam engines. There may, given cheap enough power, be a similar opening for jute mills, oil mills, timber working, sugar production, paper pulping and other industries. As regards pumping for irrigation purposes, it is unlikely that such pumping will pay on any water rate that could be demanded, where the lift is at all great.

The commercial possibilities of any hydro-electric scheme depend on two factors, the capital cost of the scheme and the cost of the competing fuel. Comparing a steam or oil-driven electrical plant with one water-driven, the latter is almost invariably much more expensive to construct; and all it saves is the cost of fuel, which is only one factor in the cost of generating power. Staff and stores, office and legal expenses, repairs and depreciation are incurred in both. Thus while the actual comparison will be between the price at which electricity can be sold in both cases the real criterion of success is whether the capital charges for interest and depreciation on the *excess* cost of the water power undertaking will be substantially less than the cost of the fuel used by the other. In certain circumstances water power may be of immense value whether it be within reach of cheap fuel or hundreds of miles from it; *i.e.*, where it is required not for existing industries but for a new electro-chemical or electro-thermal industry. These, working almost continuously at full load (*i.e.*, with a load factor of 90 per cent. or more), must go where there is cheap water power; and when 50,000 H.P. or more is being developed a very large capital expenditure on dams and other hydraulic works can readily be faced.

The cost of transmission lines operates detrimentally in two ways; first by increasing the prime cost and consequent capital and upkeep charges, and secondly by decreasing the available energy for sale at the far end, owing to losses in the line. These line losses can be made almost as large or as small as the designer chooses, but if they are made small it is by adding more copper wire, or larger wires, so that this reacts on the prime cost. While it must never be forgotten that generalities and averages in engineering problems are apt to be most misleading it is nevertheless desirable to give some indication of the permissible cost of hydraulic developments. Mr. Meares gives a table and three curves in order to give a comparison of the economy of steam and water power. As a rough example it is assumed that 10,000 E.H.P. is required in a certain district, and that the alternatives are steam and water power plant, each the most modern of its kind. The steam power station would be placed in the most favourable site within the area; the hydraulic plant would go where nature placed it. Three cases are assumed, viz., water power on the spot; transmission of 50 miles; transmission of 100 miles. As regards fuel three representative prices are taken, viz., Rs. 8, Rs. 16 and Rs. 24 per ton for Bengal coal of about 11,000 B.Th.U. calorific value; the first is about the price at the radius from the coal fields of Calcutta, on the railways, and the other prices will be found further off. Four characteristic load factors are taken, viz., 20 per cent., 40 per cent., 60 per cent. and 80 per cent. It is also assumed that the cost of the power station, with all the plant within it, is sensibly of the same order for the steam and water power plant, excluding, of course, the transmission line and the hydraulic development beyond the power station. The distribution lines, &c., for employing the power at its destination, and the power lost in them, will be unaffected to all intents by the method of generation, and may also be left out of account. Then the cost of fuel on the one hand has to be set off against the cost of the hydraulic development on the other. With modern boilers and steam turbines, using Bengal coal, an average consumption of $1\frac{1}{2}$ lb. per electric horse-power hour generated may be taken as an extremely good figure. The extremely low coal consumption is nowhere obtained in India at present; it represents the best side of the case for fuel; even if $4\frac{1}{2}$ lb. per electric horse-power per hour be assumed it would still be better than most Indian power stations can command. Load factors on these stations are mostly of the order of 40 per cent. On the three assumed costs per ton the outlay may now be 636, 1,272 and 1,908 rupees for a station at site; 510, 1,070 and 1,674 rupees for a 50 mile transmission; and 440, 980 and 1,520 rupees for a 100 mile transmission.

In Chapter V. there is a discussion of the control of water power, the existing practice as to concessions and leases, and in Chapter VI. there are two tables of the existing hydro-electric plants and of the plants under construction. The total plant installed is given as 111,860 E.H.P., and the Andhra Valley Power Supply Company is installing 90,000 E.H.P. in the Western Ghats. There is also a list of sites examined in 1905 and not developed. The remainder of the chapter is devoted to a general survey of the possible sites of water power requiring reconnaissance and lists of possible streams and sites are given in appendices. It is estimated that 1,774,000 E.H.P. (including 203,000 in Bengal, 343,000 in Bombay, 455,000 in Burma, 153,000 in the Central Provinces and 264,000 in the Punjab) is actually in sight, but this total is much below the actual available power when the final results of the survey are published. There are over 130 possible sites of which nothing is definitely known and there may be many hundreds more yet to be found. In addition, the great perennial snow-fed rivers have hardly been touched upon.

The final chapter is devoted to a plea for the completion of the hydro-electric survey and for a reconnaissance of sites, &c.

G.E.C. Tough Rubber Covered Cable.

Now that the demands of the Government have slackened, the up-to-date machinery at the Pirelli-General Cable Works (Southampton) for the production of tough rubber-covered cable is devoted to the production in large quantities of this cable for private use. During the war many thousands of miles of this cable were manufactured to meet the requirements of the Army, Navy, Ministry of Munitions, as well as other Government Departments, and the Pirelli-General Cable Works are now fortunately able to turn out this cable for private requirements in such quantities that prompt delivery can be assured.

G.E.C. Tough Rubber Covered Cable is made in all sizes, either single-cored, twin- or three-cored, and is specially suitable for use in industrial work where a flexible cable, likely to be subjected to rough usage is required. In all cases, each core, which is of the best H.C. tinned copper wire, is insulated with pure and vulcanised india-rubber, in accordance with C.M.A. standards, and the whole then sheathed with tough rubber, this being water, oil, alkali and acid proof, and not subject to damage, except wilful damage by means of a sharp instrument, such as a knife. It will stand the roughest usage to be met with in industrial work, and for house wiring it possesses the valuable features that it can be put directly into new plaster, has a long life and can be neatly and easily run round cornices, &c. It is also of interest to note that on account of its peculiar qualities, special provision is made in the Wiring Rules (No. 65) of the Institution of Electrical Engineers for the use of such cable.

A New Glow Lamp.*

By Dr. F. SCHRÖTER.

The smallest tungsten lamps that are suitable for 220 volts take about 20 watts, if we disregard some of specially fine-drawn wire, which are hardly suitable for ordinary usage. There are no lamps of this kind taking from 1 to 5 watts. A lamp for 220 volts, taking 1 watt, would require a filament with a resistance of 50,000 ohms. If a longer and thicker filament were used it would only give a red glow. For signalling purposes small lamps have a certain use. Now the slight dielectric cohesion of neon is such that bright discharges take place between neighbouring electrodes at 150 volts. Arc discharges take place in rarefied neon at 100 volts over considerable lengths of tube, and lamps of this kind have been designed, giving light at an efficiency of 0·5 watt per candle-power. A glow lamp may be said to be one that takes less than 5 watts. If direct current at 220 volts is available, then with the help of a cathode of one of the alkali metals, low discharges, taking not more than 5 watts, can be passed through considerable lengths of tube. The main source of the light constitutes the so-called positive light column, which fills the tube uniformly between the cathode and anode. If the various factors are properly chosen, such as gas pressure, width of tube, the material of the cathode, &c., a lamp can be constructed to give 2 c.p. for an expenditure of 5 watts if pure neon is used. But such a lamp requires some kind of an auxiliary starter to ionise the whole of the discharge space. This can be done either by the momentary use of a higher pressure through an induction coil, or by ionisation through radioactive substances or by auxiliary electrodes. But this complicates the lamp, and these means are quite unsuitable for lamps of such small candle-power.

Experiments were carried out by the author in conjunction with Dr. O. Schaller in the laboratory of the firm of Julius Pintsch. The method of the positive light column was given up, though they were used in all existing lamps of the kind, such as the mercury vapour lamp, the Moore lamp, and the neon arc lamp. In a bulb which contains a mixture of neon and helium at a pressure of 8 mm. or 10 mm., a cathode of large surface is placed so close to the anode that at 220 volts the discharge starts. For alternate current both electrodes have a considerable surface and are symmetrically arranged—*e.g.*, as spirals. When the discharge begins, the terminal voltage sinks with direct current to 190 volts, the remaining 30 volts being absorbed in a resistance. Theoretically this resistance is unnecessary, and it can actually be dispensed with; but the current density at the cathode is then liable to increase with consequent volatilisation of the metal. This would tend to darken the bulb, and might from secondary causes destroy the lamp. A small series resistance removes these possible dangers. The cathode surface is covered with the glow light. The radiation of light is determined by the gas and its pressure by the material of which the cathode is formed, the nature of the surface of the cathode and the fall at the cathode; this latter depends on the gas pressure, the size of the cathode and the nature of the arrangements round the cathode. The surface of the metal should be polished in order to reflect the light. If iron is used as the cathode it gives 0·44 c.p. on 210 volts with a current of 19·2 milliamperes. The terminal voltage over the lamp is 186, the watts consumed in the lamp are 3·57, and the efficiency is 8·1 watts per candle-power. If the watts lost in the resistance are taken into the reckoning, the overall efficiency is 9·2 watts; with aluminium, this last figure would be 8·2, and with potassium 3·3. Notwithstanding the fact that iron gives a lower efficiency than aluminium and potassium, it is to be preferred because it is more easily obtained and worked in the form of a very thin sheet. Moreover, it gives off less gas under a vacuum and volatilises less.

The author gives a photograph of a lamp prepared on these lines. The bulb is 55 mm. in diameter; in the middle is a hemispherical piece of polished iron sheet, which is the cathode. The colour of the discharge in neon is somewhat of an orange red. This is corrected by the addition of some mercury vapour, which contains well marked green and violet lines. The resulting light is a whitish red; as compared with pure neon the light is stronger. The anode is an iron wire in the shape of a hook, and ends about 3 mm. from the edge of the cathode. The whole system is mounted on a carrier of lead glass, as in an ordinary lamp. The lamp fits into an ordinary socket, but care must be taken to see that the resulting polarity is correct. A special socket is provided so that the polarity can be at once changed if it should be found to be incorrect. For alternate current it seems that the second electrode should not have too small a surface in comparison with the cathode. The greater the rectifying effect which such a lamp has with unequal electrodes the greater will be the volatilising effect on the smaller overloaded electrode. A special lamp has therefore been introduced for alternate current, in which the electrodes consist of thickish wire, and the lamp can also be used for direct current, all of them being suitable for 220 volts.

The new lamp is intended to be used for signalling and controlling purposes—*e.g.*, in mines, tunnels and other dark places. In mines it may be especially useful, and it is of course extinguished as soon as it suffers any damage, and, seeing there are no internal parts at a glowing heat, it is impossible for it to ignite any explosive gas mixture. There are many other purposes for which it is considered suitable in theatres, hotels, hospitals, &c. It may be used in a photographic dark room if fitted with a proper red bulb; photometric tests show that it gives as much light with a red bulb, if it takes 5 watts, as an ordinary incandescent of 20 watts, and it is thought likely to be more convenient for the purpose of the photographer, inasmuch as there is a considerable illuminated area against the plate can be examined.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 17, 1919.

Heating and Cooking Notes.

The Bastian Hot-water Tank.

The main object of this piece of apparatus is to supply a means of obtaining a supply of hot water for household requirements in such a way that electricity can be employed as the source of heat and yet be economical. The heating unit is therefore designed to be continuously on circuit, so that the apparatus has a 100 per cent. load factor, and therefore the supply authority can quote a specially cheap rate for electrical energy consumed in the form of an annual or quarterly charge, there being no need for a meter. The apparatus consists essentially of a polished copper tank, tinned inside, with the element fixed at the base in the form of a sliding tray, which slides in under the bottom of the tank. A gland type draw off cock, and an adjustable ball valve inlet provide means for controlling the intake and outlet of water. No matter how rapidly or how slowly the water be drawn off, the rate of feed and the heating element are so proportioned that the outlet water is always at the same temperature—viz., 150°F.—up to the daily capacity of the tank. The inflow is restricted, so that the temperature is maintained, and if the tank is full the heat loss is equivalent to the electrical input. The water cannot boil, and therefore there is no trouble with "stewed" water, so objectionable in connection with culinary operations. The kitchen tanks are made in three sizes—10, 20 and 40 gallons respectively—and consume 150, 300 and 600 watts, and calculated to be suitable for families of five, 10 and 20 persons. For bathroom use it is recommended that a separate tank be installed because bathroom requirements often vary with the season of the year, and for this reason the bathroom tanks are fitted with a supplementary heater, which can be switched on when more than the ordinary number of baths are required.

The supplementary heating unit is arranged for connection to a separate meter, as, of course, it cannot be supplied on a flat rate where the use is intermittent. Provision is also made for the necessary adjustment of the ball valve to increase the rate of feed when the supplementary heating unit is employed to provide for extra baths. On the average 15 gallons of water are required for a bath at a temperature of about 110°F., so that 10 gallons of water at 150°F. from the tank, plus five gallons of cold water, provide the required quantity of water at 110°F. for a bath. A 10-gallon bath tank will suffice for a family of five persons, but for larger families a 20 or 40-gallon tank would be required. The bath tanks are exactly similar to the kitchen tanks except that provision can be made for a supplementary heating unit, if same is required.

In flats where the bathroom is adjacent to the scullery, it would often be possible to make one tank fitted in the bathroom with a supplementary heater, do the work of two tanks. That is, water for scullery purposes could be obtained form the bath tank, and when additional hot water was required for a bath the spuplementary heater could be switched on. The illustration shows the tank fitted in a bathroom.

The following table shows the operating cost of these tanks. The figures have been calculated on the basis that electrical energy is supplied at a flat rate of 1d. per unit, or a quarterly charge of

£1. 7s. 4d. This figure has been taken because the figures can easily be converted into the equivalent for any other rate of charge, but on 100 per cent. load factor it should be quite possible, even in these days, to supply electrical energy for this purpose at 1d. per unit.

In connection with the bath tank it is assumed that no supplementary heater is employed. The rate charged for energy so consumed would, of course, be the same as that charged for ordinary heating purposes, which did not offer a steady load.

Consumption of heater in watts.	Daily output of water at 150°F. in gallons (kitchen tank).	No. in family for which tank is suitable for kitchen purposes.	No. of baths per day requiring 10 gallons of water at 150°F. obtained from bath tank.	Cost per week of kitchen tank in pence, at 1d. per unit.	Cost per week of bath tank in pence, at 1d. per unit.	Total weekly cost of bath and kitchen tanks in pence.
150	10	5	1	25·2	25·2	50·4
300	20	10	2	50·4	50·4	100·8
600	40	20	4	100·8	100·8	200·6

From these figures, and on the basis assumed, it is seen that with electrical energy at a penny per unit a family of five persons can have hot water supply in the bath room, five baths per week and hot water supply in the kitchen at a weekly cost of 4s. 2¼d., approximately 10d. per head.

Electric Welding of Ships.

From the report of Lloyd's Register of Shipping for the year 1918-19, we learn that at June 30 there were 8,756 merchant vessels, of 21,941,460 tons, which held classes assigned by the Committee of Lloyd's Register, and during the past year classes were assigned to 1,251 vessels of 3,801,221 tons gross.

During the past year four vessels were classed which had been fitted with turbo-electric propelling plant. The largest (the "Wulsty Castle," of 3,566 tons) was built in this country, and has a total shaft horse-power of 1,500. The "Turbinia," of 2,259 tons, was built in Sweden, and her engines have a shaft horse-power of 1,020. Both these vessels were fitted with Ljungstrom turbines. Two smaller vessels were completed in America, the "Panoil" and the "Mexoil," each of 1,370 tons, the engines in each case having a total shaft horse-power of 820. These two vessels were fitted with Rateau turbines. During the war there was a great increase in the manufacture of Diesel engines intended for submarines and other war vessels; but, owing to war conditions, the manufacture of Diesel engines for merchant vessels did not advance to such an extent as had been anticipated. Several vessels of considerable size fitted with Diesel engines have, however, been built during the war to the Society's class by Messrs. Harland & Wolff and by Messrs. Burmeister & Wain, of Copenhagen. The largest Diesel engines which have been fitted in any merchant vessel are the twin screw engines made by Messrs. Harland & Wolff, of Glasgow, for the motor vessel "Glenapp," of 7,374 tons gross, which was built in 1918 by Messrs. Barclay, Curle & Company, and classed with the Society.

Electric Welding for Shipbuilding.

The special Sub-committee on Research have arranged for experiments and tests to be carried out by Prof. Marchant, of Liverpool, in connection with electric welding, in order to ascertain the best electrical conditions to be employed in the process of arc welding, and also to determine whether the variations in the current and voltage across the arc during welding can be used as a criterion of the satisfactory nature of a weld after it has been completed. Although electric arc welding has been employed for many years for ship repair work, its use has been hitherto confined to those parts of the structure which are not likely to be exposed to severe stresses, and it is only since the early part of the war that appreciable progress has been made in the developments of welding, which would appear to justify the consideration of proposals to use electric welding as a means of replacing the usual riveted connections of structural work of primary importance. In 1917, the Committee of Lloyd's Register arranged for an exhaustive series of tests to be carried out under the direction of the Society's chief ship surveyor, to determine as far as possible the general trustworthiness of structural connections effected by electric welding, and their capacity to withstand the strains to which they would be subjected. The results of the experiments made were considered by the Technical Committee of the Society, and on their recommendation the General Committee adopted, as a tentative measure, provisional rules for the classification in Lloyd'a Register Book of vessels electrically welded, subject to the notations "experimental" and "electrically welded." The Committee also formulated their requirements regarding the tests to be complied with by all systems of electric welding for which approval was desired, and a notice was issued stating that the Committee were prepared to consider applications from any electric welding companies for the processes to be recognised by the Society for use in ship construction, and for their names to be inserted in a list of companies whose processes have been approved as fulfilling the Society's conditions.

Plans for the first vessel in which the butts, seams and other connections are to be electrically welded have been submitted and approved by the Committee. This vessel, which is about 150 ft. in length, and in which the use of rivets will be entirely dispensed with, is now nearly ready for launching, and the behaviour of the vessel after completion will be carefully followed by all who are interested in the new system of construction. Applications have also been received by the Committee for approval of a scheme of construction in which both riveting and welding processes shall be employed, but in such a manner that the vessel might be classed without the notation "experimental." After careful consideration the Committee approved, in the case of a vessel framed on the longitudinal system, a design in which electric welding will be employed in the construction of the bulkheads and for the attachment of the longitudinal frames to the structural plating, this approval being contingent upon a special notation being inserted against the vessel's name in the register book.

In June, 1918, Mr. Abell, the Society's chief ship surveyor, was appointed by the Committee to represent the Society on a Committee to be formed for the purpose of preparing a detailed scheme for a National Electrical Proving Huose. Mr. Milton and Mr. Abell have served as representatives of Lloyd's Register on the Ship-wiring Rules Subcommittee of the Institution of Electrical Engineers, whose report, it is understood, will be ready for publication shortly.

Modern Lighting Methods in Small Houses.

It should be axiomatic to all that modern scientific methods of illumination are just as necessary and beneficial in the smallest house as they are in the largest. But nevertheless this fact does not seem to be realised by many ordinary suburban householders, who appear to be under the impression that the many new kinds of indirect and semi-indirect equipment are for some reason not suitable in small rooms. Far from this being the case the very opposite is true, as it is in small rooms with comparatively low ceilings that the glare and bad distribution from bare or improperly shaded lamps are most pronounced. This is naturally a matter best shown by demonstration, and an electrical contractor should therefore have no difficulty in convincing the average householder of the advantages of indirect and semi-indirect lighting for the illumination of small and moderate sized living rooms.

B.T.H. "Eye-rest" System in a Small Drawing-room.

For example, in a sitting room lighted by a central arm fitting equipped with, say, three 40-watt lamps in ordinary ornamental glass shades, it is suggested the contractor could temporarily substitute a small semi-indirect fitting with a Veluria or Druid white glass bowl containing a single 60 or 100 watt Mazda half-watt lamp. This substitution, we are informed, will give even with the reduced wattage vastly improved lighting results.

It is further claimed that totally indirect lighting on the B.T.H. "Eye-rest" system is admirably suited to the illumination of small living rooms, as this system also gives good diffusion and glarelessness. This claim can also be substantiated by temporarily rigging up an "Eye-rest" fitting, an operation which can be performed in a very short time.

We understand that both B.T.H. semi-indirect and "Eye-rest" indirect fittings are now available in a wide range of sizes and patterns suitable for rooms of all kinds and dimensions and decorative schemes, and contractors who are interested in this subject are invited to communicate with the Illuminating Engineers' Dept., of the British Thomson-Houston Company, from whom full information may be obtained. Our illustration shows an example of the "Eye rest" system applied to a small room.

Arc Welding Equipment.

Foremost among the interesting features at the Inter-Allied Foundrymen's Congress and Exhibit, which was held at Philadelphia, Pa., from Sept. 29 to Oct. 3, was the splendid exhibit of Westinghous electrical apparatus, including the latest scientific development in the art of arc welding. The equipment consists of one 500-ampere arc welding motor generator set made up of three-phase, 440 volt, 60 cycle Westinghouse type "CS" motor mounted on a common shaft and bedplate with a 500 ampere, 60 volt arc welding generator. The control panel consists of a combination generator control and outlet panel for graphite electrode welding. The equipment provided for the control of the generator consists of circuit breaker, field rheostat, ammeter, voltmeter and necessary knife switches. By means of the resistance switches mounted on the combination panel, current values of from 150 to 550 amperes may be obtained in six steps. An additional outlet panel for metallic electrode welding is exhibited and provides for current values for metal electrode welding of from 25 to 190 amperes and for graphite electrode welding of from 225 to 350 amperes. This combination provides a flexible outfit for foundry use. Comparatively heavy graphite electrode work may be carried on or light carbon welding metal electrode welding can be accomplished at the same time. The generator can supply energy for several metallic electrode welding circuits, if no carbon electrode welding is performed.

The accessories exhibited consist of operator's hood and shield, graphite electrode holder, metal electrode holder and an adapter for equipping the metal electrode holder for light graphite electrode welding. A feature of the graphite electrode holder is its ability to remain in continuous service for long periods without heating up to a degree uncomfortable to the operator. Another interesting feature of interest to foundrymen is the electrically-heated metal pattern plates on moulding machines, which provides the most convenient, up-to-date method of heating. The advantages of this heat over gas are obvious. When it is desired to heat the pattern it is not necessary to hunt for a match, to operate or adjust valves until the correct degree of heat is obtained. Instead it is only necessary to plug into the wall receptacle and give no further thought to the matter of heat, since only the correct degree of heat can be obtained. The exhibit further includes standard alternating and direct current industrial motors, starters and controllers, outdoor fuse boxes, type *A* and *C* knife switches, oil and carbon break circuit-breakers, Frankel connectors, standard meters, stationary and oscillating fans, bayonet immersion heater, glue and solder pots, steel clad heater, type *C*, oven heater, rectangular electric stove, electric range and domestic heating devices.

The Safety First Movement.

Every year thousands of lives are lost, tens of thousands of casualties occur and millions of pounds are wasted through industrial accidents. Yet though this hideous wastage of blood and treasure continues in ever swelling volume, employers and workers alike do little to amend the situation. Either they look upon accidents as inevitable, or they are sceptical as to the value of remedies that lie within their grasp. Experience shows that accidents are not inevitable, and that they can be prevented by the use of Safety First methods and practices. In 1916 deaths and injuries were reduced 47 and 46 per cent. respectively on all railways in the United States, as a result of the use of Safety First methods. An important metropolitan company during the past five years reduced accidents by 70·9 per cent., and compensation claims by 57 per cent., while a large firm in the North of England in a single year reduced the number of accidents in its works more than 50 per cent.

Apart from the question of human life, which must ever remain the paramount consideration, the employer has every reason that self-interest can supply to adopt the Safety First creed. Accident prevention pays. The United States Steel Corporation in the nine years ended 1915 saved 14,067 employees from death and injury, and after deducting expenditure on Safety First propaganda was millions of dollars to the good. Premiums paid by leading British firms who have adopted Safety First methods have been reduced in respect of Employers Liability and Workmen's Compensation, in several instances by nearly 50 per cent. Dr Zacker, Director of the Bureau of Statistics in Germany, has stated that the amount of money saved in Germany by attention to, Saftey First, and to the health of employees, extends to one billion marks that is, 50 million pounds per annum.

A similar saving can be effected in England. The British Industrial Safety First Association is bringing about a silent revolution in the commercial life of this country. Backed by six Government departments, and supported by leading employers and trade unions, it strikes a human note, to which the representatives of Capital and Labour are proving responsive and sympathetic. It forms a point of contact between employer and worker; they meet on Safety First committees, and learn to know and understand each other. A prominent manufacturer said that he would consider every penny expended on Safety First work had been well spent, even if a single life had not been saved, or an accident prevented, because of the good feeling which had been engendered as a result of Safety First conferences between his employees and himself. The work of the British Industry Safety First Association needs no better commendation.

Presentation to Mr. W. W. Blunt.

In our issue of October 17 we gave an account of what may be called the official leave-taking to Mr. W. W. Blunt, who, it will be remembered, is giving up his work with the Metropolitan-Vickers Company for an appointment in America. In addition to this official farewell, however, several of Mr. Blunt's more intimate friends thought the occasion most fitting to show their appreciation of his qualities in some tangible form. A lunch at which a few friends were present was given to Mr. Blunt on October 9, Mr. J. A. Robertson, chief electrical engineer of the Salford Corporation, being in the chair when all sections of the engineering profession and industry were represented. On this occasion a presentation was made which, as our illustration shows, took the form of a solid silver inkstand, upon which were inscribed the signatures of those making it. A platinum-diamond brooch was also presented to Mrs. Blunt. Mr. Robertson, in making the presentation, emphasised Mr. Blunt's popularity not only with his clients but with all those he came in contact. This side of Mr. Blunt's character and the confidence felt in him generally was confirmed by other speakers, including many trade competitors. It may be mentioned that a number of those making the presentation whose names are shown on the case were not able to be present at the luncheon.

View of the Writing Case presented to Mr. W. W. Blunt.

L.C.C. Tramway Extensions.

An important report of the Highways Committee, recommending that powers be obtained to construct 17 new lengths of tramway, was presented to the London County Council on Tuesday. The report recited the steps already taken and the difficulties encountered in their attempts to develop the Council's tramway system. The last occasion on which the Council was before Parliament for powers for an extensive scheme was in 1915, when only one small section was sanctioned. The outline is given of a scheme of desirable tramway extensions (90 route-miles of track), estimated to cost about 5½ million pounds for tramway works and about 2½ million pounds for street improvements, or a total of 8 million pounds; but the Committee recommend that powers be sought in the next session for only 17 specified routes (nearly 43 miles), estimated to cost £4,205,345—£3,031,695 for construction, £928,550 for street widening, and £245,100 for spare cars, &c.

The routes recommended are:—

(i.) Charles-street to Blackfriars Bridge via Farringdon-road and New Bridge-street. (ii.) Gray's Inn-road to Farringdon-road via Holborn and Charterhouse-street. (iii.) Hampstead-road to a point north of the National Gallery via Tottenham Court-road and Charing Cross-road. (iv.) Cambridge-circus to Theobald's-road via Shaftesbury-avenue, Hart-street and Vernon-place. (v.) Victoria (Vauxhall Bridge-road tramway terminus) to Westminster Bridge via Victoria-street, Parliament-square and Bridge-street. (vi.) Victoria (Vauxhall Bridge tramway-road terminus) to Marble Arch via Victoria-street, Grosvenor-gardens and Hyde Park. (vii.) Marble Arch to Cricklewood via Edgware-road, Maida-vale and High-road, Kilburn, to Priory Park-road (double line); thence to Dyne-road, &c., to Kilburn, Shoot-up Hill and Cricklewood Broadway. (viii.) Edgware-road to King's Cross via Marylebone-road and Euston-road. (ix.) Shepherd's Bush to Marble Arch via Uxbridge-road, Holland Park-avenue, High-street, Notting Hill and Bayswater-road. (x.) Seven Sisters-road to Stamford Hill via Amhurst-park. (xi.) Aldgate terminus to Aldgate Station via Aldgate High-street. (xii.) Aldgate to Tower-hill via Mansell-street, Tower-hill and the Minories (single line). (xiii.) Tooley-street tramway terminus to Hop Exchange via Duke-street and Borough High-street. (xiv.) Waterloo-road to Blackfriars-road via New Cut and Great Charlotte-street. (xv.) High-street, Wandsworth, to Roehampton-lane. (xvi.) Forest Hill to Crystal Palace. (xvii.) West Norwood to Crystal Palace via Robson-road, Park-road, &c., to join existing tramway in Anerley-road.

The Gattie Transport Scheme.

The Board of Trado Committee dealing with this scheme concluded the hearing of evidence during the week.

Mr. W. J. Grinling, an ex-traffic manager of the Great Northern Railway, expressed doubt as to the practicability of the scheme in many details. The establishment of a flat rate per ton for all classes of goods was quite impossible. Goods had to be classed according to bulk, value, cost of handling, &c. He did not think Mr. Gattie could have been serious when he estimated the cost of transporting 4½ tons between Edmonton and Nottingham at 15s. 6d. Mr. Gattie had in many cases over-estimated the cost of transport under the present system, and for his own scheme had left out of account interest on railway capital. Mr. Gattie proposed that his clearing-house should rank as a statutory railway company. That would necessitate the carrying out of the obligations of all railway companies towards traders, one of which was to allow a "reasonable" time both for loading and for taking delivery. Experience had indicated that two days exclusive of the day of arrival was a "reasonable" time for taking delivery, and one day exclusive of the day on which the truck was placed in position at the other end. He thought Mr. Gattie had not had the assistance, in the preparation of his scheme, of anyone with much practical experience of railway transport. He did not agree that the clearing house would do away with the work in the marshalling yards, and although shunting would to some extent grow less as more clearing houses were built, it was a question whether the saving would compensate for the expense incurred His reason for thinking the continuous all day lorry system for clearing would not be a success was that traders never had their goods ready until late in the day, and there would not be anything to clear. The railway companies had made several experiments but had invariably failed to get traders to have goods ready for clearing early. He agreed with Mr. Gattie that the substituting of one goods station for the existing 74 would tend to lessen transhipping and increase the number of through trains. That would be a very desirable thing.

Mr. Alex. Ross, a past president of the Institute of Civil Engineers, said that many of the new connecting tubes proposed in Mr. Gattie's scheme did not conform with the statutory requirements, and it would, therefore, be necessary to purchase much of the land under which they passed. Further, there was quite a lot of property which would have to be pulled down if proposed junctions with other railways were to be effected. He saw no financial provision for these things in Mr. Gattie's estimates.

Mr. J. Pepper, assistant goods manager, Midland Railway, said Mr. Gattie had been invited to apply his principles to one of the company's largest goods stations at Birmingham. Witness was sorry when the negotiations fell through, but personally he thought the chief difficulty was the very large floor space which Mr. Gattie required for his machinery. The company had to deal with 80 square miles of the metropolitan area, for which they had 74 goods depots. It was a condition of modern development that commerce and railways would always follow the migration of the population. In large centres there was every tendency for the population to get further and further away from any expensive congested centre. With a central depot every ton of merchandise would have to be carted further and further away from the centre; and they would ultimately get a congested street-user curve. The tendency of the depots was to keep congestion down to a minimum. Assuming the day's work to be as suggested by Mr. Gattie, between 10,000 and 11,000 motor vehicles would be required, and with the reduction of working hours the number would go up to 14,000 at a low estimate. Mr. Gattie's scheme for delivering and taking away was impossible. Out of 3,000 London firms only three, when canvassed, favoured earlier delivery of their goods than at present. The cartage work was carried out in a scientific and highly organised way. The controller knew the conditions exactly and the whereabouts of every man. Recently railway companies had concerted together for consolidation, and there was more amalgamation of cartage management to follow. There was "on the stocks" an important practical scheme for London cartage which the Railway Executive had agreed to in principle and which it was intended to introduce soon. There was a certain amount of "unsavoury" goods which could not possibly be mixed with other kinds in a central depot, and every restriction which held up traffic would under Mr. Gattie's scheme interfere with traffic which was to follow on. The fundamental difference between the railway method and Mr. Gattie's was that they sorted the goods by means of documents and Mr. Gattie by pressing buttons.

In cross-examination, witness said he had always thought that Mr. Gattie's machinery might be utilised in some modified form; but much water would flow under London Bridge before London firms would use cranes for economy'a sake. The operating difficulties were all against a London goods clearing house.

Mr. Kirkpatrick, chief engineer to the Port of London Authority, said the improvements and progress aimed at by that authority included transport from ship to warehouse being made as economical and rapid as possible by mechanical means. It had caused him great disappointment to find that there were serious difficulties in connection with the practical application of Mr. Gattie's extremely ingenious machinery. If Mr. Gattie proved that he had a device which was good and economically sound, the Port of London Authority would be only too glad to adopt it.

Mr. P. Birch, formerly passenger manager of the North-Eastern Railway, said he was so impressed by Mr. Gattie's trucker device that he thought it should have an experimental trial. In regard to a clearing system for London, he thought the first principle should be to keep as much traffic out of London as possible. Now that railways were practically one whole, the companies ought to endeavour to establish a system of clearing houses in suitable parts of the country. He would favour two clearing houses for London, one to the north and one to the west, which would be better than having such a vast experiment as one in the heart of London. He doubted, however, whether London was a good place to begin such an experiment as Mr. Gattie's.

After counsel had addressed the Committee, the Chairman intimated that the Committee would consider their report.

The St. Pancras Tramcar Accident.

The Report of the Board of Trade inspector (Col. J. W. Pringle) into the tramcar accident which took place on Aug. 16 on the L.C.C. tramways. The car, which was travelling from Hampstead terminus on the south-bound track down Great College-street, left the rails on the curve into Pancras-road, crossed the north-bound track, as well as the double track in Crowndale-road, and collided with two section feeder boxes on the pavement. After reciting the facts, which have already appeared in The Electrician, and giving a description of the tramcar and its equipment, the condition of the track, &c., the report states that the Board of Trade regulations limit the speed in Great College-street to 16 miles an hour, and on curves with radii between 66 ft. and 150 ft. to 8 miles an hour, and all cars had to be brought to a standstill at the junction of Great College-street with Crowndale-road. A detailed examination by Mr. H. S. May, rolling stock superintendent (after Col. Pringle had inspected the car on Aug. 19) showed that the car wheels were true to gauge and without flats. He considered the flanges to be in good condition. Damage was done, when the car overturned, to the two truck magnets at the leading end of the car, and also to the hand brake sway bar chain. When this damage had been repaired the magnetic brake was found to act on all seven notches, the action being somewhat sluggish on the first three. The hand brake was in perfect order, and required 1½ turns of the brake chain on the spindle to apply it fully. Without adjustment, the hand brake was found capable of stopping the car. With regard to the electrical equipment, a rheostatic grid was found to be broken—a clean fracture, without any signs of burning indicating that the fracture must have occurred when the car overturned. In the brake circuit the turns of No. 2 magnet coil were found to be partially shorted The effect generally of the fault would be to give a sluggish initial brake action. Col. Pringle found marks on the roadway showing that the front wheels left the rails about 10 ft. before those of the rear truck. The track, as regards rails, was in adequate order, and the super-elevation sufficient, on the sharpest portion of the curve, for speeds of 4 to 5 miles an hour. The tyres of the leading wheels showed considerable wear. In addition to the wear on the treads, the depth of the flanges had been reduced to not much more than one-half that of an unworn tyre. This, and the blunted profile of the circumference of the flanges, showed that the car had done considerable riding on the flanges. The back of the flange of the near front wheel showed much wear from check rails. With such flanges there would be a greater liability to derailment, especially on left-hand curves, than with an unworn tyre. Motorman Poacher's statement that he commenced to apply the magnetic brake 70 yds. from the compulsory stopping place was negatived by the evidence of John Pearce. The latter stated that Poacher began to check the speed of the car at the "usual" place—*i.e.*, the north-east boundary wall of Goldington Buildings, 13 yds. from the stopping point. Poacher estimated the speed of the car at from 12 to 14 miles an hour when he began to try to reduce speed; but as he started from rest using five notches of current, in such circumstances a car would attain a speed considerably in excess of 12 to 14 miles an hour. Mr. May's experiment after the accident showed no defect in the braking efficiency, other than a sluggishness with the magnetic brake on the first three notches. Moreover, if the magnetic brake was utilised with the desired effect by Poacher in stopping the car at the "Stop by request" point in Great College-street, it is difficult to understand why it should have failed completely on all brake notches 185 yds. further on if the proper speed limit had been observed. Col. Pringle's conclusions are:—

(1) That there is evidence to show that the hand and magnetic brakes were in working order, if they had been properly used, when the accident took place. (2) That the speed developed on the journey towards the compulsory stopping place was higher than that authorised—*i.e.*, 16 miles an hour. (3) That the magnetic brake was, in all probability, not utilised early enough to check the speed of the car and bring it to a standstill at the required point. (4) That, eventually at least, owing to mismanagement, by an over forcible use of the hand brake in conjunction with the magnetic brake, locking of the wheels resulted, which caused derailment on the sharpest part of the curve, and the subsequent overturning. It is possible that if the wheels had not been locked the car might have kept the rails. The forward movement of the car, after collision with the feeder pillars, was not such as to indicate that it was travelling at a higher speed than 10 miles an hour when the collision took place. It is clear, I think, that retardation was taking place.

In conclusion, the report states the accident, with its regrettable results, illustratea the danger, especially with worn and shallow flanges—which are nowadays inevitable from travelling over much worn rails—that is likely to arise from speeds higher than those authorised if over hasty and forcible applications of the hand and magnetic brakes are made. The attention of motormen should be called to this point, and to the necessity for observing speed restrictions.

Electricity (Supply) Bill.

The Standing Committee of the House of Commons resumed consideration of this Bill on Tuesday. The chairman (Sir S. Roberts) said it was the desire of the Government that the Bill should be got through Committee as quickly as possible. As the remaining clauses related more or less to machinery, he hoped the Committee would make better progress than hitherto. It was agreed that the Committee should hold four sittings a week instead of three, if necessary.

On a suggestion by Mr. Marriott Clause 8 was amended and agreed to in the following terms: "Where a district electricity board of any authorised undertakers are authorised by order made after the passing of this Act to acquire or use any land for the purpose of a generating station, no person shall be entitled to restrain the use of the land for that purpose."

The remainder of the sitting was devoted to a discussion of the first section of Clause 9, which provided that "Notwithstanding anything in any special Act or Order in force at the passing of this Act, it shall not be lawful for any authority, company, or person, except a district electricity board, to establish a new or extend an existing generating station without the consent of the Electricity Commissioners, but this restriction shall not apply to the establishment or extension of a private generating station, provided that the owner thereof complies with any regulations made by the Electricity Commissioners as to the type of current, frequency and pressure to be used."

On the motion of Mr. Shortt the words "except a district electricity board" were deleted, and it was agreed to add words to ensure that the consent of the Electricity Commissioners "should not be refused unless a local inquiry has been held."

Mr. G. Balfour moved to omit the words "provided that the owner thereof complies with any regulations made by the Electricity Commissioners as to the type of current, frequency and pressure to be used." He said that many manufacturers, owing to the exigencies of their businesses, must have a current different from the standard set up for the central authority.

Mr. Shortt said this amendment went to the root of the principle of the Bill. There must be one uniform system of current, frequency and pressure, to cheapen supply, and, in the case of a breakdown, to make more certain the interchange between various systems.

The amendment was ultimately rejected by 14 votes to eight.

An amendment by Mr. Shortt limiting the proviso at the end of the sub-section to the case of the establishment of a new private generating station, was agreed to.

On Wednesday an amendment was agreed to by the mover (Viscount Elveden) and the Home Secretary to add at the end of the first section of Clause 9, providing that a railway company using or proposing to use electricity for traction shall not be refused, unless it is proved that the District Electricity Board or authorised undertakers are, or will be, willing and in a position to give the railway company a satisfactory supply at a cost not greater than would have been incurred by the company in supplying themselves.

In the second section of Clause 9 an amendment also moved by Mr. Shortt was carried. This provides that where a manufacturer having a business in which electricity can be generated from energy derived from a process of manufacture carried on in his premises proposes to generate electrical energy both for his own business and other manufacturers whose businesses are associated therewith, the Electricity Commissioners may authorise the establishment of a station by such manufacturer.

In Clause 11, the Home Secretary moved to add at the end of subsection (*b*), which provides that a District Electricity Board shall not supply electricity in any part of the supply area of a power company for any purpose for which the company are authorised to supply without the consent of the company, the words "except to the previous owners of a generating station which has been acquired by the District Electricity Board." This amendment was also carried.

A deputation from the Federation of British Industries recently waited upon Sir John Snell and other officials of the Board of Trade in order to submit their views on Clause 9 of the Bill, and on the position of "new" generating stations. Sir John Snell said he was aware of the Federation amendments to the clause, and the Government had already tabled amendments which modified the original clause in the interests of manufacturers who were desirous of providing a supply of electricity for their own use. As to what was a new generating station, Sir John Snell said he would try to insert wording in the clause which would make the matter perfectly clear.

Mr. Benjamin Talbot stated that as the clause stood the iron and steel industry would be handicapped practically out of existence, as it would mean that they would not be able to use their waste energy from the coke ovens and blast furnaces, even though they wished to utilise that waste energy for the purposes of the electric drive for their rolling mills.

In reply, Sir John Snell stated that the sanction of a joint generating station would be determined by the cost factor. If the manufacturers could provide current more cheaply than the district undertakers, no body of commissioners dare refuse sanction to the establishment of the private station. He thought that in the interests of electrical development generally it would be more advantageous for the surplus (waste) energy to be sold to the local supply authority, especially as during the week-end there would be an excess of energy over the normal works requirements. He felt that Mr. Talbot had made out a definite case, and he would be prepared to recommend to the Home Secretary the introduction of amendments which he hoped would cover the points raised.

Commercial Topics.

The Consular Service.

It is announced that the administration of the Consular Department of the Foreign Office has been transferred to the Department of Overseas Trade. The Foreign Secretary will continue officially to appoint all Consuls. The Commercial Attachés, now called Counsellors and Secretaries, are also under the Department of Overseas Trade.

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Debts of German Nationals.

By an Order in Council, under the Peace Treaty with Germany, it is provided inter alia: (1) That no person shall transfer, part with or deal in any way with any property, rights or interests without the consent of the Custodian. (2) That every person who owns or controls any such property must, within three months, communicate the fact to the Custodian unless particulars thereof have already been furnished to him in accordance with the provisions of the Trading with the Enemy Acts, 1914-18. (3) That if any person is asked to pay any money or to transfer or deal in any way with any property, rights or interests which he has reason to suspect are subject to the charge, he must immediately report the matter to the Custodian, who for England and Wales is: The Public Trustee (Kingsway, London, W.C.2); for Scotland: The Accountant of Court (H.M. New Register House, Edinburgh): and for Ireland: The Custodian for Ireland (King's Bench Division, Four Courts, Dublin).

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Merchandise Marks Committee.

The President of the Board of Trade has appointed a representative committee of 15 members to consider: (1) Whether any extension or amendment of the Merchandise Marks Act is required in respect of the provisions relating to indications of origin; (2) The utility and effect of National Trade "Marks" or other similar (collective) marks, and how far they should be authorised or encouraged in this country; (3) How far further international action may be necessary for the purpose of preventing the false marking of goods.

The chairman of the committee is Mr. Harry Green, M.P., and among its members are Mr. J. Evans-Jackson, Patent Agent, Mr. D. M. Kerly, K.C., Mr. H. Fountain, C.B., C.M.G., and Mr. W. Temple Franks, C.B. (Board of Trade). The Secretary is Mr. M. F. Levey, of the Industrial Property Department of the Board of Trade, Patent Office, 25, Southampton-buildings, W.C.2.

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Brazilian Industrial Development.

In submitting the estimates for the current financial year to the Brazilian Chamber of Deputies, the Minister of Agriculture, Commerce and Industry recently gave an outline of extensive schemes for the development of the iron and other natural resources of the country, for utilising the water-power available, &c. Even if only some of these projects are carried out it will mean that there will be extensive demands for electrical plant and apparatus, railway rolling stock, mining and other machinery. British manufacturers and exporters should, therefore, keep in close touch with Brazilian developments and study local market requirements, so that they may be in a position to take full advantage of the situation. We learn from the "Board of Trade Journal" that he put the iron ore deposits in Minas Geraes at 3,500 million tons, averaging from 60 to 70 per cent., and proportionately free from impurities. The State possesses 50 to 60 deposits of from 10 to 50 million tons, several of 100 million and one of more than 300 million tons. During the next 30 years Brazil would import 55 million tons of iron and steel products at an approximate value of 750 million pounds sterling. To found her own iron and steel industry and keep that money in the country he appealed for the outlay on the part of the Federal Government of £10,000,000, spread over seven years. The railways of the country (now 30,000 kw., or 18,600 miles) would be increased to 200,000 km., or 124,000 miles, for the rails of which alone it would be necessary to import 16 million tons. The present rolling stock (1,400 locomotives and 18,000 trucks) he wished to see increased at least 100 per cent. on existing lines. The railway needs of the country would represent 30 million tons of iron and steel manufactures. He hoped to see the mercantile marine trebled in the next 30 years, and there would be extensive demands for urban construction, the electrical industry, bridges, factories, &c.

For the solution of the problem, the gravest difficulty was the supply of fuel, which, however, he believed could be obtained by the application of electricity to the smelting industry. Although the water-power of the country was some 600 km. (over 370 miles) from the principal iron deposits of Minas Geraes, it would be possible to obtain water-power from the Serra do Mar between Victoria and Itabira, and between Rio and Sao Paulo, for supplying innumberable smelting works and to supply the principal ports of the country. The outlet for minerals would be by the Central Railway and the Minas to Victoria Railway, and the first necessary step would be the duplicating of the wide-gauge railway from Itabira and Ouro Preto to Barra-Mansha, which would call for an outlay of £700,000. Barra-Mansa, or Garra do Pirhay would thus become the Pittsburg of South America, and the construction of a line from that point to Angra dos Reis, on the coast, at a cost of a further £700,000, would allow the construction of a naval arsenal at that point. The Federal Government would bear the expense of the erection of the necessary plant for the utilisation of the hydraulic power of the Serra do Mar, which they would sell to all customers at a low price, and thereby encourage the establishment of factories of all classes. An estimated expenditure of £8,000,000 would supply the energy for the electrification of the Central Railway and the naval arsenal and smelting works at Angra dos Reis

Electricity Supply.

The question of the purchase of the local electricity works is being considered by Aberystwyth Urban Council.

At Limerick the Electricity Committee has increased the charge for electric current from 9d. to 1s. a unit.

Midgley Urban Council has asked Halifax Corporation to quote terms for the supply of electricity in its area.

Blaina and Brynmawr Urban Council will co-operate in applying for powers to supply electricity.

Canterbury Corporation has applied to the Board of Trade for a "fringe" order to supply electricity outside the city boundary.

Darwen Corporation has applied to the Lancashire Electric Power Company for terms for a supply of electric current in bulk.

The new mayor of Swansea is Ald. A. Sinclair, who has been chairman of the Swansea Electricity Committee for several years.

The charges for electric current have been increased by a further 5 per cent. by the Stoke Newington (London) Borough Council.

An inquiry was held last week into the application of the Heston and Isleworth Urban Council for sanction to borrow £9,640 for extensions of the electric supply undertaking.

A Committee of the Portadown Town Council, which was recently appointed to consider the question of erecting electricity supply works, is collecting information from similar towns where electric supply is available.

An inquiry was held at Annfield Plain on the 23rd inst. into the application of the Urban Council for sanction to borrow £17,700 in connection with their scheme for the electric lighting of the district.

Oswaldtwistle Urban Council is anxious to obtain a provisional order to supply electricity in the district, but the Board of Trade intimate that they are not prepared to entertain such applications pending the decision of Parliament on the Electricity (Supply) Bill.

An inquiry was held at Manchester on Tuesday into the application of the City Council to borrow £1,042,000 for plant, &c., for the new Barton generating station, and £50,000 for sub-station plant.

In giving evidence, Mr. S. L. Pearce, chief electrical engineer, said that at present Manchester was furnishing bulk supplies to Middleton and Salford: negotiations had taken place with regard to supplies to three authorities, and inquiries had been tentatively made by two others. If all these matured it was likely that a serious difficulty would result, and Manchester would be justified in considering whether they ought to give these bulk supplies in view of the probable developments in the city proper. The Barton station ought to be ready by the autumn of 1922, but in view of the present industrial position it might take longer than three years to build the station.

Panteg Urban Council will not oppose the application of the South Wales Electric Power Company for a provisional electric lighting order for the district, provided the company agree to sell the undertaking at periods of seven years, and that the overhead system to be adopted shall be approved by the Council.

Blackpool Electricity Department reports during the past six months 75 new consumers, compared with 29 in the corresponding period of last year. During the six months ended Sept. 30 the output of the electricity works was 3,199,191 units, an increase of 508,371 over the corresponding period of last year.

The accounts of the Edinburgh electricity department for the year ended May 15, 1919, show revenue £186,464 and working and miscellaneous expenses and special expenditure (war allowances) £126,794, leaving a surplus of £59,669. Interest required £14,512, contribution towards liquidation of debt £39,582, and income tax £9,234, and £3,659 was transferred from reserve to meet the deficiency on net revenue account. Units generated were 25,599,789 (compared with 26,203,766 in previous year) and sold 20,565,249 (20,945,404), including 11,528,055 (11,470,080) power units, other than traction.

An important report has been prepared by the city electrical engineer of Dundee (Mr. H. Richardson) on the proposal to utilise the water-power in the Tummel Valley for generating electricity, and the Electricity Committee suggest that Mr. C. S. Meik, M.Inst.C.E., and Mr. W. J. E. Binnie, M.Inst.C.E., be invited to consider the report and to investigate the scheme. In the recent report of the Board of Trade on water-power development covered the harnessing of the waters of Lochs Ericht, Laidon, Rannoch and Tummel. The whole scheme, if the power were used continuously for electro-chemical works of similar industries for a steady load of 42,000 E.H.P., including transmission to, say, the vicinity of Perth, would cost just under £2,000,000. If, however, the power were used for a varying load, such as a public supply, then a maximum load of 72,000 E.H.P. could be met, but the cost would be £3,000,000.

Mr. Richardson suggests that, if the Council decides to proceed with the scheme, the Tummel be developed first, together with partial works on the other two lochs, which may be necessary, especially with a view to the ultimate entire use of the Valley's possibilities. In his opinion, the scheme would easily supply any useful demands for power en route without prejudicing the interests of Dundee. He estimates that current can be sold by a coal-driven generating station at an average price of 1·28d. per unit. The first stage of the water power scheme would cost £1,250,000, and, on the basis of a 50 years' sinking fund, the average price would be 1d. per unit, and on the basis of a 33 years' sinking fund, 1·08d. per unit.

Electric Traction.

Sheffield Corporation are recommended to spend about £50,000 for additional electric vehicles for the collection of house refuse.

South Shields Rural Council has notified to South Shields Corporation that it will sanction the running of electric omnibuses in its district provided an arrangement can be come to as to the rate of payment to be made for the maintenance of the roads.

For the first three months there was a surplus of £7,106 on the working of the Edinburgh Corporation tramways, after providing for the proportion of £60,000 for sinking fund and interest, but without providing for depreciation.

The recent arbitration award regarding tramwaymen's wages will, according to Mr. Chas. Furness, tramway manager at Blackpool, necessitate a revision of the fare stages. Blackpool is one of the few towns which have not increased their pre-war rates.

Newcastle-on-Tyne Corporation is to promote a Bill for powers to acquire the undertaking of the Tyneside Tramways & Tramroads Company. It is not proposed to seek compulsory powers of purchase, but only authority to acquire by agreement between the parties.

Oldham Tramways Committee have decided to suspend the service on Christmas Day, and to make a grant of £75 to the expenses of a "welcome home" to ex-service men in the department to be held on that day. The number of men who enlisted from the department was 370, and of these 191 have returned, and 100 other ex-soldiers have been engaged.

Owing to the success of electric traction on the Shildon-Newport section of the North Eastern Railway it is announced that an experiment will shortly be made in electrifying a portion of the Company's main line between York and Newcastle, which is suitable for both mineral and passenger traffic. It is probable that the section from Newcastle to Darlington will be selected as ample power is easily obtainable.

Nottingham Corporation has authorised the Tramways Committee to promote a Bill to authorise an extension of the Corporation tramways to Beeston and Hucknall. But for the war the Beeston extension would have been completed. The powers expired in August, and it is now necessary that powers to alter the line should be sought. An extension of the tramway from Bulwell to Hucknell will also be made.

The recent award to tramway employees will involve an added expenditure of £3,000 a year to the Stalybridge, Hyde, Mossley and Dukinfield Joint Tramways Board, whose total working expenses are now £63,000 a year, or more than twice the pre-war figure. As reconstruction of the track, at a cost of £240,000, is necessary in the near future, an increase of fares seems probable.

The Southend Light Railway Committee, having considered the question of providing additional transport facilities, recommends that, as the Corporation would require special powers to provide trackless trolley vehicles, and as the Corporation has statutory powers to provide a service of motor 'buses, a motor 'bus service should be provided to run in conjunction with the tramways in order to open up four routes between different parts of the borough. The provision of motor omnibus services beyond the borough boundary is under consideration.

On Tuesday the London County Council approved an estimate of expenditure on capital account not exceeding £22,500 in respect of the provision of a spare alternator and rotor for the Greenwich power station. The Highways Committee reported that considerable trouble had been caused recently at the station owing to breakdowns on the three 8,000-kw. turbo-alternator sets, due to defects in the alternators. Various defects had arisen and in every case steps had been taken to remedy them by modifications as far as that had been possible. The Committee is considering what steps can be taken for the repair of the plant at present broken down, but meanwhile it was desirable to obtain a spare alternator and rotor which could be installed on the bedplate of either of the three existing sets in the event of a break down.

The decision of Stoke-on-Trent to purchase the local tramway is, leading to considerable discussion in local municipal and business circles and the subject has been one of the principal topics of debate in the municipal elections. At a recent meeting of ratepayers a resolution against the purchase was passed with a few dissentients; but, on the other hand, the principle of municipal ownership has been unanimously approved at a meeting of the local Trades Council. The objections to the purchase are based on the fact that the present is not a favourable time for such a scheme, and on the unreasonably high purchase price, coupled with the inevitably heavy expenditure that would have to be incurred in reorganising and modernising the system to meet the traffic requirements of the present day.

Glasgow Corporation has had under consideration a report by Mr. John M. MacLeod, C.A., auditor of the Corporation tramways department, on the question of the amount necessary for renewals, &c. During the four years 1914 to 1918 the allowance for renewals and depreciation was at the average rate of £325 per mile of single track, and for 1918-19 £700. Owing to the scarcity of labour and lack of material, the necessary renewals could not be executed during the war, and these arrears would fall to be overtaken at the increase of costs in both labour and material. Mr. MacLeod states he is not in a position to say whether an increase of 115·4 per cent. of the allowance for current renewals and depreciation is sufficient, but it would be for the Committee to consider whether it was not necessary to take from future revenue a percentage over and above the allowance already provided to cover the present and future costs for work not executed during the war

Imperial and Foreign Notes.

Modern coal-handling plant is to be erected at Melbourne harbour and will replace the present archaic method of hand-filled baskets, which are hoisted out of the steamships' holds by winches. The new plant will consist of four electric hoists with grab buckets which pick up four or five tons of coal at a time and deliver it to mechanically operated conveyers, which in turn carry it to great storage bins of 30,000 tons capacity, from which the coal is sent in chutes to coal trucks.

It is reported that the Ministry of State Railways in German-Austria contemplate the utilisation of the water-power in Carinthia for the purpose of electrifying the railways. The first line to be electrified is the Tauern line from Mallintz-Spittal, with a power station at Mallintz. Later the lines leading from Upper Styria to Carinthia and their branch lines are to be electrified. No plans have been drawn up for the electrification of the Sudbahn line, as the Drau would have to be utilised as source of power and the political situation in South Carinthia was not yet clear.

It is satisfactory to learn from statistics supplied by the Belgian Central Information Office that the various great Industries of Belgium are making very good progress with their reconstruction schemes, and are rapidly recovering. This resumption is due to the rapid recovery from Germany of the machinery and material stolen by the invaders in the last two years of the war. The statistics for July show that a total of 39,521 tons had been restored. The estimated value of this recovered machinery and material is 49,401,250 francs. The coal output in July last was 1,600,000 tons, against an average monthly output in 1913 of 1,800,000 tons. Many other industries are also making satisfactory progress, and indicates good organisation on the part of the Belgian authorities.

Miscellaneous.

The Anglo-Belgian telephone service was opened on Monday, the charge for three minutes' conversation being 8s., and the Anglo-French telephone service was reopened on Tuesday at the pre-war charges.

In consequence of the purchase of its undertaking by the English Electric Company, Ltd., it has been decided that Dick, Kerr & Company, Ltd., be wound up voluntarily. A meeting of creditors will take place at noon on Nov. 10 at 66, Coleman-street, E.C. 2, and claims are to be sent to the liquidator, Mr. G. R. Freeman, at that address by Dec. 31.

Sir Albert Stanley, M.P., has issued invitations to a luncheon to be held on Nov. 3, at the White Room, Savoy Hotel, W.C., in connection with the proposed formation of an Institute of Transport. After the lucnheon there will be a meeting at which a resolution will be submitted stating that it is desirable that an institute be formed for the scientific study of questions relating to traffic and transport.

The members of the Victoria Works Athletic Club (Messrs. Johnson & Phillips, Ltd.) held a dinner on the 25th instant at the Shakespeare Hotel, Woolwich, which was attended by nearly 170 diners. Mr. H. J. Sheppard (one of the presidents) was in the chair, supported by Messrs. W. H. Johns, G. C. Pearson, C. Stewart and D. A. S. Porteous (vice-presidents). Following the usual toasts, a concert was held, to which the following artists contributed : Miss Olive Turner, Miss F. L. Knight, Mr. Lawrie Garland, Mr. F. T. Warren and Mr. W. A. Booth, with Miss L. M. Andrews at the piano. Both dinner and concert were highly successful.

On Wednesday and Thursday the Court of Arbitration sat to hear the application made by about 40 trade unions in the Engineering, Shipbuilding and Kindred Trades for a further advance of 15s. a week. At the last periodical hearing a similar application was not granted, but the official figures of the cost of living have since revealed an increase. The engineering employers and unions were heard on Wednesday, and the shipbuilding trades on Thursday. It is to be hoped that the award will be issued promptly, as it may form a basis for reopening negotiations with a view to ending the strike of ironfounders, which is having an extremely serious effect on the engineering industry.

Acton Profiteering Committee, after hearing expert evidence on both sides, has dismissed the case brought by Mr. J. H. Worrall against the Metropolitan Electric Supply Company. Mr. Worrall bought some Ediswan lamps at the firm's Acton branch for 3s. 6d. each, and he alleged that the profit was unreasonable, in view of the fact that the pre-war price was 2s. 8d. each. His expert witness said the lamps could be sold for 1s. 6d. each, but that the price was kept up by two rings—an inner and an outer. The expert evidence on the other side showed that the quality of the lamps had been maintained, and that the rate of profit was reasonable. The committee decided to state a case for the Board of Trade on the question of "rings."

Mr. C. Carrington Barber, works engineer of the Birmingham Corporation Gas Works at Saltley, is the new president of the Midland Junior Gas Association, which opened its session on Saturday last. In his presidential address Mr. Barber strongly urged the need for conservation of fuel. In the past it had been the custom of those engaged in the gas industry to regard electricity as their competitor, but he thought that, in the future, the generation of electricity and the production of gas would be a joint industry. If we were to obtain the most out of our coal resources, then coal would be carbonised and the gas converted into electrical power, and the by-products, which to-day were lost at the power stations, would be recovered.

An Inquest was held at Little Crosby (Lancs.) on the 23rd inst. upon James Latham, who was killed at the Royal Army Orduance Depot, Aintree, while loading a wagon with timber. According to the evidence, electric current was supplied to the depot. There were three overhead electric wires (a red, a black and a protecting wire) for lighting a hut. Deceased was seen holding the protecting wire, which was down, in his hands. It was twisted round his arm, and his elbow was resting on an iron band. Persons who tried to knock him off the wire received a shock.

Dr. V. J. Glover and Dr. J. Huskie agreed that death was due to paralysis of the heart caused by electric current, but Capt. O. Carlisle, medical officer at the depot, said the inference that death was caused by electric shock was not absolutely definite. Deceased must have had a specially nervous system, because the voltage of 200 was very low and very seldom killed. The electrical engineer at the depot said he failed to find any part where the guard wire could have become charged. In his opinion it was not charged. H.M. Factory Inspector agreed it was difficult to say how the wire could become charged.

The Coroner found that death was caused by electric shock, but under what circumstances conveyed there was not sufficient evidence to show.

An interesting lecture on "The Generation and Application of Electricity to Agriculture and Industry" was given last week by Dr. W. E. Sumpner at Mason College, Birmingham. Dr. Sumpner said the study of electrical sparks had been of enormous importance, because it was through this study that wireless telegraphy had come into existence. It also had a bearing upon the use of electricity for agriculture. A commercial company was engaged in utilising devices for producing sparks, or something electrically indistinguishable from them, for the intensive production of crops. There were two possibilities in the application of electricity to agriculture. One was to convey power to a considerable distance, so that it could be used for agricultural machinery. But the other direction, if it was done on a large scale, was more important, as it meant the improvement of crops. It was said that considerable success had been attained by means of distributing electric sparks over fields in which crops were growing, and that increases of from 30 to 40 per cent. had been obtained. In regard to the application of electricity to industry, Dr. Sumpner pointed out that electricity meant economy; it was an ideal adjustment of the gearing between the engine and its work, and the general characteristic was that the old industry was not displaced, but it was increased, and electricity developed at the same time. He emphasised the importance of electric power which could do its work at a distance. The growth of electricity was the measure of its advantage to the public, and he mentioned that the output of the Birmingham central station had increased 60 per cent. since the commencement of the war.

Educational.

The Governors of the Royal Technical College, Glasgow, are endeavouring to raise £100,000 for the extension of research work, and nearly £40,000 has been received or promised. The main object of the fund is research in relation to the local industries. The number of new students this session has been so great that the staff have had to decide between the alternatives of refusing admission to a great many students or of reducing the time given to laboratory instruction. It has, however, been decided to reduce to some extent the time given to the laboratory courses. The Governors are considering whether some extension of the class-room accommodation should not be attempted.

The new session of the Manchester College of Technology, which opened on the 8th inst., marks a record in the growth of the College. The number of applications for admission (both to the university and to the part-time courses) have been so great that very many suitably qualified students had to be refused admission before the end of enrolment week. The increased demands of industry for suitably qualified men, a demand which has largely increased as a result of experience gained during the war, and the urgent need for men trained in the methods of industrial research, have caused the English technological colleges of university rank to be no longer able to meet the demand for advanced study and research in applied science and technology.

Over 500 students, including 270 freshmen, have been admitted to the main departments (mechanical engineering, electrical engineering, applied chemistry and textile technology) of the College. The number of matriculated freshmen is about seven times as great as the number admitted in 1911. We learn that many students who wished to gain admission to the college, but for whom accommodation could not be found, are seeking admission to other universities, with a view to returning to this university next session, so that they may continue their technological training in Manchester. Over 3,750 students have been admitted to the part-time (evening) courses, an increase of more than 1,650 compared with the last session

Special mention should be made of the courses in the departments of industrial administration and of applied chemistry. The former department, which was opened less than a year ago, and which has for its main objects the building up of a science of industrial administration, and, as far as possible, the working out of its applications to all British industries, has now arranged a full-time course which includes lectures, laboratory work and visits to works. A part-time course meeting on three evenings a week has also been arranged. The lectures which form parts of these courses will deal with questions regarding industrial management. A series of free public lectures, to be delivered at 4.30 on Tuesday afternoons during the autumn term, has also been arranged by the department. The first of these lectures was delivered last week by the Right Hon. J. H. Whitley, M.P. Other lectures will be delivered by Mr. G. D. H. Cole and Mr. Sidney Webb. The department of applied chemistry has arranged a course of 20 lectures on chemical engineering. These lectures will be delivered on Tuesday afternoons during Michaelmas and Lent terms.

Tenders Invited and Accepted.

Manchester Tramways Committee invites tenders for the supply of permanent way special track work. Tenders to chairman by Nov. 11.

Johannesburg (Transvaal) Council require tenders for copper wire, cable insulators and steel poles (contract 548). Tenders to the Town Clerk by noon Jan. 8.

Prestwich District Council require tenders by 10 a.m. Nov. 7 for electric lighting work at the Town Hall. Specifications, &c., from the Engineer and Surveyor.

Hampstead (London) Council require tenders by 4 p.m. Nov. 3 for the supply of oils to the electricity station and the removal of ashes, &c. Forms of tender from the Town Clerk.

Glamorgan County Council require tenders by Nov. 10 for electric wiring at Evanstown Council School, Gilfach Goch. Forms of tender, &c., from the Clerk of the Council, Cardiff.

Bolton Electricity Committee require tenders by noon Nov. 11 for the supply of an 8,000 kw. turbo-alternator, condensing plant, and four water-tube boilers. Specifications from the Borough Electrical Engineer.

Johannesburg (Transvaal) Council require tenders by noon Nov. 24 for the supply of tramcar spares (contract No. 531), and by noon Dec. 1 for the supply, &c., of a 500-kw. converter, or, alternatively, a 750 kw converter and spare parts (specification No. 114).

Rhondda Electricity Committee invite tenders for the supply and erection of two sets of sub-station switchgear. Specifications from the Engineer and Manager, Electricity Works, Porth, and tenders to the Chairman of the Committee, Pentre, Glam., by Nov. 5.

Tunbridge Wells Corporation require tenders for the supply of a 750 kw. to 1,000 kw. turbo-alternator, surface condenser and pumps, wet air filters, steam and other pipes, economiser, induced draught fan and engine, and extension of switchboard. Specifications from the Borough Electrical Engineer.

The directors of the Great North of Scotland Railway Company require tenders by 10 a.m. Nov. 27 for six or 12 months' supply of various stores and materials, including telegraph material, ironmongery, india-rubber goods, &c. Forms of tender from the Stores Superintendent, 80, Guild-street, Aberdeen.

Leeds City Council invite tenders for single phase, 2,000 and 6,600 volts, and Scott connected transformers, with a total capacity of 14,000 k.v.a., for early delivery, and also for further supplies of similar transformers as required for a period of two years. Specifications, &c., from the manager of the electricity department (Mr. C. Nelson Hefford), 1, Whitehall-road, Leeds. Tenders to the town clerk (Sir Robert E. Fox), 26, Great George-street, Leeds, by 11 a.m. Nov. 13..

Edinburgh Corporation recently invited tenders for turbo-alternators and other plant for the new power station at Portobello, and 16 tenders were received. Having considered the officers, the Electric Lighting Committee recommended the acceptance of the lowest tender, that of Messrs. Brown, Boveri & Company, of Baden, Switzerland at £106,618 for the turbo-alternators. Of the 16 tenders, the lowest British one (Messrs. C. A. Parsons & Company) is £174,075, or £67,475 more than the tender recommended.

The Board of Trade, which was communicated with, suggested the desirability of stipulating, so far as practicable, in all contracts placed by the Corporation, that the goods to be supplied shall be of United Kingdom manufacture. The Board intimated, however, that it could not insist upon the Corporation accepting a British tender in face of such figures unless it felt it proper to do so on general grounds.

On Tuesday the City Council adopted the Committee's recommendation to adopt Messrs. Brown, Boveri's tender, which is based on a rate of exchange of 24 francs for £1 sterling. There is also a stipulation that should there be any variation in the rate of exchange, or if import duti should be imposed by this country on machinery or apparatus of the class included in the contract, the amount of such duties should be paid by the Corporation.

In connection with this contract, the Hon. Sir C. Parsons has stated that, even without any profit, he could not look at the foreign offer, and he intended to post particulars of the contract where his workmen could read them in his works. He pointed out that in 1914 the cost of the best Scottish pig-iron was 64s. a ton, against 200s. to-day.

Appointments Vacant and Filled.

Glamorgan Education Committee require two travelling lecturers for mechanical and electrical engineering. Salaries £250 per annum, rising to £450, with expenses. Applications to the Chief Education Officer, County Hall, Cardiff, by Nov. 12.

A chief instructor in physics and electrical engineering is required at the Seddon Memorial College, Auckland, New Zealand. Commencing salary £400. Further particulars from the High Commissioner of New Zealand, 415, Strand, London, W.C.2. Applications by Dec. 6.

Applications are invited for the position of city electrical engineer at Port Elizabeth, South Africa. Three years' agreement. Salary £700, rising to £900 in third year. Applications to the Agents of the Municipality of Port Elizabeth, Messrs. Davis & Soper, 54, St. Mary Axe, London, E.C., by Nov. 12.

Applications are invited for the position of lecturer in electrical engineering at the University of Cape Town. Commencing salary £350 rising after three years' service by annual increments of £25 to £450 plus war bonus. Applications to the Secretary, High Commissioner for the Union of South Africa, 32, Victoria-street, S.W., by Nov. 30.

Liverpool Tramway and Electric Power and Lighting Committee require a qualified engineer, with civil and electrical experience, to act as superintendent of the overhead line equipment, &c. Salary £500 per annum. Particulars from the General Manager, Corporation Tramways, 24, Hatton-garden, Liverpool, to whom applications by Nov. 12.

The Corporation of the city of Cape Town invite applications for the position of station engineer. Salary £600 per annum. Applications by noon Jan. 3, 1920, to the town clerk, Mr. J. R. Finch, City Hall, Cape Town. The Corporation also invite applications for the position of temporary assistant engineer in the electricity department, salary £60 per month. Applications to the town clerk (Mr. J. R. Finch) by noon of Jan. 10, 1920. In both cases British candidates must send in applications to the London agents, Messrs. Davis & Soper, Ltd., 54, St. Mary Axe, E.C., by Nov. 15.

Middlesbrough Corporation have appointed Mr. H. P. Jenken, engineering assistant of the Leeds City Tramways, tramways manager of the Middlesbrough Corporation tramways at £750 per annum.

Business Items.

Mr. A. Anderson, of Edmundson's Electricity Corporation, has joined Messrs. Banks, Warner & Company, Diesel engine experts, of 11, Queen Victoria-street, E.C., and will act, with Mr. P.H. Smith, as joint managing director of the new company.

Chas. Hy. Davies and Wm. Hy. Arundale, electrical fittings makers, 153, Bracebridge-street, Birmingham, have dissolved partnership. Debts by Mr. Davies, who continues as C. H. Davies & Company at the same address.

The partnership between G. H. J. Hoogwinkel and Wm. A. Brown, civil and electrical engineers, 24, Martin-lane, Cannon-street, E.C., has been dissolved. Communications with regard to debts should be addressed to Anthony Brown & Hoogwinkel, Ltd., 24, Martin-lane, E.C.

Sections 4,050 and 4,060 of the latest catalogue of the Western Electric Company, of North Woolwich, London, E.16, have recently been issued. The telephone instruments listed in section 4,050, which is devoted to inter-phones and accessories, are battery ringing (except the direct line sets), and are intended for telephone service over comparatively short lines; they are arranged for intercommunication, and do not require a switchboard and operator. Several advantages are claimed for this method, including a saving in battery cost and a reduction in maintenance cost, while a uniform transmission is always maintained. The list contains details and prices of systems of intercommunication sets to meet practically all requirements. Section 4,060 of the catalogue extends to 62 pages, and contains illustrated particulars of a variety of telephone instruments and switchboards (manual and automatic), telephone apparatus and cables, switchgear, traffic control apparatus, domestic telephone appliances, &c. Other sections of the catalogue are in preparation, and the company supply a neat binder which allows for simplicity in filing.

A new list of RUBBER INSULATED WIRES AND CABLES has been issued by Messrs. Siemens Bros. & Company, Ltd., of Woolwich and London. The new list embodies the revised standards of the British Engineering Standards Association, and the prices are given per thousand yards. In future the standard coils will be 100 yds. in length. All grades of Association and non-Association cables, as well as bell wires, flexibles, &c., are listed and priced. The list also gives a British standard table of conductors, a comparative table showing the relation between the old standard sizes of conductors and the new standard sizes, a conversion table and other useful data. The Company have still in stock a certain amount of electric wires and cables made to the old standards, and for a limited period they will continue to quote for such wire or cables.

Messrs. W. T. Henley's Telegraph Works Company have also revised their price lists, and they notify that the general arrangement of their list now follows the principle of having a separate section for different classes of cable. There is a section for "Association Wires and Cables," "Non-Association Wires and Cables," "Solid Rubber Sheathed Cables" and "Flexible Cables," and there will be other sections embracing various other types of cables in due course. The new standard sizes differ from the old in that the wires will be described by their nominal area, and the conductors by the number of wires, and sizes in inches instead of S.W.G. as hitherto. Prices for cables and wires are given per 1,000 yds. instead of per mile, and for flexible cords per 100 yds. The standard coil will be 100 yds., and orders should be multiples of that length, instead of sub-multiples of a mile, as hitherto. Flexible cords will generally have their conductors made up of 0·0076 copper instead of 0·0048 and 0·006 in. as hitherto. Some special flexible cables—Class "FG"—are now listed which have never been listed before, and three-core cables are listed for the first time. The company's special thermoid flexible is listed with an asbestos serving and in a special industrial type. The flexible cord price list also contains particulars of motor car lighting, starter and ignition flexibles, and a much more complete list of solid rubber-sheathed cables (both standard and flexible conductors) is given. The lists will be issued in a loose leaf cover embracing various sections of the catalogue.

The India Rubber, Gutta Percha & Telegraph Works Company of Silvertown and London, have also issued their revised list (No. 40) of cables and wires, which gives the new standard sizes and prices of the various grades of cables, wires and flexibles manufactured by them.

Companies' Reports, &c.

At an extraordinary meeting of the Gateshead & District Tramways Company last week it was resolved that £67,500 out of the reserve fund of £68,000 be distributed to the ordinary shareholders at the rate of £5 (tax free) for each issued £10 ordinary share.

The directors of the Norwich Electric Tramways Company have declared a dividend for the past year of 2 per cent., or 4s. per share (less tax), and a sum of £4,000 has been placed to reserve and £3.000 to reconstruction and deferred repair account and £167 carried forward.

The accounts of the Marconi Wireless Telegraph Company of Canada, Ltd., for 1918 show a profit of $138,648, and after meeting interest on advances and appropriating $18,216 for depreciation, &c., the credit balance of $198,414 brought down was increased to $293,787.

The directors of Callenders' Share & Investment Trust Company, Ltd., announce a dividend of 3½ per cent. (8⅗d. per share), less tax, for the past half-year, making 6½ per cent. for year; £500 has been placed to reserve (making £3,000); £740 written off preliminary expenses and cost of debenture stock issue; and £5,603 carried forward.

At the recent meeting of the Electric Supply Company of Victoria, Ltd., it was reported that the number of lamps connected at March 31 last was 252,407, against 211,746 in 1918 and 188,402 in 1917, while 4.898,102 passengers were carried by the tramways departments, compared with 4,881,924 and 4,803,895 in 1918 and 1917 respectively. The year's revenue was £101,220 and the expenditure £67,159, leaving £34,061. Adding amount brought forward (£20,923) and deducting debenture interest, amounts transferred to debenture stock redemption account and written off cost of debenture issue, the balance was £38,468. A sum of £2,618 was written off loss on realisation of obsolete assets, £1,214 was placed to reserve for estimated liability under federal income tax, £10,500 allocated for arrears of preference dividend and £24,136 carried forward. The report stated that the payment of income tax in both this country and Australia has become a matter of serious hardship to the Company, and is engaging the attention of the directors.

Marconi's Wireless Telegraph Company, Ltd., announce that, subject to resolutions which will be submitted to the shareholders of the American Marconi Company in general meeting on the 20th prox. being approved, they have sold to the General Electric Company, of New York, the whole of their shareholding in the American Marconi Company at an advantageous price. The Radio Corporation of America has been organised in America for the purchase of the assets of the American Marconi Company. This Corporation will have a capital of 5,000,000 7 per cent. cumulative preferred shares of $5 each and 5,000,000 ordinary shares without capital denomination. The American Marconi shareholders will receive one 7 per cent. cumulative preferred and one ordinary share for each $5 share at present held by them. An agreement, entered into by the Marconi Company with the General Electric Company and the Radio Corpn. of America, provides (inter alia) that the English Marconi Company secures the sole rights for the whole of the British Empire and a licence for other parts of the world other than the United States of America of all radio patents and inventions of the General Electric Company of New York and the Radio Corpn. of America past, present and future until the end of 1945, which embraces the Alexanderson high frequency alternator. The directors of Marconi's Company recommend those who hold shares in the American Marconi Company to send their proxies duly executed to Mr. Godfrey C. Isaacs, Marconi House, Strand, W.C. 2.

The directors' report of the Edison Swan Electric Company, Ltd., states that the profit for the year ended June 30 is £137,442. 8s., making, with £50,265. 9s. 5d. from the previous year, £187,707. 17s. 5d. Deducting interest on both classes of debenture stock (£18,649. 10s. 7d.), Armistice wages grant (£3,357. 14s. 4d.), 7 per cent. dividend on the participating preference shares to Jan. 31. 1919 (£7,000) and the 3 per cent. interim dividend upon the ordinary shares paid in June last (£11,813. 1s.), the balance is £146,887. 11s. 6d. It is proposed to appropriate £35,361. 5s. 11d. to special munitions plant, depreciation, £5,645. 8s. 8d. for balance of expenses of issue of preference shares, to pay a further 3 per cent. dividend on the participating preference shares, making 10 per cent. for the year (£3,000) and a dividend of 7 per cent. on the ordinary shares, making 10 per cent. for the year exclusive of shares issued in May, 1919 (£27,755. 7s.) and to apply £13,413. 19s. 10d. as provision for debenture stock sinking fund, leaving to be carried forward, subject to Excess Profits Duty, £61.711. 10s. 1d.

Considering the inevitable dislocation of manufacturing, brought about in the change over from war to peace conditions in the year under review, the directors consider that the results achieved are favourable, and they are glad to report that the works are fully employed, and should continue to be so if no unforeseen circumstances arise. The capital expenditure, before providing for depreciation, is £39,641. 5s. 5d., of which £15,013. 7s. 4d. is in respect of additions to land and buildings. and £24,627. 18s. 1d. to plant and machinery. These extensions include an additional gasholder of a capacity of 75,000 c.f. of gas, together with the necessary retorts, &c., additions and improvements to the glass works, new shops for the manufacture of electrical accumulators, heating and cooking apparatus, bells and telephones, additions to the electroplating department, and considerable extensions of various other departments. The Company having entered into certain commercial arrangements with the Enfield Electric Cable Mfg. Company, Ltd., a concern with extensive works at Enfield, a new Company has been formed under the title "Enfield Ediswan Electric Cable Works, Ltd.," the Edison Swan Company subscribing for 50,000 £1 ordinary shares therein. A provisional argeement has been entered into with Brotherton Tubes & Conduits, Ltd., which provides for the subscription by the Edison Swan Company of 25,000 preference shares of £1 each of the Brotberton Company, and the change of name by that Company to "Brotherton Ediswan Tubes & Conduits, Ltd." The above investments will give the Edison Swan Company direct interests in the manufacture of cables, wire, tubes and conduits, and should materially increase its business in these classes of goods, and will prove beneficial in other directions. The freehold property in the north of London, acquired for manufacturing dry cells and batteries (the purchase of which was referred to in the previous year's report), has since been disposed of at a profit, and the manufacture of these articles transferred to the Ponders End works. The expansion of the Company's business makes it necessary that further capital should be provided, and it is proposed to increase the capital of the Company by the creation of 500,000 ordinary shares of £1 each. If the necessary resolution is passed at the extraordinary general meeting on the 3rd prox. it is proposed to issue a portion of these shares at an early date.

New Companies.

ANTHONY BROWN & HOOGWINKEL, LTD. (159,882)—Private company. Reg. Oct. 23, capital £10,000 in £1 shares. Objects: To carry on the business of mechanical, civil and general engineers, electricians, consulting engineers, &c. W. A. Brown is permanent director. Reg. office: 24, Martin-lane, Cannon-street, E.C.

ATLAS DIESEL COMPANY, LTD.) (159,809)—Private company. Reg. Oct. 21, capital £2,000 in £1 shares. Objects: To carry on the business of mechanical, electrical and general engineers, manufacturers of, dealers in and contractors for the supply of Diesel and other engines, rock drills, tools, &c. Directors: J. W. Flower, G. L. Jacobson, O. L. Lunn and S. Rudberg. Secretary: H. J. Simmonds. Reg. office: 7, Laurence Pountney-hill, E.C.4.

BRITISH SCIENTIFIC INDUSTRIES, LTD. (159,768).—Private company. Reg. Oct. 20, capital £10,000 in £1 shares, to carry on the business of workers in wood, vulcanite, rubber, leather, celluloid and other materials, manufacturers of and dealers in illuminating apparatus and fittings, &c. First directors are J. Brown and D. M. Colman. Reg. office: St. John's Works, Headlingley Station, near Leeds.

"C" & "R" LTD. (159,391)—Private company. Reg. Oct. 8, capital £1,000 in £1 shares. Objects: To take over the business of engineers and engineers' agents carried on at Colchester as "Chubb & Ready," and to carry on the business of motor engineers, machinery merchants and agents, &c. Directors: F. H. Reddy and T. P. Chubb (both permanent). Reg. office: 2, Recreation-road, Colchester.

COUZENS & AKERS, LTD. (159,819).—Private company, reg. Oct. 21, capital £10,000 in £1 shares (3,000 preference). Objects: To take over as from March 31, 1919, the business of an electrical engineer carried on by R. E. Akers at 79, Southfield-road, Edgbaston. First directors are E. A. Couzens (governing director(, J. W. Mayall and R. E. Akers (all permanent). Secretary: J. W. Mayall. Solicitor: O. J. Snow, 2, Bennetts Hill, Birmingham.

CLOCK TOWER ENGINEERING COMPANY, LTD. (159,919)—Private company. Reg. Oct. 21, capital £50,000 in 40,000 7½ per cent. cumulative preference shares of £1 each and 40,000 ordinary shares of 5s. each, to carry on the business of electrical and general engineers, electricians, engineers, &c. First directors are W. J. Payne, Sarah P. Kennedy and C. H. Parker. Secretary: G. F. Joseph. Reg. office: 118, Victoria-street, London, S.W.1.

H. J. CORPORATION, LTD. (159,757).—Private company. Reg. Oct. 18, capital £2,000 in £1 shares, to carry on the business of electrical, mechanical, hydraulic, constructional, light and motive power supply engineers, &c. First directors are J. Rose, I. Jascourt, F. A. Fraser and F. H. Brewerton. Solicitors: Boulton, Sons & Sandeman, 21A, Northampton-square, E.C.1.

H. J. & A. COULTHURST, LTD. (159,532.)—Private company; reg. Oct. 13, capital £4,000 in £1 shares. Objects: To take over the business of engineers and ironfounders carried on by H. J. & A. Coulthurst at Darwen, and to carry on the business of mechanical, steam, electrical and general engineers, manufacturers of internal combustion engines, motor cars, &c. First directors are Alameth Coulthurst, E. Coulthurst and Alcimus Coulthurst (life directors). Reg. offices, Robert-street Foundry, Robert-street, Darwen.

FINNEY & FORSTER, LTD. (159,795)—Private company. Reg. Oct. 20, capital £5,000 in £1 shares. Objects: To take over the business of electrical engineers and contractors carried on at Newcastle-on-Tyne as Pinkey & Forster. First directors are R. B. T. Pinkey, A.M.I.E.E., and R. A. Forster (both permanent). Secretary: A. S. Paris. Reg. office: 11, Princess-street, Newcastle-on-Tyne.

GEORGE H. ALEXANDER MACHINERY, LTD. (159,363)—Private company. Reg. Oct. 7, capital £60,000 in 30,000 shares of £1 each and 120,000 shares of 5s. each. Objects: To take over the business carried on at Birmingham as "George H. Alexander," and to carry on the business of general and machinery merchants, mill and factory furnishers, mechanical, electrical and general engineers, &c., and to enter into an agreement with G. H. Alexander, H. W. Alexander and A. H. Alexander. First directors are G. H. Alexander (chairman), H. W. Alexander, A. H. Alexander and C. I. Wroe. Reg. office: 83-4, Coleshill-street, Birmingham.

HUDSON & EVANS, LTD. (159,553.)—Private company; reg. Oct. 13, capital £3,000 in £1 shares (1,000 10 per cent. preference). Objects: To carry on the business of motor-car manufacturers, agents and dealers, consulting, electrical and general engineers, &c., and to enter into an agreement with G. J. Hudson and A. A. Evans. Directors: G. J. Hudson and A. A. Evans. Qualification, £250. Secretary, Susan C. Hudson. Reg. office, 89, Median-road, Clapton, E. 5.

MADA ENGINEERING COMPANY. LTD. (159,485)—Private company. Reg. Oct. 10. capital £15,000 in 4,000 deferred shares of 5s. each and 7,000 ordinary and 7,000 preferred shares of £1 each. Objects: To carry on the business of electrical and mechanical engineers, manufacturers of engines, tools, machinery, railway and other plant, &c. First directors are E. Adamson (permanent managing director), A. J. Davies and C. J. Adamson. Secretary: E. Adamson. Solicitor: E. V. Crooks, 14, Castle-street, Liverpool.

MARCONI-OSRAM VALVE COMPANY, LTD. (159,787).—Private company. Reg. Oct. 20, capital £100,000 in £1 shares, to carry on the business of manufacturers of and dealers in electrical valves and other articles, instruments, apparatus and things used in connection with wireless telegraphy, and to carry on the business of electrical and general engineers, &c. The number of directors is to be either two or four, half to be appointed by Marconi's Wireless Telegraph Company and half by the General Electric Company. Reg. office: Osram Works, Brook Green, Hammersmith, W.

Q-OZONE PROCESSES, LTD. (159,675).—Private company. Reg. Oct. 16. Capital £10,000 in £1 shares. To acquire and deal with certain patents and rights relating to the use of ozone and chemical processes for various electrical, chemical, metallurgical and commercial applications, &c. Permanent governing director: J. R. Quain, 55, Effra-road, Brixton, S.W.

RUSSELL JOHNSON, LTD. (159,717).—Private company. Reg. Oct. 17, capital £3,000 in £1 shares. Objects: To take over the business carried on as Russell Johnson, and to carry on the business of manufacturers of, agents for and dealers in all kinds of wire and metals, india-rubber, asbestos and electrical goods, &c., and to enter into an agreement with R. Johnson and A. J. Ford. First directors are R. Johnson and A. J. Ford. Reg. office: 22, Tib-lane, Manchester.

RUSSELL'S (MANCHESTER) LTD. (159,677)—Private company. Reg. Oct. 16, capital £20,000 in £1 shares. Objects: To carry on the business of manufacturers of and dealers in asbestos and insulating materials, dealers in engineers' stores, oil refiners, &c. The first directors are R. Russell and W. Stockdale. Reg. office: Lands End Works, Rhodes, near Manchester.

SCIENTIFIC INSTRUMENT MAKERS, LTD. (159,832)—Reg. Oct. 21, capital £6,000 in £1 shares (3,000 2 per cent. preference). Objects: To carry on the business of wholesale or retail scientific glass instrument makers, metal workers, glassblowers, &c. Directors: W. W. Cousins, A. Lond and H. C. Strachan. Secretary: L. J. Davies. Reg. office: 47-8, Langburn Chambers, Fenchurch-street, E.C.3.

WILLIAM ALLAN, LTD. (10,666).—Private company. Reg. in Edinburgh Oct. 13, capital £10,000 in £1 shares, to carry on the business of engineers, automobile, aircraft and electrical engineers, brass founders, &c. First directors are W. Galbraith, W. Galbraith, junr., and A. Galbraith. Reg. office: 219, St. Vincent-street, Glasgow.

Prices of Metals, Chemicals, &c.

TUESDAY, Oct. 28.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£111 0 0	—	£4 0 0
Electrolytic bars ...	,,	£118 0 0	—	£3 0 0
H.C. wire basis......	per lb.	1s. $3\frac{11}{16}$d.	—	$\frac{3}{8}$d.
Sheet	,,	1s. 4d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. $7\frac{11}{16}$d.	—	$\frac{3}{8}$d.
Brass 60/40—				
Rod, basis	,,	0s. $11\frac{3}{16}$d.	-	$\frac{5}{16}$d.
Sheet, basis	,,	1s. $2\frac{5}{8}$d.	—	—
Wire, basis	,,	1s. $2\frac{1}{2}$d.	—	—
Iron—				
Cleveland Warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	£32 10 0	—	£1 0 0
Lead Pig—				
English	,,	31 5 0	£1 5 0	—
Foreign or colonial	,,	30 7 6	£0 17 6	—
*Tin—*Ingot	,,	273 15 0	—	£8 5 0
Wire, basis	per lb.	0 3 $4\frac{3}{4}$	—	$1\frac{1}{4}$d.

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £21.

,, (Roll Brimstone).—Per ton £21.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40-£41.

Boric Acid (Crystals)—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6d.

Shellac.—470s. December delivery 455s.

Rubber.—Para fine, 2s. 6½d.; plantation 1st. latex 2s. 4d. lb

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W. T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Oct. 28, 1882.]

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended October 20th amounted to £3,984.

NEWCASTLE-ON-TYNE TELEGRAPH OFFICE.—The number of telegrams passing through this telegraph office during last year was about two millions.

ELECTRIC POWER FOR SHOE-MAKING.—In the Cincinnati (U.S.A. Industrial Exhibition, a model shoe factory may be seen. The Goodyear sewing machines, used for making ladies' shoes, which are shown in the factory, are driven by means of electricity.

ELECTRICAL TEACHING IN GERMANY.—The celebrated Polytechnic School at Darmstadt, which is largely frequented by English students, has just been considerably enlarged. Among the additions is that of a Chair of Electro-Technology, which will be filled by Dr. Kittler, late of Munich.

FIRES CAUSED BY ELECTRIC LIGHT WIRES.—Within a short time there have been two fires in the passenger station of the Boston & Albany Railroad Company, caused by electricity employed in lighting electric lamps. Both the fires, says an American contemporary, were caused by insufficient insulation of the wires.

THE SWAN LIGHT IN HOLBORN.—We understand that Messrs. Laing, White & Wharton have been appointed agents to the Swan Electric Light Company, and that the installation of Swan lamps in their premises at Holborn, mentioned by us in a recent note, is for the purpose of allowing anyone desirous of doing so to see the light in operation.

NEW ATLANTIC CABLE.—A "Times" telegram dated Philadelphia, of the 22nd inst., says:—"The proprietors of four influential American newspapers have subscribed the stock in the new Baltimore & Ohio Cable Company. The papers are the "New York Herald," the "New York Times," the "Baltimore Sun," and the "Cincinnati Enquirer."

ELECTRIC LIGHT AT EASTBOURNE.—The extinction of the electric lights on the Parade at Eastbourne, on Thursday week, was entirely due, we learn, to the failure of the water supply. As electric lighting stations are very dependent on the water companies, would it not be as well for them to erect small reservoirs? They would then be able to tide over any irregularities in the supply of water.

RUSSIA AND THE TELEPHONE.—We do not hear much of any progress being made with the telephone in the Russian Empire. A facetious contemporary explains this circumstance by the fact, if it is a fact, that the exclamatory halloo! with which, as everybody knows, all telephonic conversation must begin, is, in the Russian language, rendered Tzijakanfitkrajanjanzski! which, of course, no telephone yet invented can pronounce.

FOLLOWING SUIT.—At the last meeting of the Works Committee of the Clerkenwell Vestry a member moved "That this committee recommend the Vestry to oppose the application of all electric lighting companies for licenses under the third section of the Electric Lighting Act, unless they are prepared to pay a dividend of 7½ per cent., and that one-half of all profits should be given to the Vestry towards the reduction of the local rates, in consideration of the concession granted for laying down their necessary works." The resolution was not adopted, as the question was postponed to a future meeting. It is evident, however, that the example set by the Vestry of St. George's (Southwark) will be followed by others.

ELECTRIC LIGHTING IN PHILADELPHIA.—According to the regulations issued by the City Council of Philadelphia (U.S.A.) it appears that no streets can be broken up for the laying of underground wires until permission has been obtained from the Council. That no street shall be opened for a greater distance than 500 ft. at one time, and that the trench is not to exceed 2 ft. in width. Persons breaking up the streets are to be liable for damage to gas and water mains, sewers and sewer connections. No electric light circuit is allowed to use the ground as a part of the circuit, but all circuits must be metallic, otherwise have a return wire. Cut-offs must be provided where the wires pass into a building and, the City of Philadelphia may use any wire for municipal purposes free of charge. For every mile of conductors for electric lighting 15 dols. per year must be paid to the city and 5 dols. per year for every mile of conductors for telephonic and telegraph purposes.

STOPPING ENGINES BY ELECTRICITY.—An ingenious method of instantly stopping machinery when in motion is said to be in operation at the Dominion Bolt Works, Toronto. A wire rope, coiled round thea stem of the throttle valve of the engine, carries a weight which is held in place by a rest, and the whole arrangement is so placed that the passing of an electric current along a wire releases this rest, and causes the weight to fall. The tension thus thrown upon the wire rope acts upon the throttle valve, cuts off the supply of steam, and consequently stops the machinery. Buttons, with wire connections, are placed in different parts of the works, and on pressing any one of these the passage of an electric current acts as above mentioned. In any factory these electric buttons can be placed in every room, or several of them in a large room, as may be required. Should anyone happen to get caught by the machinery, the simple pressing of a button in the most distant part of the factory will stop the whole as quickly as could be done were the engineer standing ready to instantly obey a given signal.

THE ELECTRICIAN:

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Notes.

The Electrification of Main Line Railways.

EVERYONE who travels at all regularly on the railways of this country has probably come to the conclusion that they have almost reached the limit of their capacity. The usual solution of this state of things is to increase the number of trains, but it is obvious that the number of trains run cannot exceed some definite figure. It is probable, for instance, that a headway of at least five minutes must be allowed in working our present steam traffic out of a large terminal station over one set of metals owing to the slow start and the inevitable crossing and re-crossing of complicated sets of points that is necessary before the train can get well away on its journey. Shunting, marshalling and turning are also factors which must be considered in this connection. The problem then, is how to deal with the ever-increasing traffic in the most economical way. No doubt something can be done by better organisation and something by widening, but these are at best only palliatives, and in our opinion it is time some general scheme of electrification was considered by our traffic authorities. We are glad to learn this is already being done by the North Eastern Railway.

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IN this connection we may call attention to an article by Messrs. W. B. POTTER and S. D. TODD, which appeared in the ELECTRICIAN last week, and to a report by Messrs. MERZ and MCLELLAN, on the general question of the electrification of the railways in South Africa, of which we give an account in our present issue. In the first Paper we note that in the United States about 8,300 miles of track are being electrically operated, compared with 1,750 miles in the rest of the world. The authors are, therefore, able to speak not only with authority, but from experience. The reasons they give for the change from steam to electric working are the well-known ones of increased carrying capacity, decreased operating expenses and elimination of delay, though it is interesting to note that the most important of all is considered to be freedom from smoke and cinders. There is also another advantage, perhaps at the present day more important still, namely, fuel conservation, it being considered that the movement of the traffic over the United States railways in 1914 by electric instead of by steam locomotives would have resulted in a saving alone of 100,000,000 tons of coal per year. Messrs. MERZ and MCLELLAN produce some no less interesting conclusions in their consideration of the advisability of introducing electric traction on the South African railways, where the conditions on the sections which it is proposed should be electrified are somewhat analogous to those in this country. Portions of the railway system are reaching the limit of their traffic-carrying capacity, and the question is whether still to continue to use the existing methods or to turn to some new solution. In either case fresh capital expenditure will be necessary, but in the one it can at best provide a temporary relief, while in the other there is every hope of a permanent cure. At the same time the total capital required will be less and the increase in the revenue considerably more.

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THERE are one or two other points in Messrs. MERZ and MCLELLAN'S report which should be studied closely by all railway engineers to which we may briefly call attention. The high-tension direct-current system is recommended, the arrangements proposed being those adopted on the Shildon-Newport branch of the North Eastern Railway. The multiple unit system is to be employed wherever its use is possible on suburban lines, and the importance on such lines of making the service create the traffic rather than the other way about is pointed out. We can heartily endorse the recommendations that wherever possible the power supply should be drawn from existing power stations and that energy should be supplied from the power stations owned by the railway to other power users. An interesting suggestion is that of overcoming the shortage of water by erecting small power stations containing only one generating set at various places along the line and linking them by a high-tension transmission line, thus distributing the spare plant over the whole system. We sincerely hope the example set by South Africa will be quickly followed by railway engineers in this country where conditions are even more favourable to electric traction.

The Edinburgh Contract.

A GREAT shock was caused in electrical engineering circles by the recent announcement that the Edinburgh City Council had accepted a tender for three 10,000 kw. turbo-alternators from a Swiss firm, in preference to placing the order in this country. As is not unusual on such an occasion the first result is to attempt to discover a scapegoat. In this case the obvious culprits are the Edinburgh Council and its Electric Lighting Committee, and sufficient hard words have already been said about their action to render them, if they take them seriously, very uncomfortable for some time to come.

Now, while we cannot help thinking that for every reason it is a great pity that this contract should have been placed abroad, at the same time there are two sides to this question as to every other. One of the duties of the municipal authorities, a duty which, in these days, is not always carried out so conscientiously as it might be, is to save the ratepayers' money, and with this end in view it has been the practice in the past to accept the lowest tender if the contract conditions seemed to have been properly fulfilled, and if there are guarantees that the firm tendering could carry out the contract. In this case the difference between the tender of the foreign firm and the lowest tender submitted by a firm in this country is so much, amounting as it does to about £68,000, as to render it at first sight advisable that the usual policy should be followed. But we cannot help feeling that matters are not quite so simple as they appear at first sight. We know that in this country the cost of raw materials has risen, while both wages and overhead charges of all kinds have increased, and the statement that has been made, though we believe, however, without full authority, that the lowest British tender represents a price below which no engineering firm in this country could go and yet make a profit. Information goes to show that the cost and scarcity of raw materials are not likely to be very different abroad than they are in this country, even though the wages and overhead charges may not be so high. There is, therefore, more than a suspicion that the foreign firm has tendered at a cut price and that the policy which was often followed only too successfully before the war is still being continued. It is difficult to know what can be done in cases of this kind. The difference between the tenders is so much that an import duty, unless it were so high as to be almost unthinkable, would hardly meet the present occasion. The whole question, therefore, really depends on the necessity on which we have insisted before, that it is most essential for the whole of the British community, employers and employed alike, to increase their production, to improve their organisation and to adopt the most modern methods of manufacture in order that the price of their commodities may be brought as low as possible. A tariff can at best be only an assistance and the real remedy lies in the direction which we have indicated.

Minimum Rates of Wages Commission Bill.

The purpose of this Bill is to secure for employees an "adequate living wage." To effect this purpose provision is made for the immediate establishment of Commissioners to adjudicate. The most interesting clause in the Bill, and one that strikes out in a somewhat new direction, is the clause providing for the compulsory examination of an employer's books in order to see what the particular trade or industry costs are in the way of wages. It is amusing to think what apoplectic expostulations such a suggestion would have elicited from employers but a few years ago! But nowadays, it is simply received without question. As far as the electrical industry is concerned the Bill does not appear very much to affect it. Our highly respectable industry is surely well on the further side of an "adequate living wage." This Bill, like the Trades Boards Acts, is really aimed at those unorganised trades where the workers are of a poor or unskilled kind and are at the mercy of unscrupulous employers. Both these factors are practically absent from the electrical industry. There is, of course, a possibility that the Bill may affect some grades, and we understand that amendments will be put forward in the interests of certain of the statutory electric undertakings to safeguard the rights of the employers' side in the procedure provided for adjudicating.

Electrical Benevolence.

Among the questions which are at the present time receiving a good deal of attention from some of the more active of our daily contemporaries may be mentioned the hardships which are being suffered by a class that has been dubbed the "new poor." In this term is included those who derive their means of sustenance from a salary whose magnitude while it attracts the unfavourable attention of the Income Tax Commissioners, does not leave a sufficient margin to allow the recipient to provide himself and his family with those creature comforts to which he justly considers himself entitled. It includes also the large body who derive a more or less exiguous income from the investment of securities or from annuities often purchased as the result of much thrift and self-denial and upon whom the present increased cost of living presses with almost overpowering weight. The plight of these new poor is pathetic. But recognition of their condition and pity for them will not help them to buy bread or clothes, nor to provide their children with education of the right standard. It is the business of the Government, State Socialists would say, to look after these people. But the Government is at the moment otherwise engaged, and its highest speed is slow, so that if the undoubtedly hard lot of many of these sufferers is to be assuaged private enterprise must come to their assistance and lend that helping hand which, though but temporarily proffered, may make all the difference between safe harbourage and disaster. These lines are, therefore, written to remind our readers that the Annual Dinner of the Electrical Trades' Benevolent Fund is, after an interval of four years, to be held on Wednesday next, and that no better way of helping the "new poor" of our profession can be devised than by supporting this Fund to the best of our ability and thus providing, by our subscriptions, help which is most sorely needed. It may not be out of place to mention that while it is customary to think in guineas on such occasions, it should not be forgotten that the 1914 guinea is only a shadow of its former self, and that there will be no harm done in doubling or even trebling what used to be considered an adequate figure before the war. Those who dislike public functions are reminded that if a subscription is sent, no awkward questions will be asked as to their absence from the dinner.

Editorship of the "Electrician."—On Friday last, Oct. 31, Mr. W. R. Cooper, M.A., B.Sc., M.I.E.E., A.M.I.C.E., was presented by his colleagues of Benn Brothers with a silver rose bowl and Weston portable milli-ammeter, upon his retiring from the editorial chair of the "Electrician" after a period of 13 years. Mr. Cooper has decided to devote the whole of his time to his consulting practice, the growth of which renders it impossible for him to continue his editorial duties at the same time. Mr. Cooper was appointed Editor of the "Electrician" in 1906, and under his editorship the journal has made considerable progress. His place will be taken by Mr. F. H. Masters, O.B.E., A.M.I.E.E., who was chief assistant editor at the outbreak of war in 1914. Mr. Masters received his technical training at King's College, London, and Finsbury Technical College, under the late Prof. S. P. Thompson. He was afterwards engaged in sub-station work on the Central London Railway, and in the Electrical Engineers' Department of H.M. Dockyard, Chatham. He joined the "Electrician" staff in 1906, and was subsequently appointed chief assistant to the Editor. During the war he was engaged on coast defence electric lighting work and on searchlights used against enemy aircraft. He contributed considerably to the development of these defences, and did very useful work in the training of the men engaged upon them. Mr. Masters was awarded the O.B.E. and was twice mentioned in despatches.

Royal Institution.—A general meeting of the members of the Royal Institution was held on the 3rd inst., Sir James Crichton-Browne, treasurer and vice-president, being in the chair. The special thanks of the members were returned to Mr. R. Pearce for his donation of £100 to the Fund for the Promotion of Experimental Research at Low Temperatures; to Mr. R. Mond for his gift of laboratory material; and to Sir H. D. Rolleston for his gift of a drawing of Sir Humphry Davy's birthplace, and a water-colour of his statue in the Market Place, Penzance.

Institution of Electrical Engineers—*Wireless Section.*—A meeting of the Wireless Section of the Institution of Electrical Engineers will be held at the Institution of Civil Engineers, Great George-street, at 6 p.m., on Wednesday, November 19th. A Paper will be read by Prof. C. L. Fortescue on "The Design of Multiple Stage Amplifiers Using Three Electrode Thermionic Valves." Light refreshments will be provided at 5.30 p.m.

Western Centre.—The annual report of the Committee of the Western Centre calls attention to the fact that during 1918-1919 the area was extended to contain the whole of South Wales, together with the counties of Hereford and Gloucester, as well as the remainder of the west of England. During the session four meetings were held, but it is considered that in future the centre should be more active in this direction, and also do more in the way of research work. Mr. Arthur Ellis is the chairman of the section for the forthcoming session, with Messrs. A. J. Newman and A. C. McWhirter as vice-chairman, while Messrs. C. T. Allen and A. J. Newman will act as joint honorary secretaries and Mr. A. J. Newman as hon. treasurer.

Informal Meeting.—The first informal meeting will be held at the Institute of Patent Agents, Staple Inn Buildings, High Holborn, on November 17th, at 7 p.m., when a discussion on "Engineering Advertising" will be opened by Mr. W. E. Warrilow.

Wireless Society of London.—The first general meeting since the war was held on Oct. 28. There were over 150 members present, including several country members who had taken the opportunity of giving the Society a send-off and had come up to town from Plymouth, Bristol, Derby, &c.

The PRESIDENT (Mr. A. A. Campbell Swinton, F.R.S.) opened the meeting by referring to the state of suspended animation the society had been in during the war, and how with the close of the war the committee and officers had met and decided to bring the society into activity once more. It was decided that the present officers and committee should remain in office during 1920, thus obviating another election in January next. The President spoke of the loss the Society had sustained by the death of Sir William Crookes, O.M., Mr. Russell Clark, O.B.E., Prof. Silvanus Thompson and Mr. W. Dudell, and a number of other members who had unfortunately lost their lives in the war. The matter of licences for wireless telegraphy was touched upon at some length, and it was pointed out that every effort had been and would be made to influence the Post Office authorities to come to some decision, so that experimental work among amateurs might again be established.

Mr. F. HOPE JONES, the chairman, spoke of the applications from other wireless societies and clubs with a view to unity of action, and said that the Committee were alive to the possibilities, and further developments might be expected. In the meantime, all secretaries of wireless societies and clubs are invited to communicate their views to the hon. secretary. After the business of the meeting closed the attention of members was directed to an interesting exhibition of wireless apparatus. Dr. Erskine Murray explained details of the Air Force telegraphy and telephony sets exhibited, including a Robinson direction finder. Mr. Scott Taggart had a fine array of valves of the Ediswan Company, showing their manufactures in detail. The Marconi Company, Messrs. Read & Company, and the Zenith Mfg. Company, had lent some of their most up-to-date apparatus. Some of the members also had interesting exhibits, and the President had a compact and sensitive valve amplifier, which, together with a specially constructed loop aerial, is capable of making signals from European stations audible at a considerable distance.

The Electrification of Ships.—A Paper with this title was read by Capt. W. P. Durtnall, R.A.F., before a meeting of the Institute of Marine Engineers, which was held during the recent engineering exhibition at Olympia. In his introduction the author deals exhaustively with the history of the propulsion of ships by mechanical means. The first paddle steamer seems to have been invented as early as 1543, while in 1661 the method of propelling ships by forcing water through the bottom of the vessel, so-called jet propulsion, was first tried. The first successful propeller driven vessel of any size was built by Mr. F. P. Smith and was used on the Paddington Canal in 1837. Still another attempt to use jet propulsion is to be found in H.M.S. "Waterwitch," which was designed by the Admiralty, while a great advance in engineering development was shown in the construction of the "Great Eastern" which was fitted with both screw and paddle wheels. The author then goes on to discuss the problems which arose in ship propulsion when the steam turbine began to be used, and points out the early discovery of the necessity of some form of gearing being introduced between this type of prime mover and the propeller, owing to the desirability of each running as much as possible at its most efficient speed. He further deals at some length with the various systems which have been suggested for this purpose, and gives a description in detail of the Paragon system with which his own name is associated. This question of electrical propulsion of ships, the author states, has perhaps been considered more carefully in the United States than in this country and in support of this contention he gives some interesting figures of the steam and fuel consumption, thermal efficiency, &c., for the various types of drive used on similar ships in the American Navy. In conclusion he points out that it is only eleven years ago since the suggestion of using alternating current for the electrical propulsion of ships was first made. Since that time there have been great developments along these lines and the whole problem is one of vast commercial and electrical significance.

Personal.

Mr. Kennedy Jones has accepted the chairmanship of the Advisory Committee on London Traffic, which the Minister of Transport is appointing.

Mr. R. J. Sowter, B.Sc., A.R.C.S., an examiner in H.M. Patent Office, has been appointed by the Admiralty to the R.N. School of Signalling, Portsmouth, as head of the patents section.

Señor Juan I. Ruano has been appointed Director-General of Spanish Posts and Telegraphs in succession to Señor de las Atlas Pumarino.

Mr. Narakichi has been appointed Director-General of Posts and Telegraphs of Japan in place of Mr. Kenzo Nakagawa.

Sir Richard Redmayne, K.C.B., has now relinquished the temporary position which he accepted in 1917 as Director of Production and Technical Adviser to the Controller of Coal Mines, and has resumed his permanent duties as Chief Inspector of Mines at the Home Office. Sir Richard Redmayne has, however, consented to place his services, in an advisory capacity, at the disposal of the Controller of Coal Mines with regard to pending legislation affecting the coal mining industry.

Arrangements for the Week.

FRIDAY, Nov. 7th (to-day).

TECHNICAL INSPECTION ASSOCIATION.

7.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Paper will be read on "The Spectroscope in the Science of To-day," by Prof. E. C. C. Baly, C.B.E., F.R.S.

SATURDAY, Nov. 8th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At the Grand Hotel, Colmore-row, Birmingham. Paper to be read on "Automatic Telephone Systems for Works, &c.," by Mr. T. Pettigrew.

WEDNESDAY, Nov. 12th.

CONJOINT BOARD OF SCIENTIFIC SOCIETIES.

5 p.m. At the Royal Society, Burlington House, London, W.1. Discussion of Draft Report on the Metric System.

THURSDAY, Nov. 13th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Mr. Roger T. Smith will deliver his Presidential Address.

FRIDAY, Nov. 14th.

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers to be read: "On the Self-inductance of Single Layer Flat Coils," by Mr. S. Butterworth, M.Sc.; "An Experimental Method of Determining the Primary Current at Break in a Magneto," by Dr. N. W. McLachlan: and "Note on a Modified Form of Wehnelt Interrupter," by Mr. F. H. Newman, B.Sc.

The Electrification of the South African Railways.

We have received from Messrs. Merz & McLellan a copy of a report made by them to the General Manager of the South African Railways on the desirability of the electrification of certain sections of that system. The report is an extensive one, and deals fully with every aspect of the question. We give below an account of its main features.

The sections considered were included in four divisions of the system, and were as follows:—In Division 1, the main line between Cape Town and Touws River, the branch line from Cape Town to Simonstown carrying suburban traffic, the short passenger line from Monument to Sea Point, and the lines in Table Bay Docks where a considerable amount of shunting is carried on. In Division 6 the main line from Durban to Glencoe, including the extensions to the Point, and the Bluff and the branch line from Glencoe to Vryheid East, on which the traffic consists almost entirely of goods trains. In Division 7 the main line from Witbank through Germiston and Johannesburg to Randfontein with short branches to Springs and Benoni. The service on this section is also principally goods trains, but there is an important suburban passenger traffic between Randfontein and Benoni. In Division 8 the main line from Witbank to Komatipoort. The subjoined table shows the estimated net capital necessary for the conversion of these sections to electric traction, together with the profit expected and the return on the net capital outlay. It will be seen that the conversion of the main line in Natal is likely to prove by far the most profitable. This is due not only to the density of the traffic, but to the severe nature of the line. At the present time indeed the volume of traffic on this section is approaching the limit, and to make provision for the expected 50 per cent. increase would necessitate the expenditure of at least £75,000. This work could be avoided and the liability to congestion removed if the section is electrified. In the case of Division 8, where the estimated return is a good deal lower, if in future the traffic increases from any cause to more than the 50 per cent. provided for the financial profit will be proportionately increased, as the net capital outlay will be practically unaffected, while the gain in receipts will be much higher.

Financial Results of Electrification.

Division.	Section.	Net capital outlay.	Profit.	Return on net capital outlay.
1	Cape Town–Touws River ...	£1,036,414	£125,090	12·1%
	Cape Town–Simonstown ...	561,458	56,070	10·0%
	Monument–Sea Point	69,740	5,680	8·1%
	Monument–Docks	4,190	1,280	30·5%
	Docks	123,520	11,940	9·7%
6	Durban–Glencoe	£952,713	£384,110	40·3%
	Glencoe–Vryheid East	287,850	36,060	12·5%
7	Witbank–Germiston–Randfontein........................	£1,083,240	£116,560	10·8%
8	Witbank–Komatipoort......	£1,155,010	£65,110	5·6%

In considering the choice of the electrical system to be employed on the South African railways Messrs. Merz & McLellan discuss the three possible systems. Taking into consideration all the conditions present in South Africa, they recommend that power should be generated and transmitted in the form of three-phase alternating currents with a frequency of 50. As regards the advantages and disadvantages of the various possible systems of traction they come finally to the conclusion that the system best suited to South Africa is the high-tension direct-current system. This has the advantage compared with the low-tension system that the number of substations can be reduced. They recommend therefore that the working voltage should be 3,000, which would enable the substations to be spaced from 20 to 30 miles apart. Such high voltages necessitate, in a country like South Africa, where it is impossible to prevent people straying on the track the adoption of an overhead supply. The general arrangements proposed are, therefore, the same as that already adopted for the electrification of the Shildon-Newport branch of the North Eastern Railway (*see* the Electrician, Vol. LXXVII., p 246.)

Turning to the question of rolling stock, Messrs. Merz, & McLellan consider the relative advantages of the locomotive and multiple unit system. In choosing one or other of these systems the work that has to be done by electric traction must, it is pointed out, be taken into account, and for the goods traffic, which is predominant on a number of sections on which it is proposed electric traction should be employed the locomotive is the obvious solution. The strength of the draw bar gear used on the goods wagons of the South African Railways is sufficient to enable a train of 1,800 short tons to be hauled up a gradient of 1 per cent. This corresponds to a pull of about 48,000 lbs. It is, therefore, recommended that the weight available for adhesion should be about 120 long tons, and that the driving equipment should be designed to give a tractive effort of 48,000 lbs. for the usual test period of one hour, and 64,000 tons for short periods such as that required during the start of a train. The latter figure in relation to the weight on the driving wheels, *i.e.*, about 120 tons, corresponds to an adhesion coefficient of 1 to 4·2 which is well within the limits of practice in electric locomotives.

In the case of passenger locomotives considerations of platform and station accommodation limit the number of coaches per train to a maximum of 15 or 16, and, assuming the average weight of 40 short tons, the maximum load of a passenger train may be taken at about 600 tons. The maximum gradient on any of the sections under consideration is estimated at 1 in 40. The draw bar pull would, therefore, be about 40,000 lbs. It would be uneconomical, however, to design the passenger locomotives for this pull, as it would be better to use a banking engine to take the heaviest train up the maximum gradient, as these gradients are comparatively short and few. It is therefore recommended that the weight on the driving wheels of the standard locomotives should be about 72 long tons, and that the driving equipment should be designed to give a tractive effort of about 30,000 lbs. for the usual one hour test period, and a maximum of 38,400 lbs. A single locomotive would therefore be able without assistance to haul 600 tons load up a gradient of 1 in 60, and should be sufficient for all probable requirements. It is therefore considered desirable that the standard electric goods engine should be capable of hauling a 1,200 ton train at a speed of about 40 miles an hour on the level, and a train of 1,800 tons at not less than 30 miles an hour, with a speed of about 20 to 23 miles per hour up the ruling gradients. This is a very substantial increase over the present speed of the goods train. The actual horse power with the proposed standard goods locomotive would therefore be about 2,800 as compared with the 1,000 to 1,400 horse power of the steam locomotive now used. As regards passenger trains the speed should not be allowed to exceed 60 miles an hour, and the express passenger locomotive should be designed for a normal sped on the level with a train of 15 main line coaches of not less than 55 miles an hour. The motors would then exert their full power for climbing gradients at a speed of 28 to 29 miles an hour.

In designing these locomotives consideration must be taken of the limitations imposed by the track gauge, and the sharp curves to be found on the South African railways, with the result that the fixed wheel base must be short and the weight should be as small as possible. With a view to reducing the maintenance cost, design should be simple, and all the wearing parts should be easily accessible for lubrication, examination and replacement. The design which appears to meet the requirements of the goods engine best involves the use of outside connecting rods, coupling the cranks on each pair of driving axles to those on a central jackshaft which, in turn is driven through gearing by a pair of motors. The complete locomotive would consist of two single units coupled together to form a double unit. Each unit would consist of a body mounted on a pair of bogies; the complete double unit would therefore consist of two bodies and four bogies, and in this way ample flexibility would be secured and the sharpest curves could be negotiated without difficulty. The bogie would be of special design, with a pair of motors mounted in the centre, rigidly attached to the bogie framework. Each motor would be connected by twin gearing to the central jackshaft, and the driving torque would be transmitted from this shaft to the two driving axles by outside cranks and connecting rods. Each unit would be equipped with an electrically driven vacuum pump for the operation of the brakes. The express passenger locomotives would be built on the same general principles as the goods locomotives, but the design would be modified in view of the higher speeds required to include a leading four wheel bogie.

At Cape Town and other places where a large amount of shunting has to be carried out, it is advisable to use a special shunting locomotive, which would weigh about 56 tons, and be fitted with electrical equipment practically identical with that recommended for the motor coaches on suburban passenger trains. For various reasons the adoption of the multiple unit system for the passenger trains is recommended rather than the use of locomotives for this purpose, principally owing to the fact that the trains can be increased in size during the evening rush hours to as many as 8 or 10 coaches, while in the slack hours four coaches would be sufficient.

In considering the question of a time-table for suburban passenger traffic, provision should be made for uniform and frequent trains throughout the day, with additional trains during the rush hours. Such an arrangement adds greatly to the attractiveness of the system, and therefore to the revenue-earning capacity of the line. The question of whether suitable equipment of this kind can be manufactured for working on the direct-current system at 3,000 volts, taking into account the narrowness of the gauge and the limited space available for motors has been carefully gone into and a suitable design has been worked out. The use of regenerative working is recommended, as with this system trains can be run at higher speeds down the long gradient than is possible with steam working. This property of regenerative working has been taken into account in calculating the revised timings of trains due to electrification.

In considering the question of the supply of power for this electrification, it is pointed out that in a country like South Africa, with very large natural resources, the traffic on several sections will inevitably increase in course of time. The other sections of the railway which it will not pay to electrify at the present time may be converted as soon as there is sufficient traffic to justify the change. It is, therefore, advisable that the arrangements for supplying power in the sections should form part of an ordered scheme which will allow for future developments. The sections now being considered for electrification form a connected whole from Cape Town through Johannesburg to Komatipoort and to Durban, with two cross connecting lines from Glencoe to Machadodorp and Boksburg to Breyten, the north coast line from Durban and the section from Ladysmith to Van Reenen's Pass. The problem, therefore, is to select power station sites suitable for all these sections without prejudicing the supply to those sections which may be electrified in the first instance. The question of obtaining the necessary electrical energy from water-power stations has been considered; but, unfortunately, in South Africa the rainfall is very irregular, with the result that on the rivers crossed by the sections of the railway affected the flow of water is unreliable and occasionally ceases altogether, though probably the Komati and Crocodile Rivers in the Eastern Transvaal may provide sufficient water at all times for this purpose without conservation. There are at the present time electric power undertakings of some size in Durban, Johannesburg and Cape Town. The largest of these is the station of the Victoria Falls and Transvaal Power Company in Johannesburg, which undertaking also possesses a number of power stations in the mining area east and west of Johannesburg, as well as a station at Vereeniging. All these stations are connected together by a high-tension transmission network, and it is recommended that a part of the energy necessary for working the lines in Division 7 should be taken from this system if a satisfactory arrangement can be made with the company. In fact, the whole of the energy for this division might be taken from this system if the power company's network were extended as far as Witbank.

For the electrification of the main line between Durban and Glencoe it is recommended that two power stations should be provided, one at Durban and the other at Tayside, a few miles east of Glencoe, where the branch line to Vryheid East crosses the Buffalo River. For the electrification of the eastern line from Witbank to Komatipoort it is recommended provisionally that a power station should be erected at Komatipoort on the Komati River, and the station at Great Olifants River extended by the installation of additional plant. For subsequent development in Eastern Transvaal and north of Natal, one additional station at Ingwempisi would provide for the line from Vryheid East through Breyton to Machadodor, the Apex-Brayten line, and by means of a cross-country transmission line from Ermelo to Standerton, the line from Germiston to Glencoe through Volksrust. The new line from Vryheid East to Empangeni would then be supplied from the two stations at at Tayside and Ingwempisi at one end, and the Durban station via the North Coast line at the other end. For the sections in Cape Colony—viz., the suburban branches around Cape Town and the portion of the main line between Cape Town and Touws River—it is clear from all points of view that there should be a power station in or close to Cape Town itself, from which the various lines radiate. This station would supply all the local services and part of the main line. The distance from Cape Town to Touws River is 160 miles by rail, and it would be inadvisable to depend on a single source and a transmission line of this length for the supply to the whole section.

In considering the question of the relative merits of hydro-electric and steam stations, it must be borne in mind that in a country like South Africa, where coal is very cheap at the pit, and the cost of freight is low, there is not necessarily a substantial gain to be expected in the utilisation of water-power, while there seems to be no probability of obtaining by water-power an adequate supply of electricity for any part of the Cape Western line or for the Central Transvaal division, while the probability of utilisation of water-power in the Natal section is also small. In considering the question of the supply of power to the line between Cape Town and the Orange River the question of water supply is again a difficulty. The general public have prior rights to any water supplies in South Africa, first for domestic purposes, and second for irrigation. There is, therefore, no single site between Cape Town and the Orange River, where an adequate supply of water sufficient for the needs of a large station could be definitely assured. This section would, therefore, have to be fed from a number of comparatively small stations linked together, and to the main stations at Cape Town and the Orange River by means of a high-tension transmission line. Each of these small stations would probably contain a single set, with the corresponding boiler equipment and the usual accessories If necessary, the complete station could be shut down, or part of the load taken by neighbouring stations. In this way the usual allowance of spare plant would be distributed over the whole system, and not concentrated at any one point where, owing to shortage of water or other causes, it might become useless. By means of the transmission line, loads could be transferred from one point to another as circumstances required, and in very dry seasons the bulk of the load could be dealt with by the two main stations. This inadequacy of water supply seems at first sight to be an obstacle to the adoption of electric traction; but it is pointed out that the quantity of water required for operating a modern power station is only from one-half to one-third of that required by steam locomotives doing an equal amount of work. In considering the general question of the power supply, the possibility of using those generating stations which have been erected in the first place for the supply of electrical energy to railways being also utilised for supplying power to municipalities and private consumers must also be considered. This question is outside the scope of the present report, but it is advisable to bear in mind this matter, as the question of electrification should not be considered as distinct from the general use of electricity throughout the country.

Considering the various sections which it is proposed to electrify in detail, in Division 1 the Simonstown line has a total length of $22\frac{1}{2}$ miles, of which $15\frac{1}{2}$ miles is double track and 7 miles single track. It serves the residential suburbs of Cape Town and the towns of Wynberg, Muizenberg, Kalk Bay and Simonstown. Taking into account the conditions of working on this branch, the multiple unit system is recommended, and a revised time table is being prepared which provides for an increase of about 23 per cent. on the total train mileage for an ordinary week day, as compared with the present arrangements. Trains of eight coaches will be employed during the rush hours and during the slack hours trains of four coaches. It is proposed to increase the total number of trains per day in both directions from 138 to 190. Sixty-four motor coaches and 60 trailers will be required for this service, the total cost of which will be £306,600. This equipment will displace 21 steam locomotives, the estimated value of which is £57,000. For the regular inspection and for minor repairs to the multiple unit train equipments it will be advisable to build a special shed in the Cape Town yard and equip it with the necessary machine tools, lifting cranes and inspection pits and offices, store rooms, &c. About 25 per cent. of the total number of coaches on the daily service will be taken in rotation into these sheds during the night of examination, lubrication and adjustment of brakes. Power would be distributed to the trains at 3,000 volts from two sub-stations, one at Cape Town Yard and the other probably at Kalk Bay. The Cape Town sub-station would be fed from the power station about a mile distant by underground cables, and the sub-station at Kalk Bay by means of a duplicate transmission line at 20,000 volts carried on the structures from which 3,000 volt distribution line is suspended. The net capital outlay on this section amounts to £561,458, while the estimated cost of working with electric traction is £5,930 more than with the existing steam service. Against this increase in expenses must be put an estimated additional revenue of £62,000, representing a net profit of £56,070, or a return of 10 per cent. on the capital outlay.

(To be concluded.)

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Piece-Rate, Premium and Bonus," by J. E. Prosser. (London: Williams & Norgate.) Pp. vii.+122. 6s. net.

"Production Economique de L'Electricité dans les Régions Industrielles," by Fernand Courtoy. (Paris and Liége: Librarie Polytechnique Ch. Béranger.) Pp. 304.

A Current Limiting Regulator for A.C. Circuits.

A problem which often arises is how best to protect a circuit against excessive overload without at the same time making the devices employed so delicate in operation that they are always coming into action. Such a problem has, for instance, to be dealt with in a factory using motors whose horse-power in the aggregate amounts to several hundreds. In such a case the starting up at the beginning of the day or after meal times causes a short-lived demand for an excessive current. Momentary demands also occur throughout the day where processes such as electric arc welding are carried on. This latter operation is one indeed which calls essentially for current limitation, as the demand may vary rapidly from no-load to full-load, while there is also every possibility of a short-circuit should the electrode weld on to the work. In alternating-current welding, moreover, it is essential that the arc should be kept short if the weld is to be satisfactory, while at the same time sufficient current must be allowed to flow when the electrode is brought into contact with the metal to ensure the arc being struck. At the present time these conditions are generally obtained by using a comparatively high working voltage on the welding circuit in conjunction with some form of magnetic leakage air-gap transformer or series choke coil. This, however, still enables the operator to maintain a long arc, with the subsequent result that a bad weld is obtained.

Another solution of the problem is suggested in the current limiting regulator designed by Messrs. Davies & Soames. This has been patented in two forms, as a transformer and as a choke-coil. When used as a transformer the primary can be wound for any voltage, the secondary being wound to give the required working volts. Current can be taken from the secondary up to any predetermined amount, within the capacity of the winding, and when this predetermined amount is reached the current remains constant and the volts decrease gradually to zero at short-circuit. When designed as a choke coil it may be connected in series with the work. In this position when operating normally it does not introduce any appreciable choke or resistance into the circuit, though after the current reaches a predetermined value it begins to introduce choke and keeps the current constant at that value, until the load becomes a complete short-circuit.

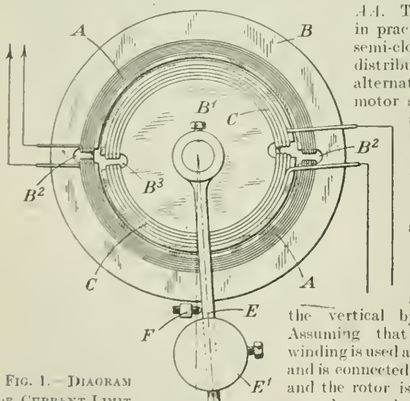

FIG. 1.—DIAGRAM OF CURRENT LIMITING REGULATOR.

The general construction of the first form of regulator, which is essentially a transformer, is shown in Fig. 1, where *B* is a stator wound with coils *AA*. These coils are in practice wound in semi-closed slots, and distributed as in an alternating-current motor stator. B_1 is a rotor, wound with coils *C*, on the shaft of which is fixed an arm *E*, upon which slides a weight E_1. This arm and weight are tilted very slightly from the vertical by a stop *F*. Assuming that the stator winding is used as the primary, and is connected to the mains, and the rotor is used as the secondary and connected to the working circuit, the action is as follows: If current is taken from the secondary the apparatus acts as an ordinary static transfomer until a certain limiting current value is reached. This value depends on the weight E_1 and its position on the arm. If the current is increased beyond this value, the machine causes the rotor to turn, and the arm and weight begin to rise—*i.e.*, the angle increases—until balance is obtained. This process can be continued to dead short-circuit, when the volts will have fallen to zero, while the working current remains constant at the predetermined limit. It must be remembered that this is the exterior characteristic of the transformer, the apparent paradox of current at no volts being accounted for by the fact that the small voltage induced represents CR, where R is the resistance of the secondary coil. The value to which the current is to be limited is fixed by sliding the weight up or down the arm. This arm may be graduated in amperes. This is the only adjustment necessary, and obviously it can be easily set with extreme accuracy, and there is nothing whatever to wear or alter. The various data obtained during the operation of this regulator on tests are given in the accompanying curves (Fig. 2).

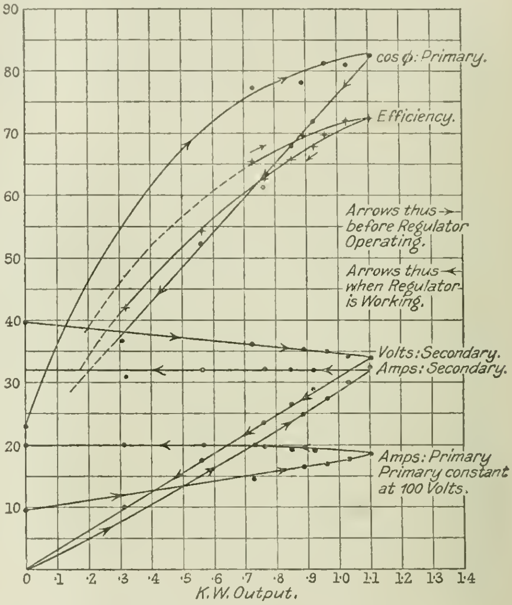

FIG. 2.—CURVES SHOWING OPERATION OF THE REGULATOR.

The second form of regulator for producing a similar current-limiting effect consists essentially of a choke coil placed in the circuit. Normally this does not operate, and there is therefore no loss such as the open circuit loss of a transformer. It is, therefore, claimed to be particularly suitable for use in work where the current is only used for a part of the day, but it should be pointed out that the regulator must be left permanently in circuit. This apparatus is constructed in exactly the same way as the transformer, but since, unlike the transformer, it is only required to choke down the excess current, it need not generally be so large. In this case the coils on the stator and the rotor are wound with the same number of turns, and are connected in series with one another. If the stator and rotor coils are co-axial and the current in the stator is in the opposite direction to the current in the rotor—*i.e.*, the coils are in opposition to one another, it is obvious that there is no choke and therefore no core loss. As the rotor is revolved through 180 deg. the coils move into conjunction with one another, and the choke thereby introduced by the apparatus increases from zero to a maximum at 180 deg. The rotor is provided with an arm and sliding weight similar to that on the transformer described above, the arm being slightly tilted from the vertical. When the apparatus is connected in series with any load it remains inoperative until a certain current is reached, this value being, as in the case of the transformer, predetermined by the position of the weight of the arm. After this value is reached the rotor turns automatically, as the load is increased, the current being kept constant by introducing choke into the circuit, and thus lowering the voltage across the load.

The special features claimed for these methods of regulation are that the working circuit is in no way affected until the predetermined current value is reached, the regulation is perfectly continuous and gradual, while the only adjustment necessary—viz., the movement weight—is simple, as there are no revolving parts the machines can be built quite as efficiently as a well-designed induction motor, and the regulating action leads to no waste of power.

A New Alternate-Current Potentiometer for Measurements on Telephone Circuits.

By P. O. PEDERSEN.

There has of late years been no scarcity of alternate-current potentiometers suitable for measurements on telephone circuits. As the first, A. Franke's alternator ought to be mentioned (1891) [1]*. An improved form has later been described in detail by Ebeling [2]. Using a phase-shifting transformer and a slide wire C. V. Drysdale, in 1909, made an alternating-current potentiometer originally used for ordinary low-frequency current [3 *a*, *c*], but which he later (1913) has accommodated to the use with telephone currents [3 *b*]. A. Larsen, in 1910, described his beautifully simple complex potentiometer for telephone currents based on a variator of mutual inductance and a slide wire [4 *a*-*c*]. This potentiometer, together with the same author's generator for currents of telephone frequencies [4 *d*, *e*], has been extensively used for telephone measurements in various countries. Another Dane, A. K. Erlang, has, by making use of two slide wires in parallel, made a still simpler alternating-current potentiometer [5 *a*, *b*].

It may, therefore, perhaps seem a little superfluous to increase the number of alternating-current potentiometers further.

Still, I hope that the new one of which a short description is given below, has some features of its own and may even have such small merits as will justify this publication.

The essential part of the new alternating-current potentiometer consists of the well-known, non-inductive, combination, shown in Fig. 1, of two resistances $R_1=R_2=R$ (ohms), a coil L (henry), and a condenser C (farad), where

$$R_1=R_2=R=\sqrt{\frac{L}{C}}\text{ (ohms)} \quad . \quad . \quad . \quad . \quad (1)$$

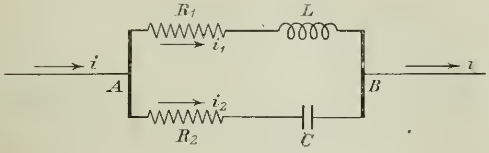

Fig. 1.

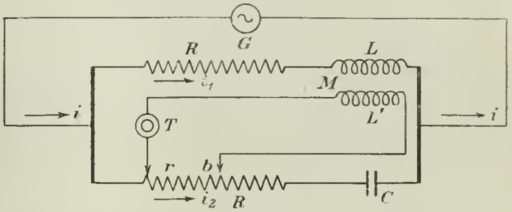

Fig. 2.

The resistances R_1 and R_2 are formed as slide wires either stretched longitudinally or wound non-inductively on a drum, the return wire in this case being of copper. Each wire is provided with a scale and with a sliding contact—a on the coil resistance and b on the condenser resistance (*see* Fig. 3). The frequency is denoted by n; $\omega=2\pi n$ being the pulsatance† In the above formula (1) R is, of course, the effective resistance at the frequency used.

Let i_1 be the current through the coil, i_2 through the condenser, and i the current in the main circuit.

We have then

$$i_1=\frac{1-j\omega CR}{1+\omega^2C^2R^2}i\,;\ i_2=\omega CR\,\frac{\omega CR+j}{1+\omega^2C^2R^2}\,.\,i=j\omega CR\,.\,i_1\text{ (amps<)} \quad (2)$$

The current i_2 is thus exactly 90 deg. in advance of i_1 for all frequencies for which the relation (1) is satisfied.

In order to test if the current i_1 is lagging 90 deg. behind i_2 the diagram sketched in Fig. 2 may be used. A coil L^1 is coupled inductively to L, the mutual inductance being M. In series with L^1 is inserted a telephone T and a part r of the resistance in the condenser circuit. The telephone will then be silent if

$$r=\frac{M}{CR}\text{ (ohms)}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This value of r is thus formally independent of the frequency. When C is an ordinary mica condenser, and L an ordinary good induction coil, the relation (1) is so nearly independent of the frequency that the telephone in Fig. 2 without altering the position of the sliding contact b will be practically silent for all values of ω between 4,000 and 7,000.

The pulsatance ω may easily be determined in the manner indicated in Fig. 3. A coil L_0 is inserted in the main circuit and another coil $L_0{}^1$ coupled to L_0, the mutual inductance being M_0. In series with $L_0{}^1$ is the telephone T and the sliding contacts a and b. The telephone will then be silent if

$$a_0=\omega^2CRM_0\text{ and }b_0=\frac{M_0}{CR}\text{ (ohms)} \quad . \quad . \quad . \quad . \quad (4)$$

while the pulsatance may be determined by

$$\omega=\frac{1}{CR}\sqrt{\frac{a_0}{b_0}}\text{ (radians per second)}. \quad . \quad . \quad . \quad . \quad (5)$$

The position of the contact b is thus independent of the frequency, and may—for a constant value of M_0—be ascertained once for all. For the measurement of the pulsatance it is then only necessary to find the corresponding position of the contact a.

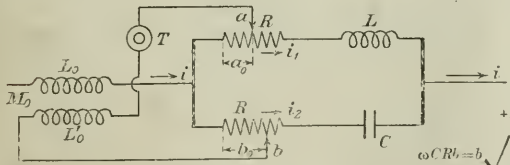

Fig. 3.

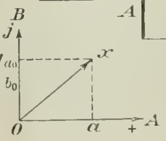

Fig. 4

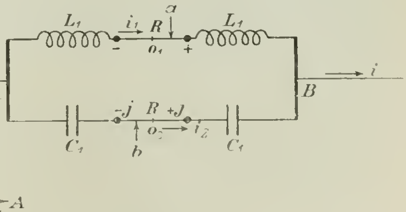

Fig. 5.

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* Figures in square brackets refer to the appended bibliography.

† A. Campbell, "Proc." Phys. Soc., Vol. 31, p. 81. 1919.

Let *OA* in Fig. 4 be the real and *OB* the imaginary axis of a rectangular system of reference and *X* a point, the co-ordinates of which are *a* and $\omega CRb = b\sqrt{\frac{a_0}{b_0}}$, *a* and *b* being the readings at the sliding contacts. The vector *OX* then represents the P.D. between the contacts *a* and *b*. In this way all P.D.'s falling in the first quadrant are easily compared. But, in order to compare all possible P.D.'s it is necessary to duplicate the arrangement shown in Figs. 1 to 3 and use two coils L_1 and two condensers C_1, as shown in Fig. 5. If

$$L_1 = \frac{1}{2} L.\ C_1 = 2C, \text{ and } R = \sqrt{\frac{L}{C}}$$

the current distribution will be exactly the same as in the former cases. The readings at the contacts *a* and *b* may now be both positive and negative, counted from the central points o_1 and o_2 of the resistances, o_1 and o_2 being at the same potential. In order to bring the "electrically" central points o_1 and o_2 to fall at the zero marks of the sliding wires, the small slide resistances r_1, r_2, r_3 and r_4 (Fig. 6) are introduced, which resistances are also very convenient in order to satisfy the conditions,

$$R_1 = R_2 = R = \sqrt{\frac{L}{C}}$$

If it is not wanted to use the apparatus for frequencies outside a range of, say, from $\omega = 1,000$ to $\omega = 7,000$, these four resistances may be replaced by four small resistance coils.

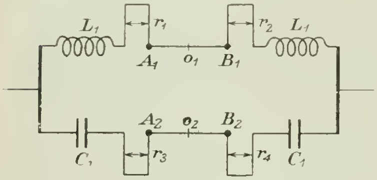

FIG. 6.

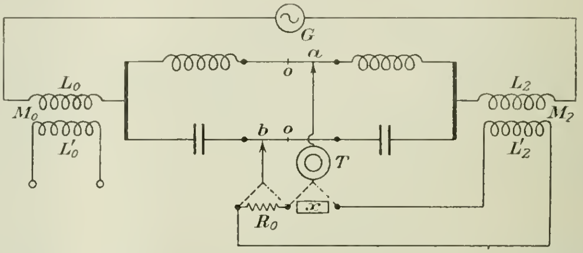

FIG. 7.

The apparatus may now, as sketched in Fig. 7, be used, for instance, for the measurement of impedances. The unknown impedance *X* is inserted in series with a known impedance R_0 and a coil L'_2 forming the secondary of an air-core transformer having L_2 as primary coil. The mutual inductance M_2 is adjustable and is given such a value that the readings at *a* and *b* get suitable values. The ratio of the unknown to the known impedance is equal to the ratio ot the corresponding P.D.'s as measured by the readings ot the contacts *a* and *b*.

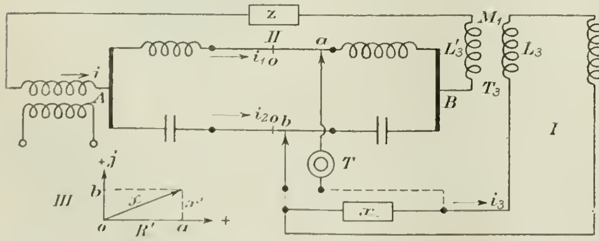

FIG. 8

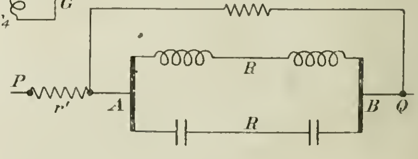

FIG. 9.

The measurement of impedances may be made even more simple by the use of the arrangement sketched in Fig. 8. A circuit *I* contains the unknown impedance *X*, the primary coil L_3 of an air-core transformer T_3 and the alternating current generator, or the secondary of a transformer T_4, the primary being connected to the alternating-current generator. Another circuit *II* contains the coil L'_3 being the secondary of T_3, the potentiometer circuit *AB* and an impedance *Z*. This impedance is given such a value that the current i_1 in the coil side is in phase with the current i_3 in circuit *I*. If, then, the impedance *X* is a pure resistance the position of *b* will be at *o* and the reading at *a* will be proportional to the resistance *X*. The mutual inductance M_1 of L_3 and L'_3 may now be given such a value that the value ot *X* in ohms is equal to the reading at *a*, that is, to the number of divisions between *o* and *a* on the scale along the wire, which number we also denote by *a*. (In some cases it is more convenient to make the measured resistance equal to $a.10^{\pm 1}$.) If instead of being a true resistance, *X* is equal to $R' + jX'$, these two components of the impedance are determined by

$$R' = a \text{ (ohms)} \quad \ldots\ldots\ldots \tag{6}$$

and

$$X' = b\ .\ \omega CR \text{ (ohms)} \quad \ldots\ldots \tag{7}$$

If the constants ω, *C* and *R* are chosen in such a way that

$$\omega CR = 1,$$

the last equation is reduced to the simple form

$$X' = b \text{ (ohms)} \quad \ldots\ldots\ldots \tag{7'}$$

In that case the *values of the resistance and of the reactance of an unknown impedance are given directly in ohms as the readings at the contacts a and b respectively.* (Fig. 8 *III*.)

The impedance *Z* may also be chosen in such a way that we get

$$R' = b \text{ (ohms)} \quad \ldots\ldots\ldots \tag{6'}$$

and

$$X' = a \text{ (ohms)} \quad \ldots\ldots\ldots \tag{7''}$$

The potentiometer may be used for many other measurements, which need not be detailed here.

The potentiometer circuit *AB* has the (non-inductive) resistance *R*. It will often be more convenient to shunt the potentiometer circuit instead of reducing the mutual inductance M_1. Let *AB* be shunted by a resistance r'' and a resistance r' be inserted in the main circuit (Fig. 9). The resistance between *P* and *Q* will then remain equal to *R*, if $r' = \frac{n}{n+1} . R$ and $r'' = \frac{R}{n}$, and the currents in the potentiometer will be reduced $(n+1)$ times by the shunt.

Example of the choice of the different electrical constants : $L=0{\cdot}02$ henry ($L_1=0{\cdot}01$H.), $C=2{\cdot}10^{-6}$ farad ($C_1=4{\cdot}10^{-6}$ farad) $R=\sqrt{\frac{L}{C}}=100$ ohms. In this case we have $\omega CR=1$ for $\omega=5{,}000$.

BIBLIOGRAPHY.

1. A. FRANKE.—" Die Elektrischen Vorgänge in Fernsprechleitungen und Apparaten." "Elektrotech. Zeitschr," p. 447-452, 458-463. 1891.

2. A. EBELING.—"Franke's Alternator for Measuring Currents of Telephonic Frequency. ELECTRICIAN, Vol. 72, p. 88-91. 1913.

3. C. V. DRYSDALE.—(*a*)—" The Use of the Potentiometer on Alternate-Current Circuits." "Phil. Mag." (6), Vol. 17, p. 402-411. 1909.

(*b*) " Tho Use of the Alternate-Current Potentiometer for Measurements on Telegraph and Telephone Circuits." ELECTRICIAN, Vol. 71, p. 687-690. 1913.

(*c*) " The Alternate-Current Potentiometer as a Standard Instrument." ELECTRICIAN, Vol. 75, p. 157-160. 1915.

4. A. LARSEN.—(*a*) " Den komplexe Kompensator." "Elektroteknikeren," p. 182-188. 1910. (Copenhagen.)

(*b*) " Der komplexe Kompensator, ein Apparat zur Messung von Wechselströmen durch Kompensation." "Elektrotech. Zeitschr," p. 1039-1041. 1910.

(*c*) " An Apparatus for the Measurement of Alternate-Currents by the Compensation Method." ELECTRICIAN, Vol. 66, p. 736. 1911.

(*d*) " Ein Akustischer Wechselströmerzeuger mit Regulierbare Periodenzahl für schwache Ströme." "Elektrotech. Zeitschr," p. 284-285. 1911.

(*e*) " A New High-Frequency Generator." ELECTRICIAN. Vol. 67, p. 827. 1911.

5. A. K. ERLANG.—(*a*) " Et nyt Kompensationapparat til Vekselströmsmaalinger indenfor Telefonien." "Elektroteknikeren," p. 157-160. 1913. (Copenhagen.)

(*b*) " New Alternating-Current Compensation Apparatus for Telephonic Measurements." "Journ." Inst. Elec. Eng., Vol. 51. p. 794-799. 1913.

The Heating of Transformers.[*]

By M. VIDMAR.

The heat in a transformer that is not oil-cooled passes from the iron or copper eventually into the air, where it is finally dissipated. There is consequently a surface cooling and an internal process, depending on conduction, by which the inside constantly endeavours to cool itself by transmitting heat to some cooler portion. The surface cooling is, of course, a matter of radiation. There are thus internal and external processes of cooling. One heat wave passes through the copper windings, and another through the iron ; these are largely independent of one another when a stable state arises. The copper wave is the more important, inasmuch as it directly threatens the insulation. As far as the internal loss of heat is concerned—*i.e.*, in the iron and copper—the temperature-fall here is small compared with that caused by surface radiation. In the author's book on " Modern Transformer Problems," the author gives a formula for the internal temperature fall in non-impregnated copper coils, which shows that the mean fall is equal to $8{\cdot}5\ i^2d\delta\left(\frac{n}{10}\right)^2$, where i is the current density per square millimetre, d the diameter of the bare wire in millimetres, δ the radial depth of the insulation, and n the number of layers of winding. With rectangular coils, the coefficient in this expression should be 6·5. Impregnated coils, as always used in transformers, have a much lower mean internal temperature fall, and the coefficient becomes 5, while impregnated flat-wire coils have a coefficient of 4. The maximum internal temperature fall is about double this value. In determining the maximum number of layers through which the heat must pass, the designer will probably not go far wrong in taking this as three-quarters of the whole number of the layers. It ought, perhaps, to be stated that these matters of design have nothing to do with those transformers in which no oil is used, and the high and low-tension windings are arranged concentrically. A simple example may help to explain matters further. A transformer without oil has a circular coil, 16 layers deep, consisting of wire 3 mm. in diameter, with insulation 0·25 mm. thick. At full load this coil carries 1·75 amperes per square millimetre. The mean temperature fall, according to the above considerations, taking the number of layers as three-quarters of 16, is 16·5°C. The resistance shows a mean temperature 60°C. above that of the atmosphere ; there must, therefore, be a surface-fall by radiation of 43·5°C. This conforms to modern designs, which allow a surface fall between 40°C. and 50°C.

This surface fall by radiation is actually the more important part of the problem. If any portion of the surface is actually radiating heat, and if the temperature-fall at this point is A°C., then each square decimetre of the surface radiates heat equivalent to $6{\cdot}7\times10^{-2}A$ watts. But the question arises as to what is the active radiating surface. The external surface of the cylinder will radiate heat, but even here one must proceed with caution. If two cylindrical surfaces are near one another, the heat at the neighbouring surfaces is merely radiated from the one to tho other. If three such cylindrical surfaces are close to one another, as on a three-phase transformer, the end ones lose nearly one-sixth of their radiating surfaces ; the middle coil loses nearly one-third. Rectangular coils could not be used on this plan. Besides the outer surface, the side surfaces of the coils radiate heat, if air spaces are arranged between the different coils, but it must be remembered that this radiation is largely oblique. Let us suppose the external diameter of the coil to be D decimetres, the radial depth of the coils to be b decimetres, the axial height of the air spaces to be δ, then it can be shown that the effective radiating side surfaces of the coil are approximately

$$D\pi\delta\left(\log\frac{2b}{\delta}-\frac{2b}{\delta}\left(1-\frac{\delta}{b}\right)\right).$$

The ordinary air spaces are 10 mm. or 15 mm. broad ; then the radiating effect of the side surfaces can be safely taken as being about 50 per cent. more than that of a free cylinder of the same diameter as the coil and of an axial height of double the air-space distance. The total radiating surface of the coil can then be represented by a cylindrical surface which has the same diameter as the coils, and is higher than the iron core by twice the total breadth of the air spaces. This is made clear by the following example. The above-mentioned transformer has limbs 700 mm. long with coils 350 mm. in diameter. Only half the limb was wound, the remainder of the length being occupied by air spaces. The equivalent cylindrical radiating surface is $7\times2\times\frac{1}{2}\times7$ decimetres long—*i.e.*, 14 decimetres. Its surface with a diameter of 3·5 decimetres is 167 sq. decimetres. The three limbs of a polyphase transformer would lose two-ninths of their radiating surface ; the remaining effective surface would therefore be 390 sq. decimetres. If the temperature-fall were 43·5°C., 1,135 watts would be lost through radiation. It is noteworthy that the air spaces cannot contribute largely to the radiating effect, unless their breadth is great in comparison to the diameter of the coils, when the above approximation no longer holds.

If we consider ventilation by forced draught, it depends on the length of time during which the current is in contact with the coils. The axial height of the coil is of importance in the upright type. Lorenz has shown that the heat is removed at a rate which varies directly with the 1·25th power of the external temperature-fall, and inversely as the fourth root of the height of the cylindrical surface. The temperature-fall is usually between 40°C. and 50°C., and the heat-removal can be considered to proceed at a rate that varies directly with this figure, for the sake of simplicity. Taking this value as A, the author finds that the heat removed is

$$6{\cdot}3\times10^{-2}\times A\times\sqrt[4]{h}\text{ watts,}$$

where h is the height of the surface. With the upright limb, there are only small values of h, say, about 30 mm. The following instance is given. The coils of a transformer cover only half tho iron limb. If there are three limbs, the external cylindrical surface, which is available for heat radiation, amounts to 115 sq. decimetres, if the constants are as above stated. In point of fact, the active surface is somewhat greater than this, because the air current eddies through the air spaces between the coils to some small extent, but the cautious designer will do well to neglect this. The mean height of the coil may be taken as 0·3 decimetre. The heat that is removed will therefore be

$$\frac{6{\cdot}3}{\sqrt[4]{0{\cdot}3}}\times\frac{1}{100}\times43{\cdot}5\times115\text{ watts}=425\text{ watts}$$

Including, therefore, the 1,135 watts, which was found previously to be removed, we get a total of 1,560 watts. This figure corresponds very well with the figures given under test.

This example introduces another question which has been treated by Hundt, but it is not capable of being solved in the offhand way ho adopts. The point is whether it is not better to arrange the limbs horizontally instead of vertically, and to use the air spaces between the coils not only for radiation, but also for conduction. If the axis of the coil is horizontal, the surface available for conducting the heat is certainly greater, while the radiating surface naturally remains as before. But the active effect of the air on the coil is not so great, because the cooling air remains longer in contact with the heated surface. If we consider the external cylindrical surface of the coils, we find that h is now half the circumference of the coil, whereas previously it was only equal to the axial height. It may therefore well be 20 or 30 times as great as before. The active effect may therefore be halved at least, but it is suggested that the effect of the air spaces will outweigh this, if they are sufficiently large to allow the passage of a proper current of air. The author investigates the matter mathematically. He assumes that the diameter of the core is half that of the coil, and that the length of the path travelled by the air is 20 per cent. greater than the diameter of the coil, which is taken as D. Then he shows that the active surface of a coil is

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[*] Abstract of an article in the "Elektrotechnische Zeitschrift," No. 15, 1919.

$$\sqrt[4]{D^3}(2{\cdot}8h+1{\cdot}14D)$$

for horizontal limbs, and $D\pi\sqrt[4]{h^3}$ for vertical limbs.

The arrangement with a horizontal axis is evidently much the better for all likely values of D; for ordinary values it may well be twice as effective as the vertical system. Still it is necessary that the original hypothesis should hold good, according to which the air spaces between the coils must be sufficiently large to allow the passage of a proper current of air. The smaller the air space is the less will be the speed of the air current. Let us take this speed as 5 decimetres per second, and the surface temperature-fall as 45°C. The air space must then be at least 1·5 mm. for each watt that is radiated from a square decimetre in a second. But this value must in practice be considerably exceeded, in order that the air current shall not be too much choked. Experience shows that air passages smaller than 10 mm. are not effective. With large transformers there is no difficulty about this, but with smaller sizes the advantage of the horizontal over the vertical arrangement tends to disappear. Just as it was with the radiation of heat, so it is with the conduction of heat as soon as a second limb is added to the first; with the conduction of heat, there is a great difference between the horizontal and vertical plans. If we consider a plan in which the limbs are placed above one another, it is evident that as the air ascends, it becomes hotter, and therefore acts less efficiently in abstracting the heat from the upper limbs. On the vertical plan, this is not so much the case, and the effect of the one limb on the others is not so marked. Therefore, it is to be expected that the advantage of the horizontal plan from this point of view will be less. The plan, however, of putting the limbs horizontal and in one plane has distinct advantages, and has been successfully tested in practice. From this it is evident that many things must be considered before arriving at a decision in any particular case.

Large Electric Steel Melting Furnaces.*

By VICTOR STOBIE.

Large electric arc steel-melting furnaces are preferable for ingot making, but smaller furnaces have a very large field in foundry work. Observations will be confined mainly to large plant and to some interesting phenomena on all furnaces.

WIRING DIAGRAMS AND SHAPES OF FURNACES.

The wiring diagrams (Figs. 1, 2 and 3) give the best connections for three sizes of furnaces. Fig. 1 is for furnaces up to 6 tons capacity, two-phase current, each phase maintained entirely separate from the other, with one end of each phase connected to separate electrodes above the bath, and the other end of each phase connected to separate electrodes embedded in the hearth of the furnace at opposite ends of the furnace to their relative top electrodes. This arrangement gives the requisite bottom heating for small furnaces and leads to crossing of the currents in the direction of flow through the bath. Fig. 2 is for furnaces from 6 tons up to 24 tons capacity, two-phase current, each phase maintained entirely separate from the other, with each end of each phase terminating in an electrode above the bath. Bottom electrodes, whilst essential in small furnaces, are undesirable in large furnaces. Fig. 3 is for furnaces above 24 tons capacity, three-phase current, each phase maintained entirely separate from the others, with each end of each phase terminating in an electrode above the bath.

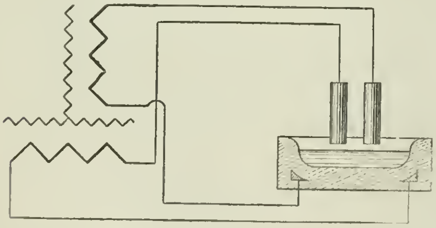

FIG. 1.

The most favourable shapes for tilting electric furnaces would appear to be:—

Up to 6 tons: Rectangular in plan and in elevation with a curved bottom.

From 7 to 24 tons: Octagonal in plan.

Above 24 tons: Octagonal with lengthened back and front walls. Stationary furnaces should always be rectangular.

The above shapes ensure the most convenient position for the electrodes in the furnace and help to keep the furnace walls at the average greatest distance from the electrodes, which should not be opposite to doors, in order to avoid the breaking of electrodes when material is thrown into the furnaces.

ARC PHENOMENA.

The arc phenomena in a steel-melting electric furnace are important and interesting. The arc proper jumps between the bath and whichever portion of the electrode is nearest. As this point is always changing, the arc travels irregularly round and under the lower extremity of the electrode. A flame of carbonaceous gas, in large furnaces as much as 2 ft. long, travels over the bath from each electrode. This is quite the hottest flame in commercial use and in some designs of furances, causes excessively quick burning away of the roof and door arches. It will rapidly flux the banks of the furnace if allowed to impinge thereon. Some control can be obtained over the direction of the flame by alterations in the direction of rotation of the magnetic field of the supply currents. Experiments on the blowing of the arc flames in furnaces by strong external continuous magnetic fields were also made.

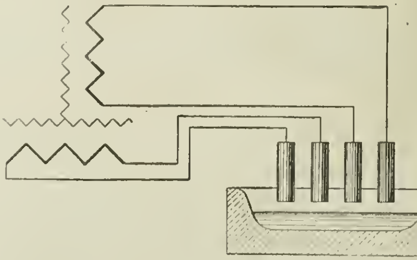

FIG. 2.

In some types of electric furnaces arcs are maintained between adjacent electrodes and not between electrodes and bath. The property of inter-repulsion of arc flames is utilised to fan the flames over the material to be melted, whilst much of the heat energy in the circuit, viz., that in the arcs proper, travels only between the electrodes. This leads to a high current consumption per ton of steel in such furnaces. It was once believed that the great heat (*circa* 3,600°C.) of the arcs in an electric furnace would have a detrimental effect on the steel. More recent experience teaches us that, so long as a steel is thoroughly deoxidised before casting, only the temperature of casting is of moment.

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* Abstract of Paper read before the Institution of Electrical Engineers.

Transformers.

One might, with reason, say that the heart of the electrical equipment of an electric furnace installation is the transforming apparatus. The stresses which the transformers have to resist are exceedingly heavy. The plant has to withstand occasional short-circuiting through the furnace and even the equivalent of almost a dead short-circuit. It has to allow frequent breaking of the circuits under heavy overload and, possibly, of occasional switching direct on to overload.

The requirements in the design of the transformers are :—

1. That the current density of both the low-tension and extra-high-tension windings shall be low enough to prevent the inevitable overloads from unduly heating up and deteriorating the insulation.
2. The ventilating channels in the windings must be specially well considered so as to provide low resistance paths for the cooling oil without excessive magnetic leakage.
3. That windings shall be braced on all sides.
4. The low-tension windings shall be taped with such material as empire tape, in addition to press-spahn or similar stiff insulation.
5. All clamps, no matter how small they may be, should be anchored to the transformer framework.
6. The whole of the apparatus must be as unyielding to magnetic stresses as mechanical skill can make it.
7. As much as possible of the total reactance required in the whole of the furnace installation should be incorporated in the transformers.

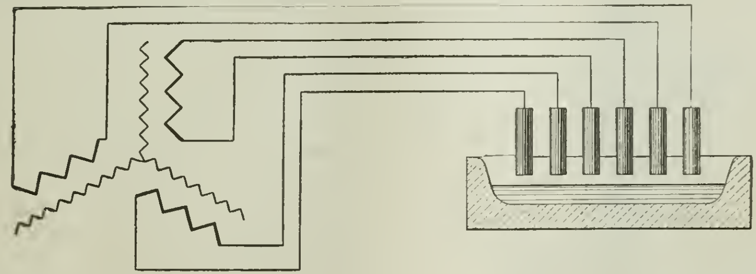

Fig. 3.

As a result of observations of the breakdown of some furnace transformers, the bracing of all sides of the windings of transformers was specified by the author in 1917. The design has now been standardised also for large power transformers.

It is usual to have several tappings brought out from the high-tension windings of furnace transformers, as the voltage required on a furnace during melting is higher than when finishing a heat. Such tappings should be brought away from the central portions of the winding, the complete high-tension winding being divided into two at the mid-point and the tappings bridged across the mid-point to cut out equal portions of each half of the windings when required. The insulation of the end turns of the high-tension windings can then be suitably reinforced to withstand any abnormal voltage stress on switching in the transformers. Useful results have been obtained by limiting the current density in transformer windings to 1,250 amperes per sq. inch, the induction in the iron to about 12,000 C.G.S lines, and the temperature rise on continuous full-load to 45°C., measured by the increase in resistance. An over-potential test at this double voltage is made on the high-tension side. Low-tension windings of large furnace transformers should be tested at a potential several times greater than normal.

Automatic Electrode Regulators.

The desiderata in automatic regulation mechanism include sensitiveness without fragility, and simple setting to limits. If the furnace circuits contain two arcs in series, the energy in each such two arcs should be balanced, whatever current is flowing. This is accomplished in Stobie electric furnaces by operating one electrode motor by an automatic current controller and the other by an automatic potential controller. The current controller is adjusted to give the limits of current required and will keep its electrode at any position at which such desired current will flow. The potential controller is adjusted so that half the phase voltage, *i.e.*, the normal voltage between one electrode and the furnace charge, is maintained on the electrode it controls. The result is that the potential-regulating motor will keep its electrode at the same distance from the molten steel as the current-regulating motor keeps the other electrode, as at that distance the current will be normal and the voltage balanced. On some electric furnaces balancing of two arcs in series is automatically controlled in a different manner.

Power Factor.

The power factor of alternating arcs varies from almost unity to lower than 0·7 in the case of arcs between cold hard metals. As is known, the apparent resistance of an arc varies with the current passing through it, being high for a low current. The voltage wave consequently is distorted and forms a sharp peak at the commencement and end of each half cycle, with a strongly marked depression between. The current wave approximately retains its sine shape, and a lagging power factor results without any phase displacement.

The circuit reactances are divided between the transformers and the leads. Due to the large sizes of conductors used, and to the large area enclosed by the circuits, reactance in furnace work has a tendency to be high. At the same time, very low reactance would be undesirable on large power systems in view of the frequent short-circuits through the furnace. The total impedance on short-circuiting through a cold charge will usually be high enough to reduce all shocks to reasonable limits. If, however, a short-circuit takes place through a molten steel bath, the impedance will be relatively low on account of the good conductivity of the bath, unless a reasonable amount of reactance is incorporated in the circuits. Such short-circuits are, fortunately, very rare in well-designed furnaces. The total impedance at the moment of starting a large furnace with poor scrap sometimes reaches over 90 per cent. With average scrap it ranges between 40 and 60 per cent. When melting armour scrap or other clean heavy material it little exceeds the reactance.

A 15-ton Stobie furnace gives the following power factors :—

On melting	0·84
When charge is half melted	0·85
When charge is almost melted	0·87
When charge is melted	0·93

It can be safely stated that large furnaces such as the 10-ton, 15-ton, and 20-ton Stobie furnaces give an average power factor of fully 0·88 over all units consumed.

The author has heard it stated at various times that one or other particular design of furnace can be worked safely at almost unity power factor. Sooner or later one hears of the collapse of some part of such gear, due almost certainly to serious current surges. Considerable experience in the designing and operating of electric furnaces teaches one to aim for safety before unnecessarily high electrical performance. The author aims at installing plant in such a manner that on dead short-circuit the power factor is momentarily reduced to 0·4 or even 0·3. This need not mitigate against the excellent normal power factors already mentioned.

Electrode Considerations.

The presence of electrodes in electric arc furnaces is, for the user and designer, an unfortunate necessity. The desirable characteristics of an electrode are: low resistivity, relative incombustibility and cheapness. No material combines these qualities. The nearest approach is found in carbon, and one has the choice between amorphous and graphitic carbon, electrodes. The resistivity of the amorphous variety is, roughly, four times that of the graphitic. This enables graphitic electrodes to be made of smaller diameter than amorphous ones for equal current-carrying capacity. The following table gives the comparative data of both types of electrodes, including the diameter of electrode sufficient to carry, in practice, 10,000 amperes safely :—

—	Specific resistance per cm. cube	Lowest temperature of combustion.	Diameter to carry 10.000 amps.
Amorphous electrode ...	0·00332 ohm.	513°C.	12 in.
Graphite electrode.........	0·00114 ohm.	624°C.	20 in.

A very important point, almost invariably overlooked by designers and users of electric furnaces, is "skin effect." Early users of graphitic electrodes obtained their experience on non-ferrous furnaces using direct current. When the electrodes were introduced into steel-melting furnaces, all supplied with alternating current, the electrodes became much too hot at current densities far below the maker's recommendations; the average current density in the main current-carrying area of an electrode being roughly twice the average current density of the whole area, due to skin effect.

The main consumption of the electrodes in ordinary electric steel furnaces does not take place at the arcing end of the electrodes, but results from the surface burning of the carbon all over those parts of the electrodes which are inside the melting chamber and up to a point about 15 in. above the roof. Fully 75 per cent. of the heavy expenditure on electrodes is wasted through this defect. Various attempts to prevent this costly waste of electrodes have been previously made, such as (1) enveloping the carbons with asbestos paste held in position by wire netting; (2) coating the electrodes with non-burning paints; (3) encircling the electrodes with steel collars held together by hinges or springs; (4) surrounding the electrodes with water-cooled cylinders extending well inside the furnace. All such methods have met with failure. Asbestos perishes quickly inside the melting chamber and is expensive; non-burning coatings all expand and fall away from the non-expanding carbon electrode; collars do not protect red-hot electrodes from the air above the roof, are not efficient in keeping back the flames, have a very short life and are expensive in upkeep; internal jackets are wasteful of heat and are dangerous and ineffective inside the furnace.

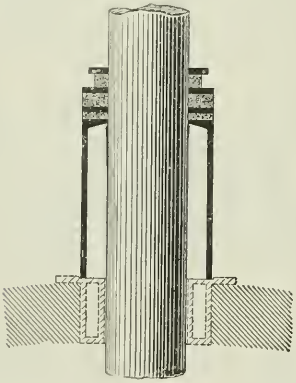

Fig. 4.—Stobie Electrode Economiser.

It is thought by some people that there is always a reducing atmosphere inside electric furnaces. This is an utterly mistaken notion. The cause of the oxidising atmosphere inside the older electric furnaces is the crude method of feeding the electrodes into the melting chamber, *i.e.*, by leaving in the roof a number of plain holes equal to the number of electrodes which have to be continuously fed into the furnace; the bricks forming such holes support annular water-jackets which fit, with a small clearance, new electrodes. The heated gases inside the furnace continuously pass up those clearances between the roof and the electrodes. As a result the clearance rapidly increased by the flames burning away the electrodes to a tapered point, the heat value of the gases and flames which are constantly pouring out of the furnace through the electrode holes is wasted; the duration of a charge is lengthened in proportion to the heat lost through the roof holes; the escaping flames cause the electrode gear and current conductors over the roof to deteriorate rapidly; and the undue heating of the electrode terminals necessitates their being water cooled. The considerable effect of all this on the cost of producing the steel, quite apart from some loss of control therefrom over the operations of the furnace, will be readily apparent.

At first sight it may seem a simple matter to close up the clearance between the roof of a furnace and the electrodes passing through it; but this presents difficulties. The difficulty has been overcome in a simple way. At about 2 ft. above the roof in most furnaces the electrodes, even when raised for charging, are seldom at a temperature at which they can burn, therefore, that is the only point at which a permanently good seal can be made round the electrodes. If an electrode is closed hermetically from the roof up to that point, the burning away of the electrode and the escaping of the heated gases from the furnace are prevented.

In practice, a light metal cylinder a few inches larger in diameter than the electrode and about 2 ft. in length is fixed on the roof round each electrode. The top end of the jacket is covered with a sealing plate which prevents the passage of the flame, the electrodes passing through a neatly fitting hole in the centre of such cover.

Fig. 4 shows the present-day economiser, which can be applied in telescopic form suitable for furnaces having only a short electrode travel. Other advantages of this simple device are as follows :—

1. No cold air is drawn into the furnace.
2. No flames or highly heated air burn away the electrodes above the roof.
3. A really reducing carbon-depositing (when desired) atmosphere is maintained within the melting chamber.
4. The oxygen-free atmosphere of the furnace prevents the burning of the electrodes inside the furnace except at the arcing ends, and, therefore, electrodes remain parallel instead of tapering.
5. The electrodes can be of smaller diameter for a given current supply, thus diminishing electrode costs and permitting a reduction in the size of the electrode holes in the roof.
6. The life of the roof is increased because the thick carbonaceous atmosphere inside the furnace acts as an opaque curtain through which the intense heat of the arcs cannot be radiated upwards.
7. The flames inside the furnace, not being able to pass out at the electrode holes, travel all over and among the charge and heat this up readily and very economically.
8. The electrode gear over the furnace does not become intensely hot as in older furnaces. Any adjustments can, therefore, be made in comfort.
9. In consequence of the exclusion of free air from the furnace, and the absolute control which this permits over oxidation, scrap steels containing oxidisable elements such as chromium, tungsten, manganese and even vanadium, can be easily melted without losing the special elements from the bath.
10. The absence of heat from the electrode gear enables the current terminals of the electrode to be made of light copper contacts built up of standard copper bars, instead of intricate, heavy, water-cooled bronze castings.
11. By preventing the heavy heat losses which formerly took place, the cost of manufacturing electric steel has been reduced and the time required per heat diminished.
12. The sealing of the roof of furnaces results in the furnace being much cooler for the furnace men to operate.

Circulation of Bath.

Many years' observation of the working of electric steel furnaces had not revealed any movements of the steel bath except such as were due to well-known causes; therefore, it was decided to devise means whereby closer observation of the effects of electric circuits through molten metal could be made than was possible in a steel furnace working at temperatures up to 1,800°C. Mercury presented itself as a suitable substitute for a hot steel bath, as it resembled molten steel in being a liquid metal and magnetically inert. The resistivity of mercury at atmospheric temperature is approximately two-thirds that of molten steel. Its specific gravity is twice that of molten steel.

Separate experiments with single, two-phase and three-phase currents, and representing every known type of furnace with arcs playing on the bath, were made.

The size of the bath, the quantity of mercury, and the current flowing were proportioned to represent average practice, but on a reduced scale. Two voltages were separately used for each system of connections; one low enough to enable the full current to be passed through the bath without arcs, and a higher one to pass the current through arcs above the bath as in normal steel melting.

The research conclusively proved that no circulatory or other stirring movement of the bath results from the electrode circuits in an electric arc furnace. The more or less complete diffusion of added elements which takes place in a bath of molten steel is a metallurgical phenomenon that occurs in all steel-melting furnaces, whether electric or other, and does not depend upon magnetic or convection currents.

Gas Engineers on Electricity Supply.

At the annual conference of the British Commercial Gas Association, held in London on October 28th and 29th, under the presidency of the Right Hon. Lord Moulton, F.R.S., reference was made by several of the speakers to questions of interest to electrical engineers.

Lord Moulton, in his opening address, said this country's greatest need at the moment was to get back to a state of steady production. The present was not the time for exaggerated schemes of a higher development; but we were threatened with huge schemes for the development of electricity on lines that were utterly strange to us, and with monopolistic features which had never commended themselves to the English people. The development of electricity delighted him, but in all these schemes the eyes of the would-be reformers were fixed on some hoped-for result, without study of what could be done with capital already invested, with skill already obtained and with no delay. They were not justified in treating electricity hostilely in any way. It had put a standard before them in the way of distribution of motive power and of light which it would take all the energies of those in the gas industry to equal. But they had to make the public realise that they possessed unrivalled power of distributing heat so that it could be used economically for domestic purposes. It was necessary to conserve the coal supply, and electricity could not be looked to as a solution of that difficulty; but the use of gas in all its forms was the most potent weapon at their command. For mechanical traction, too, there was a practically limitless supply of that which, unless the price of petrol fell, could give effectively the same power—namely, gas—and unless the price of petrol kept low the motor omnibus would have to come to the gas industry for the solution of mechanical transport. Coke was also coming into its kingdom. The public were realising that it was only ignorance of the proper way of bringing out its qualities and using its full efficiency that made it a kind of Cinderella among fuels. The industry was subject to profit restrictions which at the time were wise but had now become completely out of date, and cried out for revision as a matter of justice.

Sir Dugald Clerk, F.R.S., in a Paper on "Coal Conservation," said the gas industry was responsible for dealing with, but not consuming, about 20 million tons of coal per annum, having an average estimated calorific value of 13,000 British thermal units per pound. The electrical industry consumed about 6½ million tons per annum, if calculated on the same basis of thermal value. In the case of electricity, this coal was entirely consumed, and the only product was electrical energy. In the case of the 20 million tons carbonised by the gas industry, there were three main products—coal gas, coke and tar, and a multitude of by-products, including light inflammable oil for motor cars, sulphate of ammonia for fertilising, and many other substances. The domestic consumption in our households was nearly 40 million tons, so that domestic use, gas and electricity generation accounted for over 66 million tons of coal per annum. It was vital to economise to the utmost, and one way in which this could be done was to deal with the heat losses involved in the different operations; but another was to reduce the amount of coal required for motive power by utilising our water-power resources in the Scottish Highlands, in Wales and in Ireland. These resources amounted to about one-third of the total motive power of the United Kingdom, and if this could be substituted for steam we should obviously save 26 million tons of coal per annum. It had been asserted that the energy of coal could be best distributed by the production of electric current from it, and, inferentially, that this was better than the present method of obtaining heat from coal gas; but, if thermal efficiencies were considered this could be shown not to be the case. Indeed, the probable value of the ratio of thermal efficiencies from heating or cooking apparatus to gas works or electricity generating station, was about four—*i.e.*, electric heat supply, if substituted for gas heat supply, would necessitate the consumption of 43·6 million tons, compared with the 10·6 million tons now consumed by gas. Gas also gave higher thermal efficiencies for motive power, the efficiency of the gas power production and distribution being over 1·6 times that of electricity. With lighting, the two systems were in somewhat keener competition. The efficiency of the apparatus of light production varied considerably; but, comparing the inverted incandescent mantle at ordinary gas pressure with the 1 watt electric lamp, the former required the use of 47 B.Th.U. at the gas works for each candle-power obtained by the consumer, while the latter required the use at the generating station of 54 B.Th.U. Accordingly, if all the electric lamps were of this type, electricity would require a greater heat consumption than gas, while if the half watt lamp were used electricity would be more economical than gas.

Dr. S. Rideal read a Paper on the "Results of an Enquiry into the Alleged Hygienic Superiority of Electric over Gas Light."

He gave an account of some experiments made in a room more nearly air tight than any ordinary living room is likely to be, while special precautions were taken to prevent the ingress of further air, that the transformed composition of the air under gas illumination showed no marked difference from that under electricity, and the condition of the room as regards heat was practically the same under both illuminants. With natural ventilation, also, the proportion of carbonic acid in the air was practically identical for both illuminants. Fifteen men have been subjected on more than 50 occasions to some 6,000 tests of the kind best calculated to detect any such falling off in condition as might be expected to take place under either mode of illumination, and the results of these tests with few exceptions fail to disclose any measurable difference between one mode of lighting and the other. Not only so, but in no case do they show any deviation from any normal conditions. The conditions which the physiological tests disclosed were in all cases entirely satisfactory. The differences found between the two lights were so small as to be absolutely devoid of any hygienic significance; they were, in fact, much less than those that are constantly produced in healthy subjects by slight changes in their conditions or environment. Not less important is the fact that 15 men were confined for several hours each evening in crowded and scantily ventilated rooms in which the products of gas consumption or the heat from electric lighting were allowed to accumulate to an extent which would hardly be possible in any ordinary living room, that they were under continuous medical observation, and that in no case was there any adverse influence of any kind whatever exerted by the lights or their products. The main conclusions may be summed up as follows: (1) Owing to the better ventilation obtained by gas, the products of combustion are not found in the air in anything like the proportion which might be expected, the temperature and humidity in an occupied room being no greater than when the room is illuminated with electric light. (2) Carbonic acid has not the injurious effect which was formerly attributed to it, but considerable rises in the temperature and moisture content of a room, from whatever source, do have a prejudicial effect upon the well-being of the occupants. Even under adverse conditions of ventilation purposely created for this inquiry, neither the temperature nor percentages of moisture in the room reached a point at which any such effect could be detected by any of the recognised physiological tests. (3) It has been established that the products—viz., heat, carbonic acid and moisture—so far as they modify the health of the occupants of a room, are derived from the inmates more than from the illuminant, and that a room of moderate size can be efficiently lighted by gas without sensibly affecting the amount of these three factors. (4) Whilst, undoubtedly, it is important to ensure adequate ventilation in domestic rooms, this, with present methods of construction, is better ensured the smaller the room. The problem of securing sufficient ventilation in public rooms of a larger size has been outside the scope of this inquiry. (5) The medical conclusions are in accord with those arrived at from the chemical and physical data, and also demonstrate that the choice between the two systems of lighting does not depend upon hygienic considerations.

In seconding a vote of thanks to Dr. Rideal (moved by Mr. Geo. Davis), Mr. F. W. Goodenough said he had received a letter from a scientific man urging that steps should be taken to try and make the installation of gas fires and cookers compulsory in new houses. He thought the local authorities would find the working women would ask for gas light, because of the extra warmth it gave compared with the other illuminant. There would be a greater increase of cost if there were dual systems of mains—for electricity and gas—on an estate.

Other Papers read at the conference were: "The Smoke Nuisance in Relation to National Health," by Dr. C. W. Saleeby; "The Smoke Nuisance: A Plea for Action," by Dr. H. A. Des Voeux; "Scientific Heating in Relation to National Health," by Prof. Leonard Hill, F.R.S.; and on the "Housing Problem," by Messrs. H. A. Hall and H. H. Creays.

Midland Power Scheme.

Several Midland authorities, including the Corporations of Nottingham, Leicester, Loughborough, Burton, Derby and Mansfield, and the Urban Councils of Ilkeston and Long Eaton, are interested in a scheme for the erection of a super-power station. Some time ago Mr. J. H. Rider and Mr. C. H. Wordingham were instructed to consider the proposal, and their report was recently presented. We learn from a speech of Mr. R. H. Swain, Chairman of the Nottingham Electricity Committee, that the report recommends the erection of a new generating station on the banks of the Trent, to supply an area of 2,000 square miles, 50 miles from north to south, and 40 miles from east to west. The area includes parts of Nottinghamshire, Derbyshire, Staffs, and Leicestershire. The first section of the station would cost £5,260,000, but supply authorities from Chesterfield to Leicester, on the one hand, and Burton-on-Trent to Newark on the other, would co-operate and bear a proportion of the cost.

Mr. Swain also stated that the whole scheme was estimated to require £14,000,000 to carry through, but it meant much cheaper power, and would result in a saving of £40,000 per annum to the Nottingham Tramway Committee alone. They were desirous of getting the first section erected as soon as possible. At the station, which would occupy at least 100 acres of land, there were many advantages—an ample supply of condensing water, facilities for bringing coal by water and rail, for the disposal of ashes and coal storage, and, what was very important in future, a carbonisation plant. The capacity of the station would be 200,000 kw. and it would require 580,000 tons of coal per annum (or 1,500 tons daily) and 14,000,000 gallons of river water per hour. There were three schemes before the Government—the one he had outlined, the coalowners', and the Government scheme, but he maintained that their own was the best.

The scheme outlined above is at present under consideration by the engineers and representatives of the various authorities concerned, but progress cannot be made until the Electricity Supply Bill becomes law, when no doubt the schemes will be submitted to the Government Department concerned and to the authorities which will be set up for dealing with electricity supply generally.

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Positive v. Negative Propaganda.

A conference of electrical engineers at which the presidential address and a large proportion of the Papers read were devoted to a discussion of the advantages of a rival form of illuminant, though, perhaps, not altogether unamusing or profitless, would, we think, be something of a novelty. Yet this is what happened at the Annual Conference of the British Commercial Gas Association held in London last week, under the presidency of Lord MOULTON. Supposing for the moment that we were as much interested in the progress of the gas industry as in the development of electricity supply, we should, having considered the general tendencies of the Papers read and of the remarks made by the various speakers, have been a little fearful whether all was quite as well as it might be with the object we had at heart.

Now, we are to a certain extent interested in the gas industry, and we cannot help feeling that things have changed. It is not so many years ago that propaganda recommending the employment of gas for lighting, heating and industrial purposes was coloured with a superabundant optimism which was refreshing even to those who did not share it. It was pleasant to think that here was one form of enterprise that felt with them at least all was for the best in the best of best possible worlds, and that even the presence of rivals, in their view unsuccessful, was but another drop in their overflowing cup of success.

But now the song, though perhaps not less optimistic so far as the libretto is concerned, is being sung to another tune. To mix the metaphor, something like an olive branch is being held out to the electrical industry. We are being assured that no hostility is felt for us, and that in our place, and strictly in our place, we are doing well. Thus Lord MOULTON, though deprecating the expense involved in the huge schemes for the development of electricity supply foreshadowed in the Electricity Supply Bill, and viewing with alarm the monopolistic features present in such schemes, assured his hearers that he was no enemy of electricity, but wished, indeed, to be considered its warm friend, because of the power it gave to industrial development by the distribution of power. Moreover, he told his audience that the electrical industry had set a standard in the distribution of energy for industrial and illuminating purposes which it would take all the energies of the gas industry to touch, and which in some directions it could never hope to touch. And though against this must be recorded his conviction that the real strength of gas lies in the fact that it can place at the disposal of the consumer a far higher proportion of the calorific value of coal than electricity could ever hope to achieve, yet at the same time his clear recognition not so much of what electricity may do as of what it has done, is very significant. Lord MOULTON'S complaint that electricity supply is being unduly favoured by the Government is not without interest. This is not altogether the view taken by electrical engineers, many of whom would describe the operation as interference rather than favouritism. And when we remember what the electrical industry has suffered from similar "favours" from the days of the earliest Electric Lighting Act onwards, we cannot help feeling that some form of treatment a little less like slow poisoning is now due to us.

The same interest in the shortcomings of electricity for power and lighting purposes was taken by Sir DUGALD CLERK and Dr. S. RIDEAL. The nominal subject of the former's Paper was "Coal Consumption." But King Charles's head could not be kept out of the argument, and there was a good deal said about the enormous waste of our natural resources that was involved in the employment of electricity instead of gas. Sir DUGALD CLERK'S figures should be studied, not because we admit them to be true, but because they will form a useful basis of argument for electrical propaganda. For, after all, in dealing with the question of energy supply to consumers, calorific value, upon which Sir DUGALD bases his arguments, is not the only thing to be considered. There are also such questions as ease of distribution, and even of mere convenience, to be thought of. For that reason we do not fear any great rush of power users to replace their motors by gas engines, or by theatre proprietors to install the inverted mantle instead of the metal filament lamp for lighting their stages. Dr. RIDEAL'S Paper is interesting as an *apologia*. If gas lighting, he says, is not more hygienic than electric lighting, it is certainly no less so, and he gave the results of some experiments he had made to prove this thesis. These results show, he contends, that the difference between the two forms of illuminant are so small as to be absolutely devoid of any hygienic significance, while, if anything, the inhabitants of a room are more likely to be poisoned by their own products of combustion than by those from gas. We seem to have heard the argument before. That is not that sort of propaganda which is going seriously to brake the wheel of electrical progress. Nor is Mr. GOODENOUGH'S suggestion that the installation of gas cookers and heaters should be made compulsory in all new houses likely to frighten us.

We have perhaps dealt in a somewhat flippant spirit with the work of the British Commercial Gas Association as far as that work is reflected in the Papers read at their latest Annual Conference; but the activities of this Association are not confined to the reading of Papers, and, though we may be under the temptation to sneer, confident in our strength, yet it would be a mistake to suppose that the employment of electricity will increase and multiply automatically, and that no efforts need be made to remove causes of friction, provide lubrication and generally to ensure the smooth running of the machine. This is a day of advertisement. A thing, be it a patent medicine or a motor car, no longer stands on its own merits, unless those merits are brought to the notice of the public in a form which it understands, and, what is more important, kept before the public by fresh and enticing methods. We, as electrical engineers, know that for industrial purposes electricity has pre-eminent advantages over gas, but we must not be diffident about telling people so. Modesty is an early-Victorian virtue, as out of date as antimacassars. So, though we may afford to smile at the ingenuousness of our rival's propaganda, yet we must resolve to some extent at least to follow their example, notwithstanding that we have a much better case. There has never been such a time as the present for electrical development, and that development should be assisted by impressing upon electrical associations that have been formed for the purpose the need for a campaign of positive propaganda, so that everyone will know what we know about the advantages of the employment of electrical energy for a number of purposes.

How the Progress Department Assists.

III.—The Store and the Purchasing Departments.

By W. J. HISCOX.

In many factories, of the small and medium size varieties, the Store and the Progress Department are run in conjunction under one head, but in the larger factories this is impracticable. In this case, however, the closest co-operation between the two departments is essential if the capabilities of both are to be exploited to their fullest extent.

The Store is the supply department ot the factory, and its efficiency to a very great extent determines the amount of success achieved by the productive departments; and unless the store is strongly organised the attentions bestowed upon the machining and fitting departments are not likely to realise expectations.

The Progress Department looks upon the Store as the hub of production, well knowing that if this fails the output from each department, and consequently from the factory, will be adversely affected. It is necessary, therefore, for the progress man to interest himself in this direction, not by interfering with the internal affairs of the Store, but by extending his assistance and thus enabling the department to discharge its obligations.

The Store, catering for the needs of all departments, and endeavouring to satisfy all, is often in need of assistance, for the conflicting claims of the various departments render it necessary for a ruling to be obtained as to which shall receive priority. It is in this connection that the Progress Department renders assistance, for knowing the actual needs of the departments, as represented by the urgency of the orders on hand, it can arrange the claims in rotation, and thus ensure that material is distributed in such a way as to intelligently interpret the needs of the factory as a whole. This considerably increases the efficiency of the store, and also lightens the labours of the officials of that department.

The fact that the Progress Department controls the factory organisation with regard to delivery ensures that all demands made on the Store are put through in a systematic manner. It must be remembered that one of the greatest assets to the factory is a reliable stock record, and for this to be properly maintained it is necessary for a requisition to be received before any material is issued. It is also essential that these requisitions come through a recognised and responsible channel, and that each is worded in such a way as will obviate any doubt as to its authenticity In regard to the initial issues of material in connection with a production order, authority is given upon a material list, whilst requisitions for material to replace scrap, etc., are consequent upon information derived from inspectors' reports. This method has already been dealt with in the second article of this series, and it will be seen that the efforts of the Progress Department in this direction are of equal benefit to the Store as to the Costing Department

The receipt of material from outside suppliers (and particularly if this is a special requirement of a certain department) sometimes perplexes the receiving section of the Store on account of the inadequate information at its disposal. Here again the Progress Department is able to render assistance, for the progress man, on the look-out for everything in connection with the order in which he is interested, speedily discovers the presence of the unknown article, and is able to give particulars regarding its destination.

In the factory where large numbers of machined components are kept in stock the assistance extended by the Progress Department is very considerable. These parts are placed on order by the Store as the available stock reaches the minimum figure, and a list of those parts which are urgently required, when handed to the Progress Department, receives prompt attention.

Parts received from outside suppliers for stock are usually inspected before being placed in the bins, and this operation occasions some delay unless the Progress Department takes the necessary steps. These parts, although probably not wanted immediately for customers' orders, are much better in stock than in the inspecting section, and the Progress Department, recognising this, is assiduous in its attentions,

As with the Store, so with the Purchasing Department, and without the Progress Department these are as ships without a rudder. Each has definite duties to perform, but definite instructions are necessary in order that these duties are carried out in the manner most advantageous to the factory as a whole.

The Purchasing Department is responsible for the supply of material from outside sources, and should the supply fail, work in the factory would obviously soon be at a standstill. But with the great variety of materials required from outside, it is necessary for the Purchasing Department to know the degrees of urgency with which these parts are required, and it is here that the Progress Department can render assistance.

Ordinarily, the lowest price tender is accepted, and so long as delivery is promised within a reasonable time this is perfectly correct. Precisely what constitutes a "reasonable time," however, is a moot point, for what is reasonable in one case would be utterly unreasonable in another. Business contains many surprises, even in concerns which pride themselves upon their efficient organisation, and many firms are prepared to take a "sporting chance" in the matter of a quick delivery, especially if larger orders are dependent upon the speedy despatch of a comparatively small one.

In such a case the firm usually has in the factory an adequate supply of material to meet the demands of the order, for it would hardly risk its reputation to secure an order (on an extra special quick delivery), the fulfilment of which would have to depend upon certain material that must be ordered outside. As a rule such an order is executed at the expense of another not so urgently required, and for which the outside material has already been received, but the unexpected transfer of such material makes it imperative that supplies for replacement must be forthcoming without delay, otherwise this order will fail to be despatched in accordance with the promised delivery.

The Progress Department, having sanctioned the transfer of material from one order to another, must impress upon the Purchasing Department the necessity for speedy action. The price of the bought commodity is now subordinate to the delivery, and it is to the firm which can promise the quickest delivery (even though the price be higher) that the attention of the Purchasing Department is directed.

Many letters are written daily by the officials of the Purchasing Department to outside firms, urging deliveries, and the Progress Department can ensure that no superfluous letters are sent, by keeping the Purchasing Department posted as to the needs of the various productive departments and the degree of urgency of the various parts outstanding. Further than this, when a large variety of parts are on order with one firm, it is not expedient to send a letter to that firm by every post, each letter urging the claims of probably not more than one or two of the items on order. The inditing of, say, half a dozen letters when one will suffice is obviously wasted effort, and the Progress Department can assist considerably in this direction by ensuring that all inquiries in any one week in respect to material ordered with a certain firm are sent to the Purchasing Department at one and the same time.

When a large quantity of a certain commodity is on order, it is not always necessary for the whole to be received before work on the same can be commenced in the factory, and much delay in connection with the receipt of outside supplies could be obviated if the suppliers were informed that the goods in question would be received in instalments. The Purchasing Department, however, does not always know what constitutes a workable number, and the assistance of the Progress Department is again essential.

In the matter of returns to outside suppliers, due to inferior workmanship or material, the reasons necessitating the return must be fully though concisely given. Much trouble is experienced in the Purchasing Department in this connection owing to the vague wording of reports, and much unnecessary correspondence takes place between that department and the suppliers of the material before the matter can be amicably settled. This could be obviated with the co-operation of the Progress Department, whose business it is to know precisely why material has been rejected.

Material required by the Stores for stock purposes can usually be dealt with automatically by the Purchasing Department, but even here in some instances it is necessary for certain material to receive priority. This fact is communicated to the Progress Department by the Store, and the progress man, knowing that this material will in due course be required in connection with a certain order, can give the Purchasing Department the information regarding delivery which will ensure the necessary steps being taken to get supplies by the time desired.

Requisitions for tools, plant, etc., can be dealt with in the same way, and when the Progress Department handles the question of outside supplies in an efficient manner, it will be found that the Purchasing Department will benefit considerably.

Luminescence Effects.*

By H. BAHR.

Photoluminescence denotes the capacity which some substances have of absorbing light and emitting it in a darkened room. The usual substances are the sulphides of the metallic alkalis, and the so-called sidotblende, which is a mineral consisting of zinc sulphide, found in Spain. The sulphides of the alkali metal have been known to possess this property since the days of Balmain in 1600. These so-called glow-colours were not properly studied till lately, when Lenard and Klatt took the matter up, in connection with the theory of electrons. Lenard showed that the property depended on a crystalline structure and also on the presence of very slight impurities, mainly tungsten, lead or copper to the extent of 0·0001 per cent. The photoluminescent effect soon dies away, and it is necessary to expose the substance to the light before any further effect can be produced. Consequently this has no real technical value. But it is different with radioluminescence. Cathode rays excite nearly all substances to luminescence, and a certain limited range of substances are excited by Röntgen rays, such as barium platinocyanide. Also the natural invisible rays such as radium rays excite luminescence. By mixing a radioactive substance with some sensitive substance one gets permanent glow colours, which have lately been shown to have great technical importance. Radioactive substances are those elements which change themselves into other elements with other properties in consequence of the expenditure of energy, the best known being radium. Mesothorium and radiothorium are equally important. Radioactive substances emit three kinds of rays, called α, β and γ rays, about 98 per cent. of the energy being in the α rays. Giesel discovered in 1903 the properties of the so-called sidotblende. Some radioactive substances only emit β and γ rays—*e.g.*, mesothorium, which excite sidotblende to luminescence, but the energy is very small and too limited to produce any practical application. Radioactive substances must therefore be used which emit a sufficient proportion of α rays. Radium emits only one-fourth in the shape of effective α radiation, and radiothorium only emits a fraction, but it forms by decomposition the non-volatile substance, called thorium X, which emits α rays. After thorium X, the thorium emanation is formed, and this takes place much more quickly than with radium. Inclusive of the emanation, thorium X has six short-lived decomposition products, of which four emit α rays. Radioactive substances are never chemically pure; the amount of the impurities must be determined by radiation methods. The technical method of valuing these things is to speak of 1 milligramme of a substance as being that amount which gives the same amount of γ radiation as 1 milligramme of chemically pure crystallised radium bromide—*i.e.*, $RaBr_2 + 2H_2O$. Using the methods of commerce, 1 milligramme of radiothorium has on this definition 1·5 times as much α radiation in respect of the lighting effect as 1 milligramme of radium. The glow colours from one and the same piece of sidotblende depend on the percentage of the radioactive substance which it contains, measured on the basis of the α radiation. The important thing is the surface of the piece of the sidotblende, which must contain very fine crystals. If a radioactive substance is separated chemically from the other substance from which it arises, it loses in activity by decomposition, the rate of decrease following an exponential law. The time which it takes to decrease to half its initial value is called the "half-value time," which in the case of radium is 1900 years, though its activity varies little in the first 10 or 20 years. In the case of radiothorium it is only 1·9 years; that is, it possesses after 1·9 years only 50 per cent. of its original activity, after 3·8 years only 25 per cent., after 5·7 years only 12·5, and after 7·6 years only 6·25 per cent. It is possible to counteract the rapid loss of activity of radiothorium by adding a certain amount of mesothorium, which, however, gives out of itself no active α radiation, but by its decomposition steadily forms fresh radiothorium; in this way we obtain the so-called mesothorium glow-colours. Mesothorium has a "half-value period" of five years, and changes into radiothorium. According to the proportions of mesothorium and radiothorium, the quality of the light varies. In the first quality, the activity increases steadily at first, the increase amounting to 45 per cent. After 9½ years the activity has again its initial value. With the second quality the activity increases during the first two years by 15 per cent. Then a relatively rapid fall sets in, as compared with the constancy of radium.

The life of radium is far greater than that of any of these, but at this stage it is well to consider the peculiar properties of sidotblende. Since Marsden's Paper, which was published in the "Proceedings" of the Royal Society in 1910, a good deal has been known about the fatigue of sidotblende when exposed to the α rays. Under this action, the radio-sensitiveness of sidotblende disappears at a measurable rate. Photometric examinations in the laboratory of the Auergesellschaft have shown that the first quality of sidotblende, supplied by Haen, of Hanover, with 0·7 milligramme of radiothorium to 1 gramme of blende, lost 25 per cent. of its initial value in the first month, and 22 per cent. in the second month. It is probable that the loss follows an exponential law. Thus it is evident that the decrease due to decomposition of the zinc sulphide is very important from the point of view of the life of the light. With another sample containing 0·19 milligramme of radiothorium to 1 gramme of the same blende as above, the loss was 8 per cent. in the first month. Ordinary qualities contain 0·05 to 0·1 milligramme to the gramme of blende. Thus, for practical purposes it will be seen that there is no object in producing glow colours of great intensity when the result can be better obtained with glow colours of less luminous intensity. But in cases where there are reasons for desiring a strong light it is best to use radiothorium, because these glow colours, in consequence of the decomposition of the zinc sulphide, in any case fall off rapidly. For each kind of sidotblende, passed through a certain mesh, the best result is obtained by a layer of a definite thickness. These glow colours are to be obtained commercially in very different qualities. The buyer will not generally be in a position to test chemically and physically; for him, the light emitted is the standard by which he judges. The light emitted by the radium rays or by means of sidotblende is not strong enough to light up surrounding objects. These radioactive glow colours are exclusively used by causing the substances to adhere to the object to be illuminated. If it is a question of reading figures or letters in the dark, they are painted with the substance or printed by a special process with the radioactive substance. Some sort of binding material is needed, of which there are different kinds. An ideal material would be such as would leave the smallest possible residue on drying, while retaining its adhesive property. Pure nitro-cellulose varnish answers the purpose well, but it has the objection that on drying it does not leave a good surface. On æsthetic grounds it has been necessary to have recourse to resinous lacquers, and to put up with the loss of light due to it, which may amount to anything between 40 and 75 per cent. The best way of using the glow colours is, perhaps, to put them in capillary glass tubes, which can be cut up into any lengths and secured to the objects to be illuminated. A special process is also used for mounting a layer of the powder on a thin sheet of paper, which can be protected by a washable covering. There are many practical applications of the process, which was very largely used for military purposes for lighting compasses, clocks, barometers on aeroplanes, &c. It was also used for lighting the gangways on Zeppelins. They have also been used for opthalmic purposes in connection with tests on the eyes. It has also been used in photometers as a convenient portable standard for work in the streets. It is unfortunate that the price is high. The only possibility of reducing the price lies in increasing the radio-sensitiveness of sidotblende, so that the expense of the radioactive substance can be avoided. A good many men are at work on the problem, and it remains to be seen whether they will succeed in reducing the cost.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 25, 1919, and from a Paper read before the Deutsche Beleuchtungstechnische Gesellschaft.

In the course of the discussion which took place after the reading of the Paper, A. Bloch gave some particulars of his experiments with the photometer, using the glow substance for the standard lamp. He said he had used it for street work for some years, and considered it almost perfect, if it were not for the gradual change in the value of the standard. It requires to be calibrated once a fortnight. Great accuracy in the results is not possible, owing to the small illuminating power of the standard, which gives a slightly greenish light, not at all inconvenient for practical work. He considered that the radium photometer would be of great use in the future, and it would doubtless be improved as soon as it was possible to settle down to work of that kind. The instrument which he had used could be carried in the pocket, and gave good results, when compared with those obtained by the best street photometers on the market.

The General Principles of the Development and Storage of Water for Electrical Purposes.*

By J. W. MEARES.

INTRODUCTORY.

The extensive use of hydro-electric development is a noticeable feature of most countries which possess natural water power, especially where there is concurrently an absence of coal-fields. There is not a great deal of literature on the subject. It is proposed in this paper to examine the subject from the point of view of delivering, and continuing to deliver, water to a prime mover, from which point onwards the problem does not greatly differ from that of the ordinary central station or group of interlinked stations. In the present paper mechanical design is not touched upon: the collection, storage and delivery of water on high, medium and low falls is the whole scope of the contribution.

THE CONDITIONS REQUISITE FOR WATER POWER; CLASSIFICATION ACCORDING TO HEAD.

A country may have vast rivers and yet very little water power capable of economic development. For, unless a natural fall is ready to hand, an artificial one must be created. The problems of low, medium and high heads differ considerably, and each may be dealt with in various ways. Generally speaking, low heads involve the use of pressure or reaction turbines, often submerged, with suction or draft tubes connecting the outlet with the tail race, from about 3 ft. as a practical limit up to 80 ft. or 100 ft. High heads are dealt with by the jet impulse type of wheel exemplified by the Pelton wheel, from a possible 5,000 ft. or so down to 300 ft. or 400 ft. Between these two extremes lie the medium falls, using impulse turbines of various types according to the head. The gross head in high and medium falls is the vertical difference in height between the point of application to the wheel and the water-level at the pipe intake: for low heads the difference between the level of the head and tail waters must be taken. The net head is the gross head diminished by the loss in the connecting system. Sometimes the maintenance of supply is dependent solely on storage; more frequently flow and storage are combined.

EFFICIENCY OF HYDRO-ELECTRIC PLANT.

At the most economical load the efficiency of various types of hydraulic turbine or wheel varies from 85 to 90 per cent. in larger sizes. The corresponding overall efficiency of alternators, including excitation losses, will be from 95 to 97 per cent. Thus the overall efficiency under the most favourable conditions will be from 81 to 87 per cent. In practical working, however, the most favourable conditions are not maintained. We may assume the overall commercial efficiency E of the plant M to be as follows:—

For 500 kw.	74	per cent.
,, 1,000 kw.	76	,,
,, 1,500 kw.	78	,,
,, 2,000 kw.	80	,,
,, 3,000 kw. and over	82	,,

Using the convenient irrigation unit of a "cusec" for a flow of a cubic foot of water per second (termed a foot-second in America), we have:

electrical horse-power output

$$\frac{\text{cusecs} \times 62{\cdot}4 \times \text{gross head in feet}}{550} \times \frac{E}{100}.$$

For rough purposes indeed it is sufficient to take kilowatts = cusecs × feet/15, or brake-horse-power of turbine = cusecs × feet/11 for mechanical power, except for small installations where the divisor will be higher. From these data curves are presented in the original Paper, giving the kilowatts which will be generated from any flow under any head within practicable limits. Even in the most favourable circumstances the water flowing through the turbines is only a very variable proportion of that which is precipitated on the catchment area. It is therefore necessary to refer generally to the factors of rainfall, run-off, evaporation, percolation and other matters which affect the problem.

The author is at present engaged upon the survey of the water-power possibilities of India and Burma. As the East Indies are subject only to seasonal monsoon rainfall, the conditions there are somewhat special with regard to these disturbing factors.

RAINFALL AND RUN-OFF.

If the rainfall over a particular catchment area in any period is known, and the stream flowing from it can be gauged, the percentage of run-off can be calculated; but the rain-gauge readings must be taken at a number of points in order to ascertain the actual amount of precipitation. As well as variation in rainfall the distribution of the fall, month by month and day by day, must be taken into account. Unless enormous reservoirs can be constructed the greater part of the rainfall in a monsoon area must inevitably flow to the sea unused either for power or for irrigation. Thus the upper reaches of the Irrawaddy and Salween, assuming it possible to utilise one-fifth of the discharge (based on 100 in. of rainfall) over a head of 500 ft., would give a potential 7,000,000 H.P. Actually the greater part of the discharge is in the monsoon months and incapable of utilisation. It is doubtful if a head of even 100 ft. could be developed at places within reach of civilisation. Too much water is almost as great a disadvantage as too little, owing to the difficulty of getting rid of it. These rivers could be harnessed, at enormous cost, for perhaps 500,000 H.P. if there were not far more favourable sites among their tributaries.

Minimum discharges on small catchments may vary four or five-fold in different years, and are difficult to calculate.

Formulæ for calculating the maximum run-off from a catchment have been devised, but all employ coefficients which it is impossible to ascertain without a comprehensive study of the nature of the area and the rainfall. A study of the daily rainfall observations over a period of 30 years will give a fairly accurate idea of the conditions which are likely to occur.

Mr. G. T. Barlow, C.I.E., chief engineer of the United Provinces, India, presents the following data:—

Showing Percentage Run-off Assumed.

	A.	*B.*	*C.*	*D.*	*E.*
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Light falls	1	3	5	10	15
Medium falls	10	15	20	25	33
Heavy falls	20	33	40	55	70

A = flat, cultivated and black cotton soil catchment.
B = flat, partly cultivated and stiff soils.
C = average catchment.
D = hills and plains with little cultivation.
E = very hilly, steep and rocky with very little cultivation.

Obviously such a classification would be unsuitable in most parts of Europe or America, but it shows the nature of the variations to be met with in a particular locality. In India the rainfall varies in different localities from 450 to a few inches, mostly precipitated in about 4 months, while catchment areas vary in nature from waste sand to steep rocky country.

EVAPORATION AND PERCOLATION.

Apart from the fact that a considerable percentage of rainfall is evaporated before it reaches the big rivers, as well as from their surface, the question of evaporation arises wherever long canals or large storage reservoirs are employed. This varies greatly; in India it may be as much as 6 ft. in the year. The following figures are worth remembering in connection with water-power projects involving storage: 31½ million cubic feet of water will give 1 cusec throughout a year; or, taking losses into consideration, about 35 million cubic feet. A square mile submerged to 1 ft. gives about 27⅞ million cubic feet, and an acre-foot about 43,000 cubic feet.

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* Abstract of a Paper in the "Journal" of the Institution of Electrical Engineers.

Reservoirs.

In India many imposing streams dry up entirely before the monsoon; furthermore, practically the whole hot weather discharge is taken up for irrigation in many other instances, although it fortunately happens that the headworks of the irrigation canals are generally taken off at a point below that which would be most suitable for power purposes. Where storage can be developed on a large scale it may go far towards balancing the deficiency of flow in the dry season, whether for irrigation or for power or for both.

The best sites for the dam containing the reservoir and for the escape for surplussing the excess flood for a reservoir is where a stream with a good catchment area runs through a fan-shaped valley with flat longitudinal and transverse sections. The soil, cultivation, habitations, and other works must also be considered. The dam should be placed where the valley contracts and, if possible, where there is good solid rock to found upon. Trial pits alone are not sufficient evidence and the whole alignment should be trenched.

The economic height of the dam and the line to which storage water is to be collected depend upon:—

(*a*) The requirements for power or irrigation, or both.

(*b*) The catchment area available for storage: it is frequently possible either to add extra catchment areas at a small cost, where water is deficient, or to divert a portion of the area to another drainage when it is in excess of the requirements and there are difficulties about the escape.

(*c*) The rainfall on and the actual run-off from the catchment.

(*d*) The nature of the submerged area, where an extra foot or two of height may involve on the one hand the submergence of valuable property or, on the other hand, may mean an extra 50 per cent. to 100 per cent. of storage capacity.

(*e*) The nature of the seasons; for in some places the annual rainfall is very variable in both amount and intensity, so that the run-off may vary from zero to nearly 100 per cent. of the rainfall. In such cases provision must be made for the carrying over of the water from the good to the bad years. This is especially necessary in all reservoirs used for power or sanitary purposes and may not always be possible in irrigation projects.

Water Storage and Power.

Whether water is stored on a large scale behind dams, or on a small scale in reservoirs, there are many variable factors in addition to the efficiency of the plant. It will be sufficient to assume an overall efficiency in the plant of 76 per cent., giving straight-line "curves." With this efficiency 1,000 kw. requires a flow of 15·54 cusecs under 1,000 ft. head, or 15,540 cusec-ft. under any other head. With the assumed head of 1,000 ft. this flow of 15½ cusecs represents (in round figures and exclusive of evaporation and percolation) 1⅓ million cubic feet a day; 41 million cubic feet a month; 490 million cubic feet a year; to maintain 1,000 kw. continuously in each case.

Now 1 kw. for a year represents 8,760 B.O.T. units, so the above 1,000 kw.-years give 8¾ million units on the assumption of 100 per cent. load factor. The amount of storage is directly proportional to the units generated, irrespective of load factor.

The relation of storage to Board of Trade units for any head may be obtained from curves. Thus for 2,000 ft. head the 200 ft. curve may be used and either the units multiplied by 10 or the storage divided by 10; and so forth. A scale of kilowatt-years on 100 per cent. load factor can be laid off by taking 1 kw.-year at 8,760 units, 10 kw.-years at 87,600 units, and so forth.

Mr. Dickinson has given details of three lakes on the Bombay (Tata) hydro-electric scheme, containing respectively 361, 2,560 and 6,963 million cubic feet of water. The static head is 1,725 ft. As 31·5 million cubic feet give 100,000 units on 175 ft. head, or 1 million on 1,750 ft. head, the three lakes will give about 11½, 80 and 220 million units respectively, subject to correction for evaporation and losses. On the basis of 100 per cent. load factor they would supply about 1,300, 9,000 and 25,000 kw.-years respectively. The actual load factor of the plant on the last returns available was 30 per cent., so the plant capable of being served under working conditions is about three times the above. The height of the water in the lakes affords therefore an immediate gauge of the reserve in hand. In the Chief Engineer's office is a curve showing the actual reserve for every foot of water behind the dams.

Limitations of Storage According to Head.

The function of water storage is two-fold: increase of power throughout the year or the dry season, and regulation day by day. The latter may enable the size of the plant to be increased. Where low heads are involved storage on the above scale of power is impracticable. The amount of storage that will serve to give (say) 1,000 kw. for a year on 1,800 ft. head would give the same for a month on 150 ft. and for a day only on 5 ft.

Within ordinary limits of capital cost a project depending entirely on monsoon storage, with no appreciable inflow during the greater part of the year, is impracticable except on high heads. Where a moderate flow of water is normally available under a high head, storage on a large scale may be used to supplement the flow at seasons of low water, provided that the excess flow in flood times can be depended upon to fill the reservoir. Thus a flow of 15 cusecs under 2,000 ft. head will give 2,000 kw. continuously, or considerably more on ordinary load factors. If this flow is the minimum it follows that much water will be running to waste at other times, in the absence of storage.

In the same way where a moderate minimum flow is combined with a medium head, storage can be utilised to impound the excess flow within limits. If the minimum flow is equivalent to 2,000 kw., say 100 cusecs on 300 ft. head, and the average flow is 200 cusecs, the whole of this excess could not be stored without undue expense; but a reservoir of practicable size would enable a larger plant than 2,000 kw. to be installed. Where rainfall is fairly regular, except for a few dry months, storage would act as a reserve to tide over the dry period with a larger plant than the minimum flow could deal with. Assume 1,000 million cubic feet of storage. It generally comes about that on medium heads storage can only be utilised as reserve against drought, or against breakdown in the water channel where one is necessary, and not for increasing the plant capacity greatly above that maintained by the normal flow. For regulating purposes, however, it can be exceedingly useful, especially where the load factor is bad. Many a small proposition has been turned down for lack of understanding tbis valuable application of storage.

As a general rule large-scale storage is impracticable on low-head plants; although there may be a considerable reserve behind a dam, either feeding directly into the turbines or further upstream it is generally no more than suffices for regulation. The enormous volume of water required to maintain a large unit of plant for even a month would render such a proposition commercially impossible.

Lay-out of Hydro-electric Schemes.

With a steam generating station the main considerations in fixing a site are facilities for condensing water and for fuel delivery and ash removal; none of these operate in the case of hydro-electric plant, which must be placed where the ground admits, and designed to suit it. Thus it may happen that a high fall cannot be developed conveniently as a single station, but can be utilised in the form of two stations in series, the tail water of the one discharging into the headworks of the next. This has been done at the two Santa Ana Creek stations at Redlands, California; and in the small development at Darjeeling, India, which the author carried out in 1896, the method has been used for subsequent extensions.

High-head Lay-out.

High-head schemes are necessarily located in mountainous country, and are generally fed from torrents of small volume, liable to heavy flood and consequently bringing down much mud as well as gravel and large stones. It is generally necessary to have settling tanks and a torebay, in order to prevent damage to the wheels from foreign matter travelling at high velocity. It is almost always necessary to carry the water along the hillside for a considerable distance in an open channel, generally of artificial construction. The channel offers a weak link in the chain and duplication is impossible, though occasionally two or more separate sources of supply may be tapped by different routes. To allow for fluctuations of load a forebay at the head of the pressure pipes is essential, unless water is so plentiful that an excess is always running to waste at that point.

Thus if the channel can deal with a steady load of 2,000 kw. and the peak load averages 2,500 kw. for 2 hours, there must be at least 1,000 kw.-hours stored in the forebay. On 1,000 ft. head this amounts to about 56,000 cubic ft. This is of no practical use as a reserve against a temporary breakdown in the channel or at the headworks, and wherever possible one should have enough storage at the pipe head to tide over at least a few hours' stoppage from such causes. For this much greater capacity is necessary. Large reservoirs, constructed by means of dams, can obviously only be located where the ground offers natural facilities, *i.e.*, at a comparatively narrow neck in a valley, which opens out above and does not rise steeply. In some cases of steep ground it is possible to locate the power house so near to the headworks, even with high heads, that the water can be carried in pipes the whole way, without an open channel. Here risk of breakdown is a minimum

(*To be concluded.*)

A Submersible Electrically-driven Pump.

The Board of Trade Regulations for the Saving of Life at Sea lay down that on all ships carrying passengers an auxiliary electric lighting set must be fixed on some portion of the upper works, so as to ensure a supply of light should for any reason the main engines be out of action owing to a collision or breakdown and to provide the necessary current for the wireless telegraph apparatus. It is obvious that this auxiliary supply of power can be used for other life-saving purposes, but we may particularly mention the advance made in this direction by a well-known shipping company, which is arranging to equip certain of their vessels with an emergency electrically-driven pump. This pump will be installed on the boat deck, and will be used to pump water out of the hold, or other affected part, and thus do its part towards keeping the ship afloat in case of need. Recent experience has, indeed, shown that the use of some such equipment as this may, small as its capacity is, make all the difference between the saving and loss of life of many passengers.

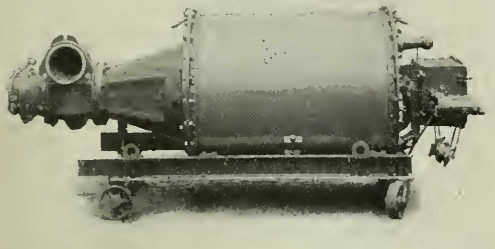

Fig. 1.—General View of the Electrically-Driven Submersible Pump.

We recently inspected an electrically-driven pump which has been designed for this class of work by Messrs. Merryweather & Sons of Greenwich. From the electrical point of view, there is this of interest about the apparatus that, although, as is obvious from what is said above, it is not intended that the pump shall normally work submerged, it may at the same time be an advantage under certain conditions that it should be able to do so. In any event, if the water is coming into the ship at a quicker rate than it is being pumped out, it is desirable that as little time as possible should be lost in shifting the gear, and better still if the gear does not have to be shifted at all. In this case no such shifting is necessary, as the motor pump will, it is claimed, work equally well when wholly or partially submerged. Another interesting point is that, though for several years it has been possible to obtain a three-phase motor to work submerged, this is, we think, the first time that a direct-current motor has been so employed. A general view of the motor and pump is given in Fig. 1, while Fig. 2 illustrates the details of the arrangement. It may be pointed out that the direct-current motor employed may be of any ordinary design. It is carried on ball bearings, so that it works equally well in any plane. The motor is enclosed in a cylindrical chamber made of boiler plate and rivetted and lagged on the inside with cork cement to reduce condensation, thus protecting the brush gear and windings. This cylindrical chamber is fitted at the free end with a hand hole, secured by butterfly nuts, the joint between the cover of the hole and the chamber itself being made with a leather washer. This chamber is fitted with slinging eyes, so that the whole pump may be hung in any desired position. The cone-shaped intercepting chamber between the pump and the motor is fitted with double glands, the gland at the pump end being on the suction side, so that a partial vacuum is caused, thus forming an additional protection against water creeping into the motor chamber. These glands are packed with greasy hemp packing. The pump is of the ordinary centrifugal type, and is driven by a 20 h.p. shunt-wound motor. Connection to the mains is obtained by means of a three-way plug and socket, one pin and hole of which is smaller than the others to ensure the plug being inserted in the right way. The socket is fixed on the cylindrical housing, and is connected to the motor by a three-core cable. The plug is connected to cab tyre sheathing cable of any desired length, and is held tightly in position in the socket by means of a screw ring, such as is used on an ordinary hose coupling, the joint being rendered watertight by means of greasy hemp packing. In the ordinary course of events the pump and motor are carried on a four-wheel trolley, shown in our illustration, to which also is fixed the starter. When required, however, the pump can be slung, as described above, and the necessary electrical connections are then made in the way we have just described. The capacity of the pump is 11,900 gallons a minute against a head of 35 ft., the combination giving an overall efficiency on test of 75 per cent. An interesting point is that the temperature rise inside the motor casing at the end of a 44-hour continuous run was found to be only 40°F. at a point closely adjacent to the motor.

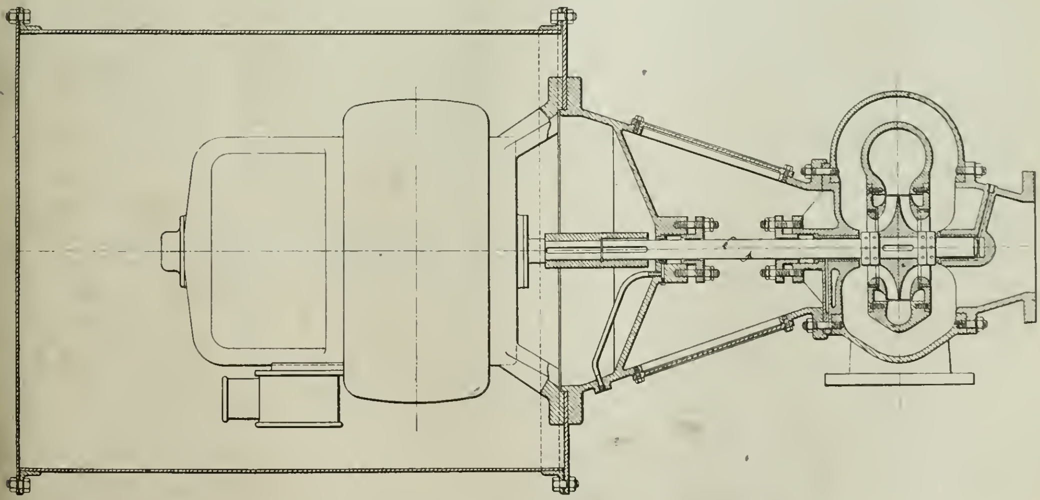

Fig. 2.—Section through the Equipment Shows Details of Intercepting Chamber and Pump.

In addition to its application on ship board, a pump of this kind can be usefully employed both on dock side and salvage work, and generally it may be said to form a combination of great utility for a variety of operations.

Some American Views on Railway Electrification.

(Communicated.)

The world-wide shortage of coal during the Great War has emphasised more clearly than ever the necessity of fuel economy in industry, while the certainty of its continuing scarcity throughout the reconstruction period forms another serious problem. Fortunately, we have at our disposal a means that will greatly assist in alleviating the condition, namely electrification. The use of electricity in industry saves both fuel and labour. This fact is recognised throughout the world to-day, and practically all nations are now considering plans for the electric generation of power. In England, Belgium and France, among others, these plans are being prepared under the ægis of the Governments or by official commissions, so that a tremendous activity in electrical power development may be expected with the stabilisation following the advent of peace.

The operation of the railways will naturally form an important part of any programme of general electrification, for in almost every country they form one of the largest users of fuel and labour. Nor are the advantages obtained from railway electrification limited solely to economy in fuel consumption and the more effective use of labour. Among others, the following advantages may be mentioned: (1) Greater speed of movement for the heaviest trains, due to the fact that electric locomotives can be made much more powerful than the largest steam locomotives; (2) greater nicety of control; (3) increased traffic capacity of existing tracks, terminals, grades, tunnels, and other points of traffic restriction, because when electricity is used, heavier trains can be operated at higher speeds and less time is consumed at terminals and in yards; (4) operation where the use of steam is impossible or objectionable, as in long tunnels; (5) independence of weather conditions, since the electric locomotive is not effected by cold weather; (6) more reliable operation, as proved by the statistics of all existing electrifications; (7) more effective use of all rolling stock, due to more expeditious movement of traffic.

Since the United States has an abundance of coal, railway electrification has been determined solely by local conditions. Passenger terminal problems caused the electrification of the New York Central at New York and the Pennsylvania at New York and Philadelphia. The limitations of the steam locomotive determined the electrification of the Baltimore Tunnel, the Cascade, the St. Clair and the Hoosac Tunnels. Examples of electrified railways with goods as well as passenger service are the Norfolk and Western, the Chicago, Milwaukee and St. Paul and the New York, New Haven and Hartford. While the other electrifications are successful and interesting, the last three are more properly representative of general railway electrification. The Norfolk and Western is an example of electrification under the heaviest conditions of freight traffic on a mountain grade. The Chicago, Milwaukee and St. Paul has in operation the longest continuous mileage in the world, and when completed will cross five mountain ranges. The New York, New Haven and Hartford has a very large movement of both freight and passenger traffic. All three installations are successful and profitable, and, when financial conditions are stabilised and the American railway question is settled, it is expected that all three will extend their electrified service. In addition, there are sections of railways about the country where the present congestion of traffic or the availability of water-power warrants the early adoption of electric power. These possibilities alone promise under normal conditions of finance (as no engineering problems now remain to be solved) extensive activity in the electrification of railways for many years to come.

Differing from America, European and South American countries, with the exception of England alone, lack an adequate supply of fuel, but many of them including Norway, Sweden, Switzerland, Italy, Spain and Brazil, have large amounts of water power, while France has a moderate amount. These resources, combined with the high cost of fuel, make extensive railway electrification in these countries inevitable sooner or later. The neutral countries will probably be the first to undertake this work. Switzerland has a programme covering a term of years well established, while both Norway and Sweden are giving active consideration to definite projects. In England, a considerable amount of electrification is in contemplation along with the general plan for the electrification of industry. A French Commission, composed of Government and railway engineers, has already visited the United States in order to familiarise themselves with American practice. The Italian Government will continue their definite programme as soon as financial conditions permit. An official Belgian Commission is planning to rehabilitate with electric power at least a portion of the railways destroyed by the Germans. In Spain, Brazil and South Africa as well, railway electrification is under active consideration. It is evident, therefore, that the next decade will see a large amount of railway electrification in almost every quarter of the world.

The Committee appointed by the Board of Trade to inquire into the Non-ferrous Mining Industry have held several sittings. Mr. H. Rich, a director, and Mr. W. Thomas, general manager of the Tincroft Mines (Ltd.), gave evidence in favour of the amalgamation of the mines in the central district. Mr. Rich said the Government should make a grant of £1,000,000 for this purpose. He thought that, in view of the services rendered to the country by the Cornish tin mining industry in the time of national emergency, the sympathy of the Government should assume practical shape in the manner indicated. Other witnesses gave evidence as to the working of particular mines, and pleaded for Government financial assistance.

The "City" Lantern.

In order to keep abreast with the efforts being made by high pressure gas authorities to push their particular form of illuminant and to assist electrical engineers to obtain the best light with the minimum of expenditure, the General Electric Company have recently designed a new form of lantern for use with Osram lamps (Atmos type) up to 1,500 watts. In this lantern, which is known as the "City," the contours of the reflecting surfaces are such as to give the wide angle of distribution necessary for efficient street illumination, and are finished in white vitreous enamelled steel, which make it easy to clean. Fig. 1 shows the general arrangement of the lantern, and Fig. 2 the distribution of light obtainable. To obtain this distribution of light it is essential that the filament of the lamp should be placed in the correct position relative to the reflector, and for this purpose a focusing device has been designed. This consists of a spring ratchet which holds the lamp in the correct position after it has been screwed into the holder.

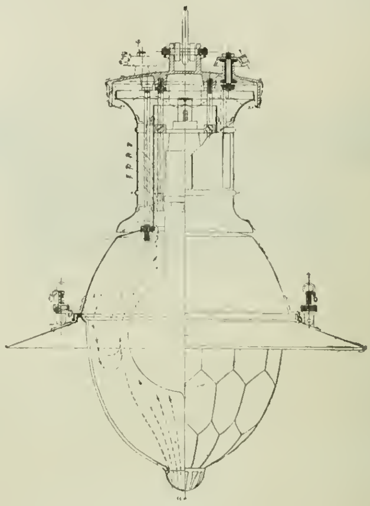

Fig. 1.

Another feature of this lantern is the ventilating device which is designed to give the maximum flow of cool air round the lamp bulb and yet maintain the whole weather-proof. This consists of two cylinders containing slots which prevent the "trapping" of the hot air in the dome of the lanterns, and thus overcomes a disadvantage which is sometimes met with in a number of the earlier designs.

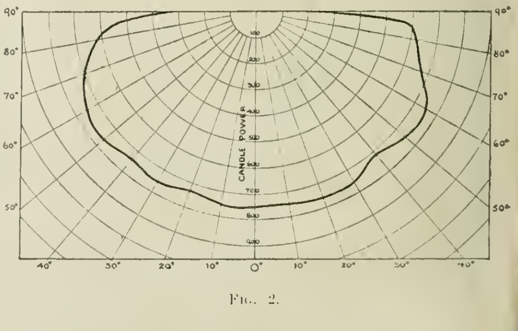

Fig. 2.

The standard "City" lantern is supplied with clear flint well glasses, unless opalescent glasses are particularly required. These globes are wired to minimise danger through breakage whilst suspended, and the lip of the glass is covered with a special U section rubber band, which, in addition to making a water-tight joint between the glass and the lantern, guards the rim from breakage. The glass can be lowered for cleaning to the extent of the two safety chains by simply loosening two milled nuts.

Legal Intelligence.

C. F. Elwell v. Universal Radio Syndicate, Ltd.

In this action, which came before Mr. Justice Roche last week, plaintiff sought to recover salary due under an agreement dated July 21, 1913, as varied on or about April 27, 1915, for goods supplied to defendants, and moneys paid at the request of defendants. Defendants counter-claimed for an account of all orders received by plaintiff for the supply or erection of wireless installations or apparatus whilst in the employ of defendants, and of all profits received by him ; for a declaration, that plaintiff was trustee for defendants of such profits ; and for damages for alleged breach of contract. Defendants alleged that plaintiff, who was engaged by them as an engineer, became aware that the French Government desired to have Poulsen apparatus installed on the Eiffel Tower, and they were seeking tenders for that purpose, and it became the duty of plaintiff to inform defendants, and to use his best endeavours to enable them to secure the order. It was alleged that the plaintiff, in breach of duty, failed so to inform defendents, and without their knowledge or consent, went to Paris and tendered in his own name for the contract. Defendants further alleged that without their knowledge or consent, plaintiff tendered to the British Admiralty for the supply of wireless apparatus and installations.

As plaintiff's claim for a month's salary was admitted, Mr. Douglas Hogg, K.C., opened defendants' counter-claim. He said defendants' case was that Mr. Elwell had got contracts (the profits of which they could not tell) which they said he had no right to take, as he was their servant at the time of getting them. The defendant syndicate was formed on Sept. 20, 1912, for acquiring patent rights in the Poulsen system of wireless telegraphy. In addition to obtaining patent rights for a limited period, it had also to erect installations and to exploit the Poulsen invention. That arrangement ran till March 1, 1914. It was afterwards extended to Sept. 1, 1914. The syndicate were anxious to erect an installation at Horsea Island for the British Government. The Admiralty had investigated the working of the Poulsen system in California by the Federal Telegraph Company, and they stipulated that if they gave the syndicate a contract the Federal Telegraph Company's engineer should supervise the work that was done. On July 31, 1913, an agreement was made between defendants and Mr. Elwell, by which they undertook to employ the plaintiff as their engineer, and plaintiff agreed to devote the whole of his time, attention and abilities to defendants' business, and to use his best endeavours to promote their interests. In addition to the installation at Horsea Island, his clients were anxious to get an installation erected on the Eiffel Tower. They alleged that, having covenanted to devote his whole time to their employment, any profit made by Mr. Elwell when he ought to have been working for them was profit of which he was trustee for them.

Mr. Francis Walrond, liquidator of defendant syndicate, gave evidence of its incorporation, &c. The British Admiralty said they wanted the designs as used by the Federal Company of America, and they made it conditional that an American engineer should be appointed to supervise any contracts which they might give defendants. In July, 1913, the syndicate appointed Mr. Elwell engineer, and they afterwards entered into a contract with the Admiralty. In 1913 they were in communication with the French Government. In December, 1914, they had failed to come to terms with the patentees, and a meeting was held for passing a resolution to wind up the company, which was confirmed in January, 1915. Witness wrote and told Mr. Elwell that the company had gone into liquidation. On Jan. 25 they got an Admiralty contract, which was forced on them. They had the plans. The work was for national purposes, and further it was in the interests of the syndicate to do it. In February he had several conversations with Mr. Elwell, who refused to take less than £1,500 a year, but he offered to accept half-pay while on a holiday. In March witness received information that Mr. Elwell had gone to Paris. When plaintiff came back he said nothing about any French contract. On April 29 witness served Mr. Elwell with a notice terminating his engagement on July 31.

Witness, in cross-examination, denied that Mr. Elwell told him if he consented to a reduction of salary it would be on condition that he should be free to work for himself.

Plaintiff was called and gave evidence as to his conversation with Mr. Walrond on the question of half-pay. He said it was agreed that he (witness) should accept half-pay, and that he should be free to re-commence for himself, subject only to the fact that he was to look after the contract with the Admiralty. He completed the installation on the Eiffel Tower towards the end of December, 1915, and he obtained an Admiralty contract in connection with ships.

His Lordship, who said he preferred Mr. Walrond's version, and suggested an agreement between the parties as to the mode of settling the accounts.

Mr. Whitehead said plaintiff had already expressed his willingness to account for the profits if the defendants paid him for the work he did.

After consultation it was announced that the case had been settled. The record would be withdrawn, and plaintiff would pay a sum of money which was not mentioned. Any imputations would be withdrawn.

Electric Motor Contract.

In the Shoreditch County Court recently, Miss A. Joseph sued Messrs. Kelly & Tarshes to recover £24 damages in connection with the installation of a 3-H.P. electric motor with starter and pulley, guaranteed. Evidence was given that the motor was for driving a fur skin dressing machine. It did not go right from the start, and after many complaints defendants re-wound the machine, but it did not improve. Another firm was called in to effect repairs and was paid for this work. Mr. A. J. Barlow, electrical engineer, said the armature was wrong, besides other things, which he put right, and had been paid £24. 7s. 6d.

Defendants did not appear, and Judge Cluer gave judgment for plaintiff for £27. 7s. 6d. (including £3 overpaid) and costs.

Electricity (Supply) Bill.

Further progress with this Bill has been made by the Standing Committee of the House of Commons.

Amendments safeguarding the position in regard to the Electricity of the London County Council were inserted, Capt. C. E. W. Bowyer moved an amendment to Clause 11 precluding the Electricity Board from supplying, or offering to supply, electricity to any one who, at the passing of the Act, was being supplied by any authorised distributors under contract, so long as such distributors were willing and prepared to give such supply. He said it was unfair to leave district boards in a position to offer to supply better terms than existing distributors who, having expended considerable sums in putting them in position to give perhaps large supplies on low terms for long contracts, might find those customers taken from them by more favourably placed district boards.

Mr. Shortt pointed out that there was no necessity for the amendment. No existing contracts could be broken without rendering parties liable to the ordinary operation of the law, and there was nothing in the Bill which would give any one any immunity in law from the consequences of such a breach. The Bill would give freedom to consumers who might contemplate the renewal of contracts, and to fresh consumers desirous of making them.

After discussion the amendment was withdrawn, and the clause was then passed.

Considerable discussion followed on a proposal to postpone consideration of Clauses 12 and 13 on the ground that many of the amendments thereto had only been put down the previous night, and there had been no opportunity to consider them. The clauses in question deal with the method and terms of transfer of existing undetrtakings to district boards, where such transfer is desirable in the public interest.

On Tuesday Captain Bowyer moved an amendment providing that the right of transfer under the Electric Lighting Acts to the District Board should not be exercised until the expiration of not less than 50 years from the passing of the Act, and that the right of purchase at the end of the period should be exercisable on the terms of Section 2 of the Electric Lighting Act, 1888.

Mr. Shortt said it was proposed to give the companies an extended lease of life, and no consideration was to be given in exchange, while at the end of the period the compensation would be on the same terms as they would get if their period expired five years hence. Under an amendment which he had put down, if the companies agreed they could be taken over at once, when they would get their capital back.

Captain Bowyer withdrew his amendment.

On Wednesday Mr. Shortt proposed an amendment to add at the end of sub-sec. (a) of sec. (2) of clause 12 (which deals with cases where the area of a local authority is partly in the district of one electricity board and partly in that of another), the words "and when part of such area is situate in a locality which is not included in an electricity district the right of purchasing that part may, if the Electricity Commissioners consent, be transferred to a district electricity board within whose district any part of such area is situate. The amendment was carried.

Mr. Shortt also proposed to add at the end of sec. (3) of clause 12 a provision that where a generating station or main transmission line is over and vested in an electricity board, the board shall, if so required within *12 months* by the company or person from whom it is taken over purchase the whole of the remaining part of the undertaking upon payment of a sum equal to the capital expenditure on the whole undertaking less any sum paid or payable as purchase money in respect of any generating station or main transmission line. Mr. Shortt said the intention was that the value of the undertaking should be taken to be the capital represented by existing assets.

A proposal by Sir Fredk. Hall that *two years* be substituted for the words *twelve months* shown in italics in the above paragraph was adopted.

Mr. Shortt's amendment was carried as amended.

Clause 13 in the draft of the Bill provides that the Electricity Commissioners may exclude from the area of a power company part of that area which is not being supplied by the company, and which it appears to the Commissioners could be better served by the Electricity Board, and in consideration therefor may confer on the power company power to supply electricity for *lighting purposes* in other parts of their area of supply. On the motion of Mr. Shortt, *all purposes* was substituted for *lighting purposes*.

A further amendment proposed by Mr. Shortt, to be added at the end of Clause 13, was carried. Its main provisions are that where a generating station of a power company is vested in a district electricity board the date fixed for the vesting thereof shall not be earlier than one year after the order constituting the board comes into operation, and if within that year the power company so require, the district electricity board shall purchase the whole of the undertaking of the power company upon the terms of paying to the power company the fair market value of the undertaking as a going concern at the date of the constitution of the district electricity board.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

132,542 Slack. Cleaning or renovating carpets. (7/2/17.)

132,548 Marconi Wireless Telegraph Co. of America. Method of and apparatus for receiving radio signals. (19/7/17.)

Relates to a method of reducing interference in radio communication, which consists in receiving static and similar disturbances in such a manner that a plurality of electric impulses are created in the system by each disturbance at substantially the same instant, combining said impulses in such a manner that substantially no effect is produced thereby on the detector circuits of the system, receiving signal waves in such a manner that a plurality of electric impulses is created in the system by each wave at different instants of time, and influencing the detector circuits by impulses from said waves.

132,561 Jenkins & East Stratford Works. Electrolytic cells. (20/6/18.)

132,562 Western Electric Co. High-frequency signalling. (24/6/18.)

132,567 Ewen. Means for measuring electrical currents. (19/7/18.)

132,574 & 132,575 B.T.-H. Co., Hastings & Martin. Starting devices for alternating current dynamo electric machines. (14/8/18.)

132,579 Cleverley. Detachable clips for attaching electric cables to balloon cables. (15/8/18.)

132,607 Aldred. Dynamo-electric generators and motors. (18/9/18.)

132,610 B.T.-H. Co. & Hastings. Electro-magnetic switches. (18/9/18.)

132,616 Bibby & Boving. Electric blast furnaces. (20/9/18.)

132,630 Pessell & Pessell. Appliances for operating signals and telephonic codes. (27/9/18.)

132,633 Clifton, Cox & Cowell. Electric bells. (28/9/18.)

132,635 Lawton & Hampton. Electric furnaces. (28/9/18.)

132,638 B.T.-H. Co. Manufacture of incandescent electric lamps. (1/10/18.)

120,901 Scintilla (Firm of). Magnets of magneto electric ignition apparatus. (6/11/17.)

132,665 British Lighting & Ignition Co. & Bennett. Means for securing the pole-shoes of a magneto machine. (14/11/18.)

132,668 Latour. Audion or lamp relay or amplifying apparatus. (17/11/17, addition to 3,140/18.)

132,673 Barbour & Partridge. Transmission of a rotational or turning movement in electrical switchgear. (23/11/18.)

132,678 Graham. Shock absorber and protector for electric lamps. (30/11/18.)

132,700 Moss. Couplings or connectors for electric lighting wires, cables and the like. (9/1/19.)

123,734 Girardeau. High-frequency generators. (14/2/18, addition to 12,809/13.)

132,715 Hughes. Electric bell construction. (19/2/19.)

128,543 British Westinghouse Electric & Mfg. Co. Rotary electric converters. (17/6/18.)

130,598 Aktiesolaget Svenska Kullagerfabriken. Pawl and ratchet gear having an electro-responsive releasing device. (27/7/18.)

1919 Specifications.

132,818 Waters. Electric signalling apparatus. (17/11/17.)

116,088 Allgemeine Elektricitats-Ges. High-frequency dynamo electric machine with turbine drive (24/1/17.)

132,840 Marks. (Splitdorf Electrical Co.) Ignition devices. (20/8/18.)

132,876 B.T.-H. Co. (G.E.C.) Alternating electric current machines. (25/9/18.)

Comprises a machine provided with nine terminals and connected to corresponding terminals of one winding of a transformer, said winding comprising two groups of mesh connected windings, one group consisting of six windings having windings of alternate large and small number of turns, the ratio of the large number of turns to the small number being substantially as two to one; the other group consisting of three windings having equal number of turns, the ratio of the last said number to the smaller number of turns in the six winding group being substantially as two and a half to one.

132,879 Crosby. Electric furnaces. (25/9/18.)

132,903 Automatic Telephone Mfg. Co. & Remington. Electric signalling systems such as are used in mines. (8/10/18.)

120,561 Akt. Ges. Brown, Boveri et Cie. High-tension distributor for multi-cylinder internal-combustion engines. (20/10/17.)

132,909 Electrical Improvements & Beard. Protective arrangements for electric distributing cables and the like. (12/10/18.)

132,928 Collie. Spring contact clips for replacement electric fuses. (11/11/18.)

132,936 Railing, Garrard & Searle. Electric switches. (19/11/18.)

132,956 Neale. Electrical means for locating masses of metal. (18/12/18.)

133,002 Jorgensen. Electric supply systems for use on ships. (20/5/19.)

133,010 Stalnane & Kring. Contact pins for electric connecting plugs. (19/6/19.)

132,938 Kemp & Burnand. Electrically propelled vehicles. (22/11/18.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

September 20, 1919.

23,150 Calvert. Electric heating of water.

23,169 Riley. Portable electric lamps.

23,193 Desplats. Combined automatic switch or button for electric bell.

23,195 McKim. Locking strap for magnetos.

23,209 Smeddles. Trollies or current ocllectors for electric trams, &c.

September 22, 1919.

23,223 Baydon. Vacuum tubes, &c.

23,254 Hodgson. Radio instruments.

23,260 Potter. Secondary generator.

23,270 Bradshaw. Electrically driven talking machines.

23,274 Pfester & Phillips. Electrical indicating number switch.

23,275 Redsnaw. Variable inductances for wireless telegraphy, &c.

23,279 Berwick & Sizairr. Electric sirens.

23,292 B. T.-H. Co. (G. E. Co.) Welding machines.

23,313 Gill. Wireless telegraph receivers.

September 23, 1919.

23,319 Stopford. Apparatus for detecting temperatures of demagnetisation of steel, &c.

23,321 Fox. Trolleys for tramways.

23,324 Taylor. Improving current carrying capacity of existing three-phase systems.

23,345 Matson & Roberts. Electric telegraph sending key.

23,377 Fletcher & Green. Cut-outs.

23,396 Uren. Protective fuses for electric circuits.

23,406 Smart & Tucker. Telegraph or telephone recorders, relays, &c.

23,425 Hooper & Hobley. Electrical indicators, &c.

September 24, 1919.

23,440 Kirkland & Tidswell. Trolley heads.

23,450 Austin Motor Co. & Walker. Electric generating plants.

23,470 Assersohn. Lamp-holders, &c.

23,495 Bastian. Electric heating stove or fire.

23,510 Franklin. Aerial systems of wireless signalling.

23,522 Akt. Ges. Brown, Boveri et Cie. Electrical propulsion of ships. (1/10/18, Switzerland.)

23,538 Smith. Apparatus for operating points of tramways, &c.

23,450 Brown. Relays.

Commercial Topics.

An Important Engineering Amalgamation.

It is announced that negotiations are proceeding, and are practically completed, for the absorption of the business of Messrs. Brown, Boveri & Company, by Messrs. Vickers, Ltd. It will be remembered that the former firm were recently successful in securing, in competition with British firms, a contract for the supply of three turbo-alternators to the Edinburgh Corporation, and the amalgamation, or working arrangement, will have important consequences for the British electrical industry.

* * * *

A Brussels Commercial Fair.

The Brussels Municipal Council is organising a commercial fair, which will be held in April, 1920. It is hoped to make the fair, which is under royal patronage and supported by the Government and the Province of Brabant, an annual one, and the first fair will be open to Allied and Neutral countries. Its object is the bringing together of actual manufacturers and buyers. Business will be done from samples, models, designs, &c.; the sale of goods at the fair is strictly forbidden. Exhibits will be divided into groups. Firms must indicate the origin of the goods they desire to exhibit, and if required by the committee must produce certificate of origin. Copies of the regulations (in French) and forms of application for spaces may be consulted at the Inquiry Office of the Department of Overseas Trade, 4, Queen Anne's-gate Buildings, S.W. 1.

* * * *

Private Bill Procedure.

In consequence of the passing of the Ministry of Transport Act, 1919, it is proposed to make important changes in the Standing Orders of the two Houses of Parliament which will affect the procedure in regard to private bills. It will be provided that copies of every local bill relating to railways, tramways, canals, waterways or inland navigations, roads, bridges or ferries, or vehicles or traffic thereon, or to harbours, docks or piers, shall be deposited at the office of the Ministry of Transport; of every such measure measure relating to gas, water or patents, or to the generation or supply of electricity, or for incorporating or giving powers to any company, at the office of the Board of Trade; and of each one relating to the generation or supply of electricity at the office of the Commissioners of Works as well as the Board of Trade.

* * * *

Trade with South Russia.

As the South of Russia has now been cleared of the Bolshevik forces there should be opportunities of securing contracts for the supply of electrical engineering plant in that area. In this connection it is interesting to note that several of the railway companies and Government, industrial and other establishments in South Russia have formed an Association, with a capital of 50,000,000 roubles, for the purpose of making purchases abroad of machinery, railway plant and other goods required. It is proposed to work the scheme on the barter principle, and as some of the members are very influential they may succeed in obtaining the necessary goods for transport. The temporary head office and title of the association are as follows: The buying Committee of the Economic & Technical Association of the liberated Provinces of Russia, 116, Bolshaya Sadovaya-street, Rostov-on-Don.

* * * *

Hydro-Electric Works in Bolivia.

In a recent issue we pointed out that the possibilities of extending the export trade in electrical plant and machinery in Bolivia were good. We now learn that the Bolivian Chamber of Deputies is considering a Bill to authorise the development of the country's numerous waterfalls in the generation of electric current. A preliminary survey of the available sources of water power has been made by a British engineer, and owing to the lack of native coal and oil it is recommended that the Government should defray the cost of a detailed survey of the available falls and also the expense of hydro-electric schemes and installations. The country is rich in mineral resources, but it lacks modern scientific equipment. The Bolivian General Enterprise, a British company operating chiefly with French capital, is the only big electrical company in the country. The company supplies the municipality of La Paz with about 1,500 kw. for traction and light, but the plant capacity is 3,000 kw. It is stated that there are good possibilities of hydro-electric development in three main localities—La Paz, Tres Cruces and Colquechaca. For La Paz, power would be obtained from the Yungas River, and could also be used for the Yungas Railway (now under construction) and the Corocoro copper mines, as well as supplying cheap current for heating cooking, lighting and industrial purposes. There should also be a good demand for electrical apparatus and accessories in the city. In Tres Cruces, a rapidly developing mining region, a large number of mines require power and light; a tramway is needed to connect with the town of Oruro, and another with Cochabamba. The Cochabamba Valley railroad, a narrow gauge line, needs capital to complete the electrification of its system and to reconstruct and widen its lines. The wealthy mining district of Colquechaca also needs electric current for power, heat and traction. A railway extension to Uncia, another rich mining centre, is urgently needed, and there should be improved communication with the city of Sucre. In each case there is an abundance of water-power available.

According to estimates the cost of hydro-electric plants in the three regions named would be £2,000,000 sterling. "The Times" trade correspondent states that as hydro-electric power is the best solution of Bolivia's transport, lighting and heating problems, there is little doubt that Government encouragement will be given to sound and comprehensive schemes. If British firms want to have a share in this highly promising work, steps should be taken to secure representation in La Paz.

Electricity Supply.

CULLINGTON Urban Council has decided to apply for a provisional electric lighting order.

It is proposed to install electric light at the Primitive Methodist Church and School, BRIERFIELD.

A local company, with a capital of £4,000, is being formed at CAVAN for the purpose of establishing electric supply works.

PENANG Municipal Council is raising a loan of £250,000 for extensions of the electric supply undertaking, for new drainage works, &c.

An inquiry was recently held at BATH into the application of the Corporation for sanction to borrow £30,404 for extensions of the generating plant.

An inquiry has been held at ST. HELENS into an application of the Corporation for sanction to borrow £57,100 for extensions of the electric supply undertaking.

In consequence of the recent temporary failures of electric supply at ACCRINGTON it has been decided to make a connection with the Rawtenstall supply system.

WIMBLEDON Corporation has referred back a recommendation of the Electric Lighting Committee to fix a minimum charge of 13s. 4d. per quarter for electric current.

Owing to the high price of gas, WIGTON Urban Council has asked the surveyor (Mr. J. J. Davison) to prepare a report upon the question of lighting the town by electricity.

The Corporation of BASINGSTOKE propose to expend £12,000 on extensions of the electricity undertaking, and an inquiry has been held into the application for sanction to borrow this sum.

CROYDON Corporation has decided to replace some of the transformers put in during 1905 and 1906 by a more efficient type. The cost will be £2,025, and will be charged to reserve and renewals fund.

ASPATRIA Urban Council has decided to call in an electrical engineer to report upon the advisability of establishing electric supply works, and the Gas and Lighting Committee has been instructed to make the appointment.

At a recent meeting of residents it was decided to form a local company, with a capital of about £2,000, at TARVES (Aberdeen), for the purpose of establishing a small electricity station for supplying current fo lighting. It is thought that electricity can be supplied at 1s. 3d. a unit.

COLNE Electricity Committee has adopted a revised scheme for transforming plant and mains, and application is to be made for sanction to borrow £37,648 for the work. A recent extension scheme was rejected, but it is now proposed to take a supply in bulk from a neighbouring authority.

At LOUTH (Lincs) the Council is considering the question of electricity supply, and as several factories are to be erected in the town it is essential that a supply should be available for power and lighting purposes. A local company has submitted proposals to the Council, which also proposes to erect 50 new houses in the district.

In a report to OLDHAM Electricity Committee, Mr. Robert Blackmore, consulting engineer, suggests the advisability of erecting a new generating station to meet the future demand for electrical current. He considers that there is no area in the whole country where the horse-power per acre will reach the high figure that obtains at Oldham.

CRICCIETH Town Council is embarking upon a housing scheme and other improvements, and at the last meeting Mrs. Lloyd George spoke strongly in favour of an electric light scheme. She said she felt that they as a Council should obtain expert opinion on the water power at Rhydybenllig, which could be utilised in generating electric current.

Several applications for a supply of current for power have been received by BURNLEY Electricity Committee from local cotton mills, but owing to the inadequacy of the present plant the Committee have been compelled to refuse them. As the consumption is on the increase and in future is likely to grow considerably larger, a sub-committee has been appointed to consider the question of extending the plant at the electricity works.

EDINBURGH City Council has approved the draft of a provisional order for extending the boundaries of the city, so as to include the burgh of Leith and Musselburgh and certain suburban districts of Midlothian. Application is to be made for authority to construct the following tramway extensions—viz., (1) from the tramway terminus at Nether Liberton to the cross roads on the main Liberton-road; (2) From Craiglockhart to Colinton; and (3) from King's-road, Portobello, to Seafield. It is proposed also to obtain powers to run motor omnibuses on five routes.

YORK City Council proposes to erect a hydro-electric station on the River Ouse at Linton Locks, about 10 miles above the city, and on the 30th ult. Col. T. C. Ekin held an application for sanction to borrow £46,610 for the purpose. The Electric Lighting Committee has been considering the utilisation of available water power and for schemes for harnessing the power on the weir at Naburn Lock (below the city) and the weir on the Derwent at Stamford Bridge are also proposed.

The Town Clerk, Mr. P. J. Spalding, explained that the enormous increase in the cost of coal encouraged the Corporation to go on with the scheme, and to utilise all their natural resources. It was estimated that they could save several thousands of tons of coal yearly by the scheme. It was proposed to turn the water from the present main stream into a new cut to be made in the island between the lock and the weir, which would give a flow of 100,000 cubic feet of water per minute. The length of the transmission cable from Linton to the sub-station at Lendal Bridge would be 15,000 yards.

Mr. J. W. Hame, City Electrical Engineer, gave technical details and said the power obtainable was estimated to vary from 150 to 2,000 h.p. the proposal being to utilise up to 1,350 h.p. There would be a power house on the island with a turbine pit, a head race through the island, generators and a transmission plant, and a transmission cable to York. The four turbines—two of 30,000 cubic feet per minute and two of 20,000—would give a total capacity of 100,000 ft. Allowing for loss in transmission (about 7 per cent.) there would be 3,300,000 units available for distribution, equal to a third of the present total requirements of the city. The Corporation would also be able to supply power to the villages en route from the new station to York. They estimated a saving of £5,500 per year in coal alone, and there would be saving in repairs and maintenance of steam plants, and it would be possible to shut down the existing generating plant over week-ends at certain portions of the year. The estimated cost of £46,610 was distributed as follows: Excavation and foundation of buildings, £12,370; mechanical plant, £12,920 electrical plant, £10,620; overhead line, £7,110; contingencies, £3,590. The works cost of the existing steam power station was £43,200. There would be a gross saving shown on working costs of £4,760 a year, and the annual saving when the Linton scheme was paid for would be £5,000.

Electric Traction.

Owing to increasing running costs, &c., CHESTERFIELD Corporation has revised the tramway fares as from Dec. 1.

Owing to the expense of horse and cart collection, BARNES Urban Council has decided to purchase an electric tractor.

The Tonbridge Chamber of Trade is strongly in favour of ELECTRIC TRACTION on the RAILWAYS, and especially on the S.E. & Chatham lines. The National Chamber of Trade has been invited to ask their provincial branches to consider the matter with a view to more efficiency of transport.

The chairman of BIRKENHEAD Tramways Committee has stated that the municipal tramways undertaking will be free of debt and a clear asset to the town within eight years. The system is in a fairly satisfactory position, and it is estimated that this year between 23,000,000 and 24,000,0600 passengers will be carried.

Owing to the introduction of the eight-hour day on the tramways, railways and omnibus services of the UNDERGROUND ELECTRIC RAILWAYS COMPANY OF LONDON, an additional expenditure is incurred of nearly £700,000 per annum, and approximately 20 per cent. more staff are required to work the services.

The Minister of Transport has decided to establish an Advisory Committee on London Traffic, of which Mr. Kennedy Jones will be chairman. The other members are Sir Henry Maybury, Admiral Sir Charles Bartholomé, Mr. G. H. Hume, Mr. E. Underwood, Ald. Francis Dent and Mr. Will Thorne, M.P.

The LONDON COUNTY COUNCIL will apply in the next session of Parliament for the removal of the limitations imposed by the Council's Act of 1912 in respect of the use of the tramways in Tooley-street between Bermondsey-street and Joiner-street.

On Tuesday the Council adopted the report of the Highways Committee recommending the tramway extensions set out in our last issue.

LANCASTER Council has discussed a report of the Tramways Engineer as to the cost of substituting petrol omnibuses for the present electric tramways. Councillor Smith said the town was not suitable for tramways, but he favoured electric rather than petrol omnibuses. According to the report £13,500 could be realised by sale, and to put the system in order would cost £25,000. The report has been referred back for reconsideration.

Owing to the satisfactory experience which SHEFFIELD Corporation has had with electric vehicles, in the collection of house refuse, it has been decided to increase the present fleet of 12 vehicles to 66, and to abolish horse-drawn wagons. For the normal work of the cleansing department 60 electrics will be required, but it is proposed to keep a margin of 10 per cent. for emergencies and to cover breakdowns. It is also proposed to equip a suitable garage and to put in three additional 100 kw. motor-generators for charging batteries, &c. The total cost of the scheme, which will be carried out gradually, is estimated at £100,000.

It is announced that the directors of the NORTH-EASTERN RAILWAY COMPANY have provisionally sanctioned a scheme for adopting electric traction on their main line between York and Newcastle (a distance of 80 miles). The scheme has been prepared by Sir Vincent Raven, chief mechanical engineer, in consultation with the company's consulting electrical engineers, Messrs. Merz & McLellan. The scheme also provides for the electrification of the loop line (31 miles in length) from Northallerton to Ferryhill via Stockton. Hitherto the experience of the company with electric traction has been confined to working dense local passenger traffic on Tyneside between Newcastle and Whitley Bay, and of mineral traffic between Shildon and Newport (Middlesbrough). The former was opened in March, 1904, and the latter in 1905. In both cases the results obtained have proved very satisfactory. No other company in Great Britain has, however, experimented with electric haulage of freight trains. On Tyneside the third rail system is in use, but between Shildon and Newport overhead electrical equipment has been adopted. A combination of the third rail and overhead system will now be adopted, the general idea being that the former should be used on running lines and the latter in goods yards and at large stations. All trains will be hauled by locomotives.

Imperial and Foreign Notes.

Mr. C. H. Merz has been appointed consulting engineer to Cape Town City Council in order to advise generally on the development of the electric supply undertaking. Mr. Merz will receive a fee of £600 per annum plus travelling and other expenses.

It is proposed to erect a hydro-electric power plant capable of developing 160,000 H.P. at Little du Bonnet Falls, on the Winnipeg River, north-east of the city of Winnipeg. There will be eight 21,000 H.P. turbines, and the total cost is estimated at $9,000,000.

According to Sir William Hearst, Premier of Ontario, one home in every two in the rural district of the province has a telephone. If this statement be correct, and there is no reason to doubt its accuracy, the position of affairs is very much better than in this country, where very few farmers have telephone facilities. The telephone is essential for farmers and market growers, and pressure should be brought to bear upon the Postmaster-General to improve, not only the urban, but the rural telephone service.

New Zealand Dominion Government recently purchased the Horahora hydro-electric undertaking, at £212,500, from the Waihi Gold Mining Company, and took possession of the installation on Oct. 1. The Government will make arrangements to give the company all the power it requires, distributing the remainder for domestic and industrial uses in the towns of the Hauraki district and in urban and rural parts of the Waikato. The total sum expended on the works by the company was about £200,000, and the present plant is capable of developing about 9,000 H.P., but the addition of two more units would give an additional 3,000 H.P. The Waihti Company's maximum demand is about 4,000 H.P. The transmission line to Auckland will follow the railway line, and supply Cambridge and Hamilton and several smaller townships between Hamilton and Auckland. The distance of Horahora from Auckland is over 100 miles. The purchase is looked upon as an important matter for the Auckland Province, as the Horahora scheme promises to be the means of supplying an almost unlimited supply of electricity for the industries of the province and the city, and should, within a short time, place the province in as good a position in regard to hydro-electric power as Canterbury now is as a result of the Lake Coleridge scheme.

In consequence of the damage caused during an air raid in February, 1918, the hydro-electric power station building at Padua has collapsed and toppled over into the canal. A huge crevasse was discovered in one of the main walls, but before steps could be taken to repair it the whole building crashed.

As a result of the preliminary investigations of the "Committee of Study and Research" for the practical application of hydro-electric forces by Utilising Tidal Forces, M. Cels, Under Secretary of State for Public Works, has decided to arrange for experiments for that purpose. These experiments will be conducted off Cape Finisterre, and in Saint Briso Bay (St. Malo).

Under a French law, promulgated on the 8th ult., the term of French patents, which had not expired prior to Aug. 1, 1918, and patents issued or applied for subsequent to that date and before Aug. 1, 1919, may now be extended on application, when it can be proved that the patentees or holders of the patent rights have not been able, owing to war conditions, to work their patents normally. The "Board of Trade Journal" states that the extensions are subject to numerous conditions and formalities, and those interested would do well to consult a competent firm of Franco-British patent lawyers.

The following goods may be imported into Poland without import permit :—

Various accessories for electrical installations (except chandeliers, lamps and glass shades), electric bulbs and hand lamps ; cables and insulated wires ; engineering supplies, including belting, rubber hose, robber articles ; automatic fire extinguishers ; emery and carborundum grinding wheels, graphite crucibles, &c. ; various kinds of small tools (except hammers, files, axes and pickaxes) ; meteorological, physical and mathematical instruments and apparatus ; weighing and measuring apparatus, clock mechanisms ; raw and semi-manufactured metals, including copper, aluminium, nickel, lead, tin, wolfram, ferro-manganese, ferro-silicon, iron ores and tool steel ; also china clay, celluloid, indiarubber, caoutchouc, &c.

By an Italian Royal Decree of Sept. 2 important regulations are laid for the supply of Telephone Material to the Italian State Administration. We learn drom the "Board of Trade Journal" that the supply of plant and all work in connection with the telephone service will be confined to national industry whenever, in the judgment of the Telephone Administration, such a course is feasible. By "national industry" is meant companies which manufacture in Italy, with Italian capital, Italian overseers and Italian labour, and employing, so far as possible, material of national production. After national industry, preference will be given to those firms, whatever their origin, or from whatever source their capital is drawn, which possess and work in Italy establishments for the manufacture of material required and which produce such material with overseers and labour for the most part Italian. The mere assembling of parts from abroad does not give the preferential right referred to. Whenever it is necessary to call for competitive tenders, the following preferences will be granted : (*a*) A protective margin in favour of national industry of 10 per cent. over foreign firms, and of 5 per cent. over those firms which, though not exactly national in character, manufacture in Italy. (*b*) A protective margin of 5 per cent. in favour of the last-mentioned firms over foreign firms.

Miscellaneous.

The British Cyanides Company has resumed the experiments on the Fixation of Atmospheric Nitrogen which were interrupted by the war.

At Manchester John Wm. Hewitt, cashier in the Corporation tramways department, has been committed for trial on charges of embezzlement. Accused pleaded not guilty.

Marconi's Wireless Telegraph Company now accept messages for the United States of America, via their Trans-Atlantic Wireless Service between Ireland and Nova Scotia. The commercial rate is 4d. per word less than that charged by the Atlantic Cable routes.

The Minister of Labour (Sir R. Horne) introduced into the House of Commons on Monday a Bill to provide for the establishment of an Industrial Court and Courts of Inquiry in connection with trade disputes, and to continue until Sept. 30 next certain provisions of the Wages (Temporary Regulation) Act, 1918. The Bill was read a first time.

The Eastern Telegraph Company announces that the increase to the general delay on telegrams has been due to the recent interruptions of two main-line cables, which in both cases were caused by ships anchoring on the route of the cables and breaking them when lifting their anchors. These sections have now been restored, and an improvement in the times of transmission is expected shortly.

The Board of Trade are leaving Whitehall Gardens for their new offices in Great George-street. The President, Parliamentary Secretary, Permanent Secretaries, the Commercial Relations and Treaties, the Industries and Manufactures, the Power, Transport and Economic, Marine and Legal Departments, the Secretariat of the Board of Trade Council, the Board of Trade "Journal" and the Establishment Department will form the nucleus that is being transferred now, and more Departments will follow as further accommodation becomes available.

Some amendments of the Patents and Designs and Trade Marks Bills are being sought by the London Chamber of Commerce and the Association of British Chambers of Commerce. The proposed amendments include one to provide that in cases where patentees have been hindered from working or using their inventions during the war the term of the patents shall be prolonged. Both Bills received inadequate consideration in the House of Commons, and we hope that the House of Lords will find time to deal with these important measures more fully, and to include the proposed amendments.

The G.E.C. Social and Athletic Club held their first dance and social evening of the season at the Cripplegate Institute, Golden-lane, E.C., on the evening of the 31st ult. Nearly 200 employees and their friends were present to enjoy a most pleasant and successful evening. Mr. H. Hirst and his daughter (Mrs. Leslie Gamage) were present, thus once again, as on other occasions, showing their great interest in the Club. Musical items rendered by members of the staff were interspersed between the dances, and were so much appreciated that it is felt that a separate evening must be set aside later for a concert. In every way the event was an unqualified success.

At Wolverhampton Police Court, on Saturday, Mr. George Besant was summoned for non-payment of 5s. for the hire of an electric meter at his premises. Defendant said his account was marked "for the supply of electrical energy," and there was not a word about the meter. No current whatever had been burned through his meter, and there had been no expenditure whatever upon his meter since he had occupied the premises.

For the Corporation Mr. William Charlesworth, secretary to the Electricity Committee, gave evidence of resolutions passed by the Council increasing the charges for "all electricity accounts."

The Chairman said the meter charge was included in the gross charge, and was quite just, and an order for the payment of the 5s. claimed, with costs, was made.

On the application of defendant the Bench agreed to state a case.

The British Industries Fair, 1920, which will be held from Feb. 23 to March 5, is being organised in three sections, in London, Birmingham and Glasgow. The sections will be organised in groups of industries, and at the London Fair, which will be held at the Crystal Palace, the trades will include glassware, scientific and optical instruments, &c. The most important Fair from the electrical point of view is that which will be held in Birmingham. The trades to be represented in this section include lighting fittings for electricity, gas, oil, &c. ; cooking stoves and utensils, general hardware and ironmongery ; tools (hand) of all descriptions and small machine tools ; nautical instruments : machinery belting ; indiarubber goods ; motor-cycles and cycles : accessories for motor-cars, cycles and aeroplanes ; weighing and measuring appliances and instruments ; paints, colours and varnishes ; tubes in copper, lead, brass and steel, and pipe fittings ; architectural and ornamental metal work, &c.

At Glasgow the Fair will be held in the Kelvin Hall of Industry. The following will be the class of manufactures, and include textiles, chemicals, &c.

At Chesterfield Police Court, on Saturday, prosecutions arising out of the Oxcroft Colliery explosion, which occurred on April 6, were heard. The defendants were Mr. Geo. Anderson, agent, and Mr. R. M. Percy, late manager of the colliery, who were summoned for contravening certain regulations made under the Coal Mines Act, 1911, including failure to provide such efficient means for cutting off all pressure automatically from the part, or parts, of the system affected in the event of a fault, so as to prevent danger.

It was explained that the explosion resulted in six men losing their lives and six others being injured. It was alleged that there were no automatic device for cutting off the electric current from a number of sub-circuits. When the installation was examined a deplorable state of things was revealed. There was not a single fuse in the whole of the system, and the only way in which the current was automatically cut off was by means of a switch at the pit bottom, which was practically useless as a safeguard for the sub-circuits. The explosion was caused by an electric spark igniting the gas, and the importance of having the electric installation in good condition was therefore obvious.

Evidence was called, and after a hearing lasting over five hours all the summonses were dismissed.

An inquest was held at Burton on Friday last into the death of the two victims of the unfortunate tramcar accident on the 8th ult. Evidence showed that a Midland tramcar, which was ascending Bearwood Hill, stopped from an unaccountable failure of power, and, when the brakes were applied, ran backwards at a great pace along the rails to a curve at the bottom, when it overturned.

Mr. Wm. Lilley, assistant engineer of the Burton and Ashby Light Railway, said the cars were examined every day. The last time he examined the car in question was on Sept. 14, and he found all the gear underneath in a fair state of repair. After the accident, he examined the car and found all the electrical equipment in order. All the brakes were off, and he did not think that the overturning of the car would cause them to go off. If the motorman had made use of the brakes at his disposal in a proper manner there would have been no running back.

The driver of the car, who had been over 12½ years on the particular route, said the wet leaves on the rails cut out the power. He applied the magnetic brake, which proved effective for a moment, but the car a second later rushed headlong down the hill.

The jury returned a verdict of "Accidental death," and expressed the opinion that it should be compulsory for conductors to be on the rear platform when ascending all steep gradients.

Last week the Manchester Profiteering Committee investigated a charge brought against the Cinema Engineering Company by Mr. G. A. Haygarth. The latter stated that in September he sent a sample coil to the respondent firm and asked them to make six like it. When he received the invoice he thought the charge (£1 19s., less 6s. discount) exorbitant, and asked the firm to take the coils back, but they refused. Each of the coils weighed approximately an ounce, and he thought the best resistance wire of that size was, roughly 12s. a pound. He had since received a quotation from another firm who were prepared to make the lot for 3s. 6d.

It was said that the Electric Repair Company, who had made the coils to the order of respondents, charged them 18s., and it was contended that a profit of 15s. on this amount was not unreasonable, taking into account the skill needed for testing the coils. They were required for a kinema installation in a private house, and were of an unusual size, which had to be made specially.

The Sub-committee had decided that the charge was unreasonable, and must be reduced to 10s. The full Committee had also decided to recommend a prosecution.

Notice of appeal was given against the order to reduce the price.

Appointments Vacant and Filled.

A competent engineer is required by a company for its electric heating and cooking department.

An assistant works manager is required by a firm of scientific instrument manufacturers in the London district.

The Council of the Glass Research Association (7, Seamore-place, London, 1) require a director of Research and a secretary. Applications by Nov. 15.

Applications are invited for the position of principal of Wolverhampton Technical Schools. Salary, £750. Applications to the Director of Education, Mr. A. S. Elford, M.A., Town Hall, Wolverhampton, by Nov. 15.

A mains foreman is required for the Birmingham electric supply department, wages £4 10s. per week, plus 12½ per cent. Application forms from the Secretary of the department, 14, Dale End, Birmingham, and applications by Nov. 17.

Glamorgan Education Committee require two travelling lecturers for mechanical and electrical engineering. Salaries £250 per annum, rising to £450, with expenses. Applications to the Chief Education Officer, County Hall, Cardiff, by Nov. 12.

A professor of physics and electrical engineering is required at the Municipal Technical Institute, Belfast. Salary £600 per annum. Forms of application from the principal, Major Rupert Stanley, and applications must be in by Nov. 18.

Applications are invited for the position of lecturer in electrical engineering at the University of Cape Town. Commencing salary £350, rising after three years' service by annual increments of £25 to £450, plus war bonus. Applications to the Secretary, High Commissioner for the Union of South Africa, 32, Victoria-street, S.W., by Nov. 30.

Liverpool Tramway and Electric Power and Lighting Committee require a qualified engineer, with civil and electrical experience, to act as superintendent of the overhead line equipment, &c. Salary £500 per annum. Particulars from the General Manager, Corporation Tramways, 24, Hatton-garden, Liverpool, to whom applications by Nov. 12.

The Corporation of the city of Cape Town invite applications for the position of station engineer. Salary £600 per annum. Applications by noon Jan. 3, 1920, to the town clerk, Mr. J. R. Finch, City Hall, Cape Town. The Corporation also invite applications for the position of temporary assistant engineer in the electricity department, salary £60 per month. Applications to the town clerk (Mr. J. R. Finch) by noon of Jan. 10, 1920. In both cases British candidates must send in applications to the London agents, Messrs. Davis & Soper Ltd., 54, St. Mary Axe, E C., by Nov. 15.

Mr. R. H. Humphrey has been appointed lecturer in physics at the Sir John Cass Technical Institute, London.

The London County Council have approved the appointment of Mr. W. W. J. Studd as publicity assistant in the tramways department.

Dudley Education Committee has appointed Dr. J. H. Grindley, of Cork, as principal of the technical college, at a commencing salary of £700 a year.

Woolwich Borough Council has appointed Mr. D. Dunn as charge engineer, in succession to Mr. W. Scott, who has secured an appointment at Stepney, and Mr. W. H. N. Stiff has been appointed in place of Mr. C. Hobson, who has gone to the L. & S.W. Railway Company.

Tenders Invited and Accepted.

Manchester Tramways Committee invites tenders for the supply of permanent way special track work. Tenders to chairman by Nov. 11.

Kettering Urban Council require tenders by Nov. 13 for a cooling tower and foundations for the electricity department. Forms of tender, &c., from the Electrical Engineer.

Johannesburg (Transvaal) Council require tenders for copper wire, cable insulators and steel poles (contract 548). Tenders to the Town Clerk by noon Jan. 8.

St. Pancras (London) Guardians require tenders for the supply and fixing of an electrically-driven lift at the South Infirmary, Pancras-road, N.W. Particulars from the Steward.

Glamorgan County Council require tenders by Nov. 10 for electric wiring at Evanstown Council School, Gilfach Goch. Forms of tender, &c., from the Clerk of the Council, Cardiff.

The directors of the Sligo, Leitrim & Northern Counties Railway Company invite tenders (by Dec. 1) for Stores, including Electric Telegraph Materials. Tenders to the Secretary, Enniskillin.

Bolton Electricity Committee require tenders by noon Nov. 11 for the supply of an 8,000 kw. turbo-alternator, condensing plant, and four water-tube boilers. Specifications from the Borough Electrical Engineer.

Bradford Corporation invite tenders for supply of steel girder tram rails, tiebars, bolts and nuts, copper rail bonds, &c. Specifications from Mr. F. Marsden, city engineer, and tenders to the Town Clerk by Nov. 15.

Dundee Corporation require tenders by Nov. 20 for the supply and erection of steel work at Carolina Port generating station. Forms of tender, &c., from the General Manager of the Electricity Department.

The Victorian Railway Commissioners require tenders by 11 a.m. Jan. 7, for the supply of steel strand g.-i. wire (contract 32,718). Samples can be seen at the Contractors' Room, Railway Offices, Spencer-street, Melbourne.

The Cheshire Lines Committee require tenders by 10 a.m. Nov. 26 for one year's supply of stores, including telegraph materials, carbons, iron and lead tubes, oils, paints, &c. Specifications from the Stores Superintendent, Warrington.

The Great Western Railway Company invite tenders for Electric Wire and Cables, Telegraph Instruments, Apparatus, Ironwork and Tools, Drysalteries, &c. Tenders to the Secretary, Paddington Station, London, W., by Nov. 10.

Tynemouth Corporation invite tenders for the supply of some three-core insulated lead-covered cable for 6,600 volts, four pair paper-insulated lead-covered telephone cable and three-core cable carrying conductors for Merz-Price protective gear. Specifications, &c., from the borough electrical engineer, Mr. C. Turnbull, and tenders to the town clerk, Mr. Stanley Wilson, by Dec. 1.

Glasgow Corporation Cleansing Department require tenders by Nov. 12 for six months' supply of stores and materials, including electrical materials, iron and steel, ironmongery, oils, paints, &c. Specifications from the Superintendent of Cleansing, 20, Trongate, Glasgow.

Glasgow Corporation Cleansing Department also require tenders by Nov. 12 for electric light installation work at Kelvinhaugh Refuse Despatch Works. Specifications from the Superintendent of Cleansing.

The Australian Commonwealth Postmaster-General's Department, Melbourne, want tenders by 3 p.m., Nov. 25, for the supply of switchboard cable and switchboard parts (schedule 1,585). Specification, &c., from the General Post Offices, Melbourne, Brisbane, Adelaide, Perth and Hobart, and the Stores Branch, Sydney.

Tenders are also required by Jan. 20 for supply, &c., to the Australian Commonwealth Postmaster-General's Department, State of Victoria, of Automatic Telephone Switchboards at Collingwood, as per schedule 1,583. Tender forms, &c., from the High Commissioner, Room 406, Australia House, Strand, London, W.C.

The directors of the Great North of Scotland Railway Company require tenders by 10 a.m. Nov. 27 for six or 12 months' supply of various stores and materials, including telegraph material, ironmongery, india-rubber goods, &c. Forms of tender from the Stores Superintendent, 80, Guild-street, Aberdeen.

Leeds City Council invite tenders for single phase, 2,000 and 6,600 volts, and Scott connected transformers, with a total capacity of

14,000 k.v.a., for early delivery, and also for further supplies of similar transformers as required for a period of two years. Specifications, &c., from the Manager, Mr. C. Nelson Hefford, and tenders to the Town Clerk (Sir Robert E. Fox), 26, Great George-street, Leeds, by Nov. 13.

Hammersmith (London) Borough Council invite tenders for the supply of static transformers, e.h.t. and l.t. cable, h.t. oil-break switches, black and galvanised corrugated iron sheets, and steam piping. Forms of tender from the borough electrical engineer, Mr. G. G. Bell, 85, Fulham Palace-road, W.6. Tenders by 4 p.m. Nov. 20 to the town clerk, Mr. Leslie Gordon, Town Hall, Hammersmith, W.

For the supply and erection of modern alternating-current switchgear for the Docks-road power station, Cape Town City Council recently accepted the tender of the South African General Electric Company (on behalf of the General Electric Company of America) at £28,278.

Bolton Corporation has accepted the following tenders: English Electric Company, two pairs of Brill maximum traction trucks, with steel tyres, wheels and axles; Metropolitan Vickers Electric Company, 10 magnetic brake equipments; and British Thomson-Houston Company, rotary converter.

Glasgow Corporation have accepted the following tenders: Orwell Electrics, one 3½-ton vehicle at £1,200; General Vehicle Company, one 2-ton vehicle at £910; R. Garrett & Company, one 2-ton vehicle at £1,120; and the Edison Accumulators, Ltd., for one 2-ton vehicle at £1,120, one 3½-ton at £1,470, and one tractor at £1,448.

Wolverhampton Corporation has accepted the following tenders: British Westinghouse Company, one 250 kw. rotary converter, with transformer, starting gear and e.h.t. and l.t. panels, £2,420; Bastian Meter Company, 168 electricity meters, £402; Ferguson, Pailin, Ltd., six sets of e.h.t. switchgear, £720; Ransomes, Sims & Jeffries, fitting electric tipping gear to the 3½-ton electric vehicle, £50.

Barnsley Corporation has accepted the tender of the British Insulated & Helsby Cables for the supply of h.t. cable to supply Messrs Redfern's & Wilson & Longbottom's works, at £1,145. 15s. 2d.; and that of Ferguson Pailin, Ltd., for h.t. switchgear, at £318. For switchgear extensions at the electricity works an order has been placed with the Metropolitan Vickers Electrical Company at £1,240.

Shoreditch (London) Borough Council has accepted the following tenders: Union Cable Company, 700 yds. 1 sq. in. single-core paper-insulated lead-covered cable, £748; Edison Swan Electric Company, 1,550 yds. 13 sq. in. three-core paper-insulated double-armoured e.h.t. cable, £1,728, and 1,500 yds. 7/20 six-core pilot cable, £300 per mile; Pirelli-General Cables Works, 880 yds. three core 7/16 service cable, £203; 880 yds. three-core 7/14 cable, £259; Metropolitan Vickers Electrical Company, one 2,000 kw. feeder, cubicle and desk panel, £977.

As stated in our last issue Edinburgh Corporation has accepted the tender of Messrs. Brown, Boveri & Company for the supply of turbo-alternators for the Portobello Power Station at £106,618. The tender of the Stirling Boiler Company for six boilers at £200,661 was also accepted.

Though the subject has aroused considerable interest in electrical circles the recommendations of the Electric Lighting Committee were adopted practically without discussion. The Chairman (Mr. Bruce Lindsay) explained that the matter really lay between Messrs. Brown, Boveri & Company and Messrs. C. A. Parsons & Company. They had every confidence in recommending the tender for acceptance as Sir Alex. Kennedy, their expert adviser, informed them that the firm had any amount of their machinery in this country, and that some which had been for many years in operation in M'Donald-road station gave perfect satisfaction. The town clerk had been informed that the British firms invited by the Board of Trade to reduce their prices had intimated that they had not been able to do so. The tender was from a neutral firm at a vastly cheaper price than the plant could be bought at in this country. If it had been £1,000 or £2,000 the Committee would not have thought much about it, but they thought £70,000 too much to throw away on a British firm. He had been reflecting on the price of raw material in connection with the offer. In 1914 the best Scottish pig-iron could be bought at 64s. a ton; to-day it was 200s. a ton. Cleveland pig-iron was £8 10s. a ton, and his firm was delivering last week French pig-iron at a still lower price. Those facts spoke for themselves, and until things were vitally changed, and the cost of everything in this country was changed, he did not see much hope for British industry.

In reference to the report in our last issue, we are informed that neither Sir Charles Parsons nor Messrs. C. A. Parsons & Company, Ltd., have expressed any opinion in regard to the contract, nor do they intend to do so.

Liquidations.

Meetings of creditors and contributories of Connolly Bros., Ltd., Blackley, Manchester, will be held on Nov. 13 at 33, Carey-street, London, W.C.

A meeting of the creditors of the Bentham Electric Supply Company, Ltd., will be held at the office of the liquidator, Mr. A. E. Stringer, 31, Manor-row, Bradford, on Nov. 5.

Claims against Harry W. Cox & Company, Ltd. (in voluntary liquidation) are to be sent by Dec. 3 to Mr. B. H. Morphy, 84, Acton-lane, London, N.W.10.

Business Items.

The General Electric Company, Ltd., has acquired a site of over 70 acres just outside the borough boundary at Luton for the erection of new works.

The War Risks Insurance Office at 53, Cornhill, E.C., has been closed, and correspondence relating to the business of the office should be addressed to the War Insurance Accounts Branch, Board of Trade, Gwydyr House Annexe, Whitehall, S.W.1.

The proprietor of patent No. 24,702/08, for "Improvements in and relating to electric fusible cutouts," desires to enter into arrangements for exploiting same in this country. Communications to Messrs. Haseltine, Lake & Company, 28, Southampton-buildings, London, W.C.

Mr. Charles P. Sparks, M.Inst.C.E., M.I.E.E., has resigned his position with the County of London Electric Supply Company, Ltd., and from Jan. 1, 1920, will cease to act as engineer-in-chief of the Company. Mr. A. R. Bacon has been appointed chief station engineer, and Mr. J. D. Dallas chief mains engineer.

Mr. F. D. Egan, former works manager of the Pittsburgh Iron & Steel Foundries Company, has accepted a position in the general engineering department of the Westinghouse Electric & Mfg. Company at East Pittsburgh, where he will devote his entire time to the development of electrical apparatus for steel mill application.

Messrs. A. W. Neate & Sons will Sell by Auction at the Ufton Camp, Mortimer, on Nov. 18, the timber and felted huts, 12 g.i. tanks, 2 vertical boilers, oil and steam engines, dynamo, some tools, heating stoves, &c. Catalogues from the Board of Trade (Timber Supply Dept.), 2, George-street, Oxford, and 160, Friar-street, Reading, and from the auctioneers, Newbury and Hungerford.

Messrs. Joseph Hibbard & Sons will Sell by Auction on Dec. 3 and three following days, some camp equipment, telephones, electric lamps, electric light plant, engineers' tools, wagons, soft and hard woods, &c. Catalogues from the Board of Trade (Timber Controller's Dept.), 80, Newman-street, London, W. 1, or from the auctioneers, Newington Green, London, N. 1, and 18, High-street, Brentwood.

We have received from Messrs. Cassell & Company, La Belle Sauvage, E.C. 4, Part 1. of "Electrical Engineering," by Messrs. H. H. Simmonds and A. H. Avery. This is published at 10d. net, and is to be completed in 14 fortnightly parts. The present issue deals in an elementary and popular fashion with the electric circuit, with simple and complex circuits and with various types of cells. It should form a useful work for the study of the amateur and student.

The Electrical Installations, Ltd., have made an arrangement with Messrs. Hays, Hunter & Standen, of 71, Southwark-street, S.E. 1, to take over the electrical contracting department of their business as from the 1st inst., and it will now be amalgamated with Electrical Installations, Ltd., and carried on from their existing offices, 27, Martin's-lane, Cannon-street, E.C.4. Mr. Bratton, chief engineer of Messrs. Hays, Hunter & Standen, enters into the service of Electrical Installations, Ltd.

Messrs. Watson & Sons (Electro-Medical), Ltd., 45, Parker-street, Kingsway, W.C.2, have recently issued an elaborate catalogue of 370 pages which gives illustrated particulars and prices of their X-ray and electro-medical apparatus. Apart from the lengthy list of electro-medical apparatus, transformers, instruments, X-ray tubes, lamps, &c., there is a great deal of information in the catalogue which should be of real value to medical men, electricians, radiologists and all interested in the subject.

Arrangements have been completed for the amalgamation of the business carried on by Mr. Robt. W. Paul at New Southgate, London, with the Cambridge Scientific Instrument Company, Ltd. Mr. Paul will join the board of directors, and the manufacture of instruments will be continued both at Cambridge and at New Southgate. Until the end of the year the selling and manufacturing arrangements will be unchanged, but on January 1, 1920, the name of the company will be altered to the Cambridge & Paul Instrument Company, Ltd., and as soon as possible the head office and showrooms transferred to London.

A cable message from the representative of the Federation of British Industries, stating that in spite of inclement weather there have been great crowds visiting the Exhibition of British Manufactures at Athens, and that during the first seven days 15,000 paid for admittance. On Oct. 26 the improved weather brought a record crowd of over 7,000 people. Practically all exhibits have been sold many times over, and there has been an especial demand for machinery and textiles of all descriptions. Members of the business and trading community are arriving in increasing numbers from Constantinople, Smyrna and all parts of the Balkans as well as the Levant.

A series of publications issued by the British Westinghouse Electric & Mfg. Company (now the Metropolitan Vickers Electrical Company) during recent months deserves notice. One useful booklet deals with "Individual Motor Drive of Planing Machines," the commutating pole motor being directly connected and reversing at each stroke. Automatic contactor control gear is used, and a feature is the exact adjustment possible for the cutting speed, according to the metal and tool used, while the machine is running. The return speed can readily be altered up to four times the cutting speed, and this flexibility leads to economy in power and increased production. Full details of operation and accessory apparatus are given. Other leaflets before us refer to bracket pedestal bearings for motors, direct-current motor starters, motor generators and transformers; particulars are also given of electric winding engines of 1,500 H.P. and over, as used in many well-known mines and collieries.

Companies' Reports, &c.

The recent issue of 50,000 ordinary "B" shares of £1 each of the Northampton Electric Light & Power Company, Ltd. (offered at £1. 0s. 6d.) was over-subscribed.

The directors of the City of Buenos Ayres Tramways Company (1904), Ltd., have declared a dividend of 1s. 3d. per share (at rate of 5 per cent. per annum), less tax for the quarter ended Sept. 30.

The directors of the Calcutta Electric Supply Corporation, Ltd., have declared an interim dividend at the rate of 8 per cent. per annum (less tax) on the ordinary shares for the past half-year.

The net profit of the Nitrogen Products & Carbide Company, Ltd., for 1918 was £118,814, and a dividend of 9 per cent. has been paid ; a sum of £10,000 has been added to the contingencies fund and £14,396 carried forward.

The following companies were Struck off the Register of the Joint Stock Companies on Oct. 28: Birmingham Electrical Accessories Manufacturing Company, British Compressed Air Pumps, Read, Holliday & Sons.

The directors of the Lima Light, Power & Tramways Company announce a dividend of 1½ per cent. Messrs. Grace Brothers & Company, of 144, Leadenhall-street, E.C., will pay the dividend (less tax) on all coupons presented to them.

The accounts of the Singapore Electric Tramways Company for the year 1918 show a loss of £9,626, after providing for debenture interest, depreciation, &c., converting a credit balance of £4,220, into a debit balance of £5,406, which is carried forward.

The directors of Rawlings Bros., Ltd., recommend a dividend of 12 per cent. on the preference shares, bringing the arrears up to May 24. 1919, and 3 per cent. on the ordinary shares for the past year, allocating £600 for directors' fees and carrying £880 forward.

The accounts of the Electric Supply Corporation, Ltd., for the year 1918 show (after transferring £1,906 to repairs and renewals fund and including £396 brought forward) an available balance of £4,002. It is proposed to place £3,000 to reserve and to carry forward £1,002.

The directors of Erinoid, Ltd., announce a dividend of 15 per cent. (9d. per share), less tax, for the past year. A sum of £10,284 has been placed to reserve, making £15,262 (£40,000 having been distributed as bonus shares during the year), and £1,068 carried forward.

The directors of the Vera Cruz Electric Light, Power & Traction Company, Ltd., have declared a dividend of 2½ per cent. (6d. per share) for the past half-year, making 7½ per cent. for year ; £10,000 have been placed to depreciation and reserve and £23,399 carried forward.

An extraordinary general meeting of Marconi's Wireless Telegraph Company, Ltd., will be held on the 13th inst. for considering a resolution to increase the capital by the creation of 1,500,000 new ordinary shares of £1 each. If the resolution be passed it will be submitted for confirmation to a further extraordinary general meeting on the 28th inst.

The report of Claud Hamilton, Ltd., for the year ended April 30 was presented at the meeting last week and stated that, including the sum brought forward, the credit balance was £19,232. A dividend of 7½ per cent. on the ordinary shares, also a bonus of similar amount, both less tax, were declared. £5,000 was transferred to reserve and the balance (£10,732) carried forward. The company has now resumed operations, and additional branches are being opened.

The directors of the British Mannesmann Tube Company are unable to present the final accounts for the year ended June 30 until sundry outstanding items in connection with the war period are adjusted. A preliminary profit and loss account has been prepared and the directors consider they are justified in recommending the shareholders to declare a final dividend of 4 per cent. and a bonus of 1 per cent. making a total. dividend at the rate of 8 per cent. per annum, plus a bonus of 1 per cent. (both less tax).

In the course of his speech to the shareholders of the Askern Coal and Iron Company, Ltd., last week the Chairman, Mr. S. Instone, stated that the directors had secured quotations for building a cooking and by-product plant which would involve an outlay of some £400,000. They had also obtained tenders for an increase of the electric power plant, and pumping plant for the large amount of water required both for the Company and for the increased demands of the Doncaster Rural District Council.

Tube Investments, Ltd., which was recently formed to acquire the shares in a number of tube and conduit companies, including Accles & Pollock, Credenda Conduits Company, Simplex Conduits, Ltd., and Tubes Limited, is making a further issue of 7 per cent. cumulative £1 preference shares at par and ordinary £1 shares at a premium of £1 per share. The issue is made in accordance with the recent promise of the directors to those shareholders who exchanged their shares that they should have the opportunity of subscribing for further preference and ordinary shares.

The report of the United Electric Tramways Company of Caracas, Ltd., for the year ended June 30 last states that, with £7,294 brought forward, the disposable balance is £21,846, out of which the directors recommend a dividend for the year at the rate of 7 per cent. (less tax), leaving £9,946 to be carried forward. The net receipts of the local company (the whole capital of which is owned by this company), at exchange of 25·25 were £29,663, a decrease of £1,680. This result is mainly due to increased wages and an advance in rates for materials, &c. Notwithstanding the increase in wages granted in February, a strike occurred in July, which, after lengthy negotiations, was eventually settled by the concession of a further general increase in wages of 25 per cent. After adding the balance brought forward (Bs539,809) to the net receipts for the year, providing for mortgage interest (£10,200 or Bs257,550), setting aside Bs50,000 to reserve and renewal funds, and paying a dividend amounting to Bs441,449 the local company carry forward the same amount as last year. The percentage of operating expenses in its ratio to gross receipts is 52·77, against 49·20 in the previous year.

EDISON SWAN ELECTRIC COMPANY, LTD.

Tho 36th ordinary general meeting of this company was held on Monday at Winchester House, London, Mr. C. Jermyn Ford (chairman) presiding.

The CHAIRMAN, in moving the adoption of the directors' report (which was abstracted in our issue of Oct. 31) said : You will notice from the balance-sheet that for the first time, with the exception of the 7 per cent. cumulative preference shares, the whole of the capital is now represented by ordinary shares, of which there are issued 598,307 of £1 each, and this amount has practically all been paid up. The debenture stock sinking fund amounts to £12,599, to which must be added a further £13,413, which will be appropriated out of profits for the year under review, making a total of over £26,000, and the debenture stock to be purchased with this sum will be cancelled in due course. As a matter of fact, however, as we shall doubtless be able with this sum of £13,413 to purchase stock for less than its par value, the sinking fund will amount to more than the figure quoted. General reserve account stands at £50,000.

We have earned a profit of £137,000, which, added to the balance brought forward, makes a total of upwards of £187,000, from which deductions have to be made for interest on both classes of debenture stock, dividend on the preference shares and the interim dividend on the ordinary shares.

When the armistice came in November last, or shortly after that date, we found ourselves in the serious position of having to switch over at very short notice from war to peace conditions, and this we were fortunately able to do with a minimum of disorganisation to our works and output. Since the commencement of this year our works have been employed to their fullest capacity in the output of almost all classes of goods used in the electrical trade, and are still so employed, and, as far as one is able to judge, this should continue. The additional capital raised in May last had not time to beneficially affect the earning capacity of the company during the year under review. The major part of the cash received from that issue did not come into the coffers of the company until a week or two before the accounts were closed at June 30.

As foreshadowed in my remarks at the last annual meeting, we have taken an interest to the extent of £50,000 in a company now known as the Enfield Ediswan Cable Works, Ltd. This concern was previously known as the Enfield Electric Cable Mfg. Company, Ltd., and we have been for some time past closely connected with it as purchasers of cable and all classes of wire for electrical purposes. I told you on a previous occasion that it was our policy, where possible, to be in the position of manufacturers of every class of goods which we were able to sell, and the alliance we have made with the Enfield Company, we think, should have an important effect, not only upon our sales, but upon our standing in the electrical industry. In furtherance of this object we have entered into an arrangement with Brotherton Tubes and Conduits, Ltd., under which the name of that company has been altered to Brotherton Ediswan Tubes & Conduits, Ltd., and we are taking an interest therein to the extent of £25,000. This will give us facilities to supply all classes of tubes and conduits used in carrying wires for heating, lighting and power purposes, and for which there is at all times a very large demand. We have also entered into arrangements with the Sangamo Electric Company, of the United States, who are manufacturers of a high-class electrical meter for which there is a very alrge demand. The company is sole agent for this meter in Great Britain and the Colonies, but in due course it will be manufactured at our Ponder's End works.

We have during the past year largely increased our plant and buildings, so as to enable us to cope with the increased demand for almost every class of electrical work which we had previously been engaged in, and various new lines which I need not trouble you with. Since the date of the balance-sheet we have expended approximately £50,000 on plant and buildings, included in which are extensive additions to the glassworks and the erection of additional gas works to cope with the increasing output of electric lamps, and we are maturing our plans for the erection of buildings and the laying down of plant for further classes of work which we have not previously embarked upon. For these reasons it is absolutely essential the company should be provided with a considerable amount of additional working capital, and we propose to ask your consent to create 500,000 additional ordinary shares.

The CHAIRMAN then moved, and Mr. E. B. ELLICE-CLARK seconded, the resolution for the adoption of the report and accounts.

In reply to questions the CHAIRMAN said that the Enfield Ediswan Electric Cable Works, Ltd., was not a member of the cable ring. The Sangamo meter was a meter for registering all classes of electrical current, either for domestic or for power purposes.

The resolution was then carried unanimously. The dividends as set out in the report were approved, and the retiring directors (Mr. C. J. Ford and Mr. J. Cross) were re-elected.

At an extraordinary general meeting which followed a resolution to increase the capital to £1,198,307 by the creation of 500,000 additional ordinary shares of £1 each was passed.

New Companies.

ANGLO-SWISS SCREW COMPANY, LTD. (159,956). Private company. Reg. Oct. 25, capital £10,000 in £1 shares, to carry on the business of screw manufacturers, especially screws for watches, electrical and scientific instruments and small engineering and scientific apparatus, &c. Agreement with E. Homberger and O. Frey. First directors: E. Homberger and O. Frey (both permanent managing directors subject to holding 100 shares). Reg. office: Tavistock Works, West Drayton, Middlesex.

BRITISH SIGN MFG. COMPANY, LTD. (159,961).—Private company. Reg. Oct. 25, capital £2,000 in £1 shares, to carry on the business of sign writers, shop fitters, advertising agents, &c. First directors are Lieut. B. N. Leahy, P. J. Bowling and M. A. S. Sturt. Reg. office: 97*c*, Queen Victoria-street, E.C

ELECTROFER, LTD. (160,047).—Private company. Reg. Oct. 28, capital £10,000 in £1 shares, to acquire and exploit patents and/or processes for the electrolytic deposition of various metals, &c. First directors are A. F. Berry, G. Berry and N. Bosanquet. Reg. office: Maxwell House, Arundel-street, W.C. 2.

ELPO ELECTRICAL ENGINEERING COMPANY, LTD. (160,010).—Private company. Reg. Oct. 27, capital £1,500 in £1 shares (1,000 preferred). Objects: to carry on the business of electricians, mechanical engineers, suppliers of electricity, electric cable makers, &c. Reg. office: Towngate, Holbeck, Leeds.

KARTRET ENGINEERING COMPANY, LTD. (159,910) Private company. Reg. Oct. 23, capital £25,000 in 24,000 7 per cent. cumulative preference shares of £1 each and 10,000 ordinary shares of 2s. each, to take over the business of an electrical and mechanical engineer carried on by V. G. Middleton as the Kartret Engineering Company, and agreement with said V. G. Middleton and C. J. Baker. First directors: V. G. Middleton, C. J. Baker, W. F. Furse, Harry Blofeld and Hamilton Blofeld. The latter may retain office whilst holding 2,000 preference and 1,000 ordinary shares. Reg. office: 7, Carteret-street, Broadway, Westminster, S.W.1.

RUSHMORES (1919), LTD. (159,716).—Private company. Reg. Oct. 17. Capital £100,000 in 85,000 8 per cent. cumulative participating preference shares of £1 each, and 150,000 ordinary shares of 2s. each. Objects: To carry on the business of manufactureers, repairers and cleaners of and dealers in searchlights and lamps of all kinds, magnetos, dynamos, self-starters and other electrical devices, &c. Solicitor: C. H. Dodd, 16, Friar-street, Reading.

WALLACE-GRIFFIN ELECTRICAL COMPANY, LTD., (159,636.)—Private company; reg. Oct. 15, capital £2,000 in £1 shares. To take over the business of electrical and mechanical engineers carried on by G. Wallace and T. R. Griffin at 58, High-street, Bloomsbury, as "Wallace & Company." First directors are G. Wallace and T. A. Griffin (both permanent).

WHILO'S ELEVATORS, LTD. (159,689).—Private company. Reg. Oct. 16. Capital £10,000 in £1 shares. To acquire certain patents relating to elevators, and to enter into an agreement with F. B While, T. O'Sullivan and G. Sizer. First directors are: G. Sizer, F. B. While, T. O'Sullivan, W. H. Baker, F. Trim, E. W. Blew, V. Harper, A. W. Pearce, C. H. Lock, H. J. Richards and D. D. Plunket. Secretary: T. O'Sullivan. Reg. office: 7A, Oxford-street, Southampton.

Prices of Metals, Chemicals, &c.

TUESDAY, NOV. 4.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£113 0 0	£2 0 0	—
Electrolytic bars ...	,,	£118 0 0	—	—
H.C. wire basis......	per lb.	1s. 3$\frac{11}{16}$d.	—	—
Sheet	,,	1s. 4d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 7$\frac{11}{16}$d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 11$\frac{3}{8}$d.	$\frac{3}{16}$d.	—
Sheet, basis	,,	1s. 2$\frac{5}{8}$d.	—	—
Wire, basis	,,	1s. 2$\frac{1}{8}$d.	—	—
Iron—				
Cleveland Warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	£32 10 0	—	—
Lead Pig—				
English	,,	33 0 0	£1 15 0	—
Foreign or colonial	,,	32 15 0	£1 7 6	—
Tin—Ingot	,,	272 15 0	—	£1 0 0
Wire, basis	per lb.	0 3 4$\frac{1}{2}$	—	0$\frac{1}{4}$d.

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Ton £22 10s.

,, (Roll Brimstone).—Per ton £22.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40

Boric Acid (Crystals)—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6d.

Shellac.—470s. December delivery 460s. to 470s.

Rubber.—Para fine, 2s. 6d.; plantation 1st. latex 2s. 5d. lb

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W. T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Nov. 4, 1882.]

ELECTRIC LIGHT AT HOLBORN.—The Holborn Restaurant has been completed, and is to be lit throughout by the Edison Light Company. About 1,000 lamps in all will be used, partly of 8 and partly of 16-candles.

THE EDISON SYSTEM IN AMERICA.—We learn that there are 123 isolated plants on the Edison system now running, or in process of being fitted up, in various parts of the United States. These plants give an aggregate number of 21,998 lamps.

SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—The first meeting of the autumn session of this society will take place on Thursday, Nov. 9, at 8 p.m., when a Paper will be read on "The Munich Electrical Exhibition, 1882," by W. H. Preece, F.R.S., past president.

ELECTRIC LIGHT IN GASWORKS.—It is said that the Gas Company of Ghent in Belgium have fitted up some Nothomb incandescent lamps for the purpose of lighting some of their rooms in which work is carried on during the night. We do not know how the necessary power is obtained.

ELECTRIC LIGHT AT WATERLOO STATION.—The Windsor platform of the Waterloo Bridge Station is about to be lit with Edison lamps. About 300 B or 8-candle lamps will be used, the current being furnished by an Edison L dynamo, driven by an Armington and Sims' engine. The directors' room will also be lit from the same plant.

TIME BY TELEPHONE.—At Ann Arbor, Mich., astronomical time is furnished by the observatory to subscribers daily at 9 o'clock a.m. by telephone. The telephone transmitter at the observatory is placed close to a Morse sounder, which is operated automatically by the observatory clock. From 8.58 to 8.59 the sounder clicks once for each second, and from 8.59 to 9 o'clock twice for each second. At 9 o'clock it ceases. The click of the sounder is heard distinctly in the receiving telephones of the subscribers.—*Operator.*

IS IT TRUE?—An American paper says:—"There was excitement in front of the Central Methodist Church, Market-street, Newark, N.J., on Saturday evening last. Adjoining the church is a building with iron columns, which is supplied with electric light, and somewhere in the circuit a telegraph wire had fallen upon the electric wire, thus charging the building near the church. The current extended to the iron fence outside, and four persons who had touched the fence in passing had been knocked down. They were not seriously injured."

SOMETHING LIKE A PATENT.—In looking over the patents recently filed at the Patent Office, we came across one containing the provisional and complete specification together, no less than 38 pages, besides several sheets of drawings. This patent was intended to cover an invention the object of which was to utilise the water power in cities for actuating turbines, which in turn were to drive dynamos, the current so generated being stored in secondary batteries, and distributed for use by wires as required. Surely it would not take 38 pages to secure the rights to such an invention, if it be one at all. We think there is a little exuberant verbosity or rather scriptology here.

THE COST OF ELECTRIC LIGHTING.—The correspondent of a provincial paper writes as follows:—"I have recently seen the new building erected by W. Rowntree and Sons, of Westboro', Scarboro'. It is large and handsome, and is lighted by about 250 incandescent lights. The power required is supplied by an Otto gas engine of 16 horse-power, which, when working at its full power consumes 690 feet of gas, costing about 2s. 7d. per hour. The engine is a splendid piece of workmanship and is started and in full action in two minutes. The light supplied was very beautiful, soft, pure and steady, and, of course, neither heats nor vitiates the air, as gas does to such a lamentable extent. But (there is generally a 'but') the first cost at present is such that it can be adopted by only wealthy firms. The total expense to Messrs. Rowntree of engines, fittings, etc., exceeded £1,200."

ELECTRIC LIGHT EXHIBITION AT BOSTON (AMERICA).—There is a large exhibition of the electric light at the New England Manufacturers' and Mechanics' Institute Fair now being held at Boston, says the "Sanitary Engineer." Nearly the whole of the illumination of the building is furnished by the three electric light companies having exhibits there. The Edison Company have about 870 incandescent lamps, most of them being 16 c.p., though a few are of 32 c.p. The New England Weston Company have about 100 arc lamps, known as 2,000 c.p., 16 being outside in front of the building, 150 ft. above the ground (at the top of a 50 ft. mast from a 100 ft. tower). The same company have about 150 incandescent Maxim lamps of 24 c.p. The American Electric Light Company, of New Britain, Conn., have 55 Thomson-Houston arc lamps, known as 2,000 c.p.

ELECTRIC LIGHTING AT BIRMINGHAM.—At a special meeting of the Birmingham Town Council held on Tuesday last, the report of the Gas Committee on the question of electric lighting, which was given in our last issue, was adopted, and, on the motion of the chairman of the Gas Committee it was unanimously resolved that no application be made by the Council for authority to supply electricity in the borough or in any part of the district, either by licence, provisional order, or by special Act of Parliament, and that, with respect to the application for licences, the Council decline to consent to the same, and that with respect to the several applications for provisional orders, that the recommendations of the Gas Committee (Nos. 2, 3 and 4 on page 17 of the report) be approved; also that the Gas Committee be authorised to take all such measures, to employ such professional assistance, and make such conditions with the applicants in the name and on behalf of the Council and where necessary, under the corporate common seal, as they may deem necessary or advisable for carrying the said recommendations into effect.

THE ELECTRICIAN

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The Electromagnetic Principle of Relativity.

The reports on the results of the Brazilian and West African eclipse expeditions of May 29, 1919, were presented last Thursday to a crowded joint meeting of the Royal Society and the Royal Astronomical Society. The main object of these expeditions was to test a prediction, based on the electromagnetic principle of relativity, that the images of stars near the sun would be found displaced from the centre of the sun by an amount inversely proportional to their angular distance from that centre, the maximum displacement being close to the limb or edge of the disc, where it would amount to 1·75 sec. of arc. The results, as announced by the Astronomer-Royal and Dr. Crommelin, amount to a practically complete justification of that prediction. At Principe, West Africa, Prof. Eddington, working with a fixed telescope of 8in. effective aperture and a 16in. heliostat, obtained images of five stars from which a maximum bending of 1·64 sec. of arc could be calculated. At Sobral, in North Brazil, Dr. Crommelin got the best results with a lens of only 4in. aperture and 19 ft. focal length. This, with an exposure of 28 secs., gave seven good star images on as many photographs; and the definition was good enough to reduce the probable error to less than 6 per cent. The mean result was a bending amounting to 1·98 sec. of arc. The fact that the inverse distance rule held good excludes any explanation based upon refraction.

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When Albert Einstein, then Professor of Mathematical Physics at the Zürich Polytechnic, launched his electromagnetic theory of relativity in the "Annalen der Physik" of 1905, he based it upon certain elementary considerations concerning the actual measurement of time, and more especially concerning the definition of the "simultaneity" of two events. He found that when this was done on any considerable scale, our methods depended entirely upon light signals. These involve the velocity of light, which is generally regarded as propagated by a "luminiferous ether" whose relative motion should affect the result. Now it is a remarkable circumstance that no such effect of ether drift has ever been successfully demonstrated, the best-known negative result being that obtained by Michelson and Morley in 1886. Einstein took the bold step of erecting this consistently negative reply into an axiom, declaring that it was impossible to discover motion with respect to the "ether" by any electrical or optical experiment, just as Newton had found that it was impossible to discover absolute motion by any mechanical device. The velocity of light in any direction is the same whatever may be the motion of the axes of reference. This is not the first time that such a step has been taken. The conservation of energy and the second law of thermodynamics are based upon similarly negative evidence, and yet nobody doubts their value. But the consequences involved in the new principle are sufficiently novel to excite considerable criticism. Among these consequences we may mention the finite velocity of propagation of gravitation (not exceeding the velocity of light); the probable identification of mass with stored energy (1 gramme being the equivalent of 9×10^{20} ergs); the interdependence of space and time, brought out in a striking manner by Minkowski's four-dimensional treatment of electromagnetic phenomena, with time as the fourth dimension; and the action of gravitation upon masses of moving energy. It is this last conclusion which has been numerically verified by the eclipse photographs, in which beams of starlight suffer a deflection by the intense gravitational field surrounding the sun. Practically, this brilliant verification means that most of our mechanical and electromagnetic quantities will involve the factor $(1-v^2/c^2)^{\frac{1}{2}}$, where v is the velocity of the body under consideration and c is the velocity of light (3×10^{10} cm. per sec.). It is obvious that for all ordinary purposes the factor is negligible. But when v begins to approach c, as it does, for instance, in the projection of electrons from radium, the factor becomes important. It was, indeed, one of the successes of the relativity theory that it accurately predicted the effect of speed upon the mass of the electron. In the full explanation of the secular displacement of the perihelion of Mercury the theory scored another success. No doubt some further confirmations will be obtained at the next eclipse in September 1922, or even earlier, if a method of observing stars near the sun without an eclipse is found in the meantime.

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A New Solution of the Irish Problem.

A new method of solving the difficulties which at the present time confront those who are responsible for the government of Ireland is suggested by Sir John Griffith in his recent presidential address to the Institution of Civil Engineers. With a good deal of that enthusiasm which, as his name implies, is his by birth, combined with not a little of that rueful sympathy which her friends are too often made to feel for the distressful country, he told his hearers what Ireland and Irishmen had done for engineering progress and of the opportunities that exist by developing her natural resources to bring her into more constant touch with the outer world, and so rid her of the injuries due to her insular position. Indeed, as he points out, the story of engineering achievements in Ireland is one of the brightest spots in her sad history. Ireland was the birthplace of the largest telescope. Within her shores have also been built some of the largest ships, and here also was erected the first Stoney sluice, a type of construction which has since been widely employed on waterworks all over the world. The constructive and dredging work connected with the improvement of Dublin harbour are also of historical and practical interest to port engineers. While one of the first electric railways, that from Portrush to the Giant's Causeway, in connection with which one of the first hydro-electric stations was erected, had its genesis on Irish soil. So much for the past; for the present and future, the resources of Ireland should receive earnest consideration from all whose business depends upon an adequate supply of fuel, for there are peat deposits from which fuel amounting to some four thousand million tons may be won, and offering, therefore, an opportunity for development of which, it is regrettable, the Government has so far been slow to take advantage. Ireland further possesses water-power resources which could be usefully employed in generation of energy. As Sir John Griffith rightly points out, how best to use these resources for the improvement of the country and for the good of the community is both an urgent and important question. With it must go the consideration of the provision of adequate harbours on the west coast, not only for strategical reasons, but to develop the fisheries and to improve the high-speed passenger and mail traffic between these islands and the United States. Such development, indeed, cannot help being of an advantage to Ireland, bringing, as it must, a prosperity and contentment to its inhabitants which would do more to cure imaginary wrongs than any political propaganda. It is a dream, as Sir John Griffith admits, but we do not see why it is a dream which should not come true. If it did come true, it would not be the first time that engineers have brought contentment to a distressed country.

The Disabilities of Power Station Staffs.

We are glad to see that Mr. Arthur Ellis in his inaugural address to the Western Centre of the Institution of Electrical Engineers, pleads for the better remuneration of the technical staffs engaged in power station work. The present position is at least anomalous. The various increases and bonuses which have been granted to the non-technical grades have resulted in its being the rule rather than the exception for foremen, fitters and even labourers to be paid at higher rates than shift engineers or switchboard attendants. It is not to be wondered at therefore that the central station branch is beginning to be neglected by qualified engineers and to be looked upon as a job where the work is hard and the remuneration pitiable. This state of affairs is, we fear, more than a little due to the fact that the technical staffs have had no trade union to safeguard their interests, with the result that electricity committees, and too often chief engineers as well, have been responsible for the employment of something very like sweated labour. We agree with Mr. Ellis that the formation by power station engineers of a trade union is regrettable, but at the same time we feel it is a necessity. For if that constancy of supply of which electricity undertakings have always been so proud is to be maintained, properly qualified men with adequate salaries must be employed. And there seems no way of ensuring this shall be done except by combination. It is time this was generally realised, for we cannot help thinking that the numerous serious breakdowns of plant which have recently occurred are in some extent due to the knowledge of the subordinate staffs not being of that high character which is a necessity in the operation of modern plant. Some recognition is also due to these staffs for another reason. The work they have done during labour troubles is beyond all praise. There has been, as far as we know, no case of any member of the technical staff withdrawing his services during those periods of stress. On the contrary, they have worked harder than ever. For this reason alone some adequate recognition of their services should be made throughout the country.

Electricity Profits and the Relief of Rates.

The question of how best the profits of trading departments of local authorities can be dealt with crops up from time to time, and not seldom leads to more or less heated discussions in municipal circles. The subject has been again raised at Manchester, where for some years the tramways, electricity supply and gas departments have been contributing a certain percentage to the relief of rates from the trading surplus obtained. A Special Committee of the Corporation, which was appointed about 18 months ago, reported against any alteration in this policy; but we are pleased to note that in considering the allocation of the present profits the Council have agreed to another inquiry. The desirability was urged of reducing the price of electricity, gas and tram fares to a figure as low as practicable to cover the cost of production, and Ald. Bowes, chairman of the Tramways Committee, welcomed the prospect of an inquiry, complaining of the 5 per cent. contribution with which his undertaking had been saddled. In our opinion, it is highly undesirable to devote the profits of an undertaking such as electricity supply to subsidising the rates; they should rather be applied to the development of the undertaking and to a reduction of the prices charged for energy. We have always advocated this policy, and at the present time the arguments which we have advanced in its favour are stronger than ever before. We hope this will be realised at Manchester.

Industrial League and Council.—The fourth lecture of the present series arranged by the Industrial League and Council (incorporating the Industrial Reconstruction Council and the Industrial League) will be held in the Council Chamber of the Guildhall on Tuesday, November 18th. The chair will be taken at 4.30 p.m. by the Right Hon. the Lord Mayor, and an address on the "Industrial Outlook" will be delivered by the Right Hon. Sir Auckland Geddes, K.C.B., M.P. Admission is free.

The third of the present series of Conferences on Scientific Management arranged by the Industrial League and Council will take place on November 19th at 5.30 p.m. in the Hall of the Institute of Journalists, 2 and 4, Tudor-street, E.C.4., when Mr. John Cole, of the Spirella Company of Great Britain Ltd., will deal with the experiences of the firm. Sir Herbert Austin, K.B.E., in the chair. Questions and discussion will follow. No tickets are necessary for either of these meetings.

The Birmingham Electric Club.—At the meeting of the Club on Nov. 8 a Paper was read by Mr. T. Pettigrew on "Automatic Telephones for Works, Offices, &c." The Paper described an automatic telephone system arranged for 100 lines, upon which the conversation efficiency factor could be varied. Standard sets were made for 16 and 28 instruments to be in use at one and the same time. This system had a great field of usefulness, but had certain limitations, by being designed to include many existing standard telephone parts. There was also described and demonstrated a new design of automatic telephone system known as the "Select-o-Phone" system, which was designed without regard to existing patterns or parts in general use. The standard set after much investigation was made for 33 direct lines. This type of apparatus had a large number of advantages, and it was claimed that within the limits of size this system was the most perfect yet devised.

"Nature."—We have received a copy of the Jubilee issue of "Nature," which was first published on November 4, 1869. This well-known journal had its genesis in a fortnightly column of scientific notes, which were started in the "Saturday Review" in 1858. Two years later Huxley became the chief editor of the "Natural History Review," which was at first intended to be a quarterly, which would deal with scientific matters systematically and thoroughly. In 1863 he became associated with the "Reader," a weekly journal, of which Sir Norman Lockyer was science editor. When the "Reader" ceased publication, it occurred to the latter that a general scientific journal of more comprehensive scope than the "Natural History Review" was required. On discussing the matter with Mr. Alexander Macmillan the inauguration of "Nature" was agreed upon. This journal has, with good reason, always had the sympathy and interest of scientists and others of the highest standing. With whatever hopes, doubts and fears its founders started it on its way, we may be certain that all the first have been realised, while all the other two have been long ago dispelled. It is fitting that, in this Jubilee issue, Sir Norman Lockyer should be the subject of "Scientific Worthies," a form of biography which has introduced the most important personalities of science to a numerous circle of readers. A supplement to the issue is an excellent photogravure of Sir Norman Lockyer. Our one regret is that we have not at our disposal a copy of the first issue of "Nature," in order that we might compare it with the one about which we are now writing. We feel sure the difference is tremendous.

The Institution of Electrical Engineers, South Midland Centre.—The first annual dinner of this section since the war was held at the Grand Hotel, Birmingham, on November 5th, under the presidency of Mr. S. T. Allen, the retiring chairman. Immediately prior to the toasts Mr. Allen introduced the chairman for the ensuing session, Dr. C. C. Garrard, and the latter then occupied the chair.

Prof. Sir Wm. Ashley, in proposing the toast of "The Institution," remarked on the tendency to form combinations which was characteristic of recent preparations to meet the commercial demands of the future. For successful action it must be realised that standardisation was also necessary. In providing a body of scientific experts who could serve in the setting up of standards the Institution had an important task. Yet he thought the Institution had also a more important and fundamental work, namely that of stimulating the spirit of scientific enterprise which would enable commerce successfully to occupy new fields and fully to explore the old ones. The speaker's tribute to the members of the Institution who had fallen in the war was endorsed by those present standing in silence. In responding on behalf of the Institution, Mr. R. T. Smith, the President, spoke in optimistic terms of this country's future.

Mr. W. B. Woodhouse, in proposing the toast of "Kindred Societies and Guests," dwelt on the advantages of co-operation between the various technical and other societies. He emphasised the fact that intercourse between kindred societies became more and more necessary as industry became more specialised. The toast was responded to by Mr. H. C. Field, the president of the Birmingham Chamber of Commerce, who referred to the inseparable bond between Capital and Labour, and remarked that if in this connection co-operation was to be successful, Capital must become larger-hearted and Labour broader-minded.

The toast of the "Electrical Industry" fell to Mr. C. H. Wordingham. In the course of his speech he referred to the necessity for mass production, and pointed out that this did not necessarily require huge organisations as was commonly supposed. By limitation of activity to a few specialised articles it was possible for comparatively small manufacturers to engage in and avail themselves of its economic advantages. Mr. Wordingham also referred to the tenders which had been received by the Edinburgh Corporation for electrical machinery, in which a foreign firm had been able to quote terms which were very much lower than those of any British firm. He insisted upon the danger to British prestige by orders being placed abroad, and suggested that if the Government felt it necessary to interfere in the wages of workers it should also take steps to protect the employers' markets. This toast was replied to by Mr. F. Forrest.

The newly-formed Preston sub-centre of the North-Western Centre of the Institution of Electrical Engineers, of which Mr. J. F. Simpson, borough tramway engineer, is secretary, held its first general meeting last week, when the chairman, Mr. J. Connor, gave an interesting address on "The Nation's Concern in the Utilisation of Fuel." There was an attendance of 100, including several visitors.

Obituary.

We regret to record the death of Mr. W. S. Foale, for many years electrical engineer and manager of the Portsmouth Corporation electricity department. For some time Mr. Foale had been in failing health, and recently he had been at a nursing home, near Chelmsford, Essex, where he passed away on the 23rd ult. Deceased, who was about 46 years of age, was educated at the Independent College, Taunton, whence he proceeded to Manchester, where he received the first part of his training in mechanical engineering. After spending two years at Manchester he joined the Brush Electrical Engineering Company, and was employed by them at Lambeth and at Loughborough. Subsequently he went to Hanley as engineer in charge of the installation of the electric light plant in the town. Afterwards he was engaged by the Brush Company in laying electrical mains in St. Luke's and Clerkenwell. In 1895 Mr. Foale was appointed Clerk of Works at Portsmouth, being engaged on a large extension of electric mains, &c., in various parts of the borough, but before the work had been completed, he was appointed mains engineer, under Mr. Price, the superintendent. On that gentleman relinquishing his position, in 1903, Mr. Foale was appointed engineer and manager, a position he continued to hold until his death.

Arrangements for the Week.

FRIDAY, Nov. 14th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers to be read: "On the Self Inductance of Single Layer Flat Coils," by Mr. S. Butterworth, M.Sc.; "An Experimental Method of Determining the Primary Current at Break in a Magneto," by Dr. N. W. McLachlan, and "Note on a Modified Form of Wehnelt Interrupter," by Mr. F. H. Newman, B.Sc.

Institution of Electrical Engineers, Students' Section of the Scottish Centre.

7.30 p.m. At the Royal Technical College, Glasgow. Opening Address of the Session by Mr. F. H. Whysall.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Irrigation Engineering in Burma," by Mr. A. P. Morris.

MONDAY, Nov. 17th.

Batti-Wallahs Society.

1 p.m. Luncheon at Holborn Restaurant. Address on "The New World," by Mr. E. J. P. Benn, C.B.E.

Institution of Electrical Engineers.

7 p.m. At The Chartered Institute of Patent Agents, Staple Inn-buildings, London, W.C. Informal meeting. Discussion on "Engineering Advertising" will be opened by Mr. W. E. Warrilow.

TUESDAY, Nov. 18th.

Institution of Electrical Engineers, North-Western Centre.

7.30 p.m. At the Engineers' Club, Manchester. Chairman's Address by Mr. J. A. Robertson.

Institution of Civil Engineers.

5.30 p.m. At Great George-street, Westminster, London, S.W. Paper on "Admiralty Harbour, Dover," by Mr. M. F. Wilson, M.Inst.C.E.

WEDNESDAY, Nov. 19th.

Royal Society of Arts.

4.30 p.m. At John-street, Adelphi, London, W.C. Opening Address of the Session, on "Science and Industry," by Sir Henry Trueman Wood, M.A.

Institution of Electrical Engineers, Wireless Sectional Meeting

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "The Design of Multiple Stage Amplifiers using Three-Electrode Thermionic Valves," by Prof. C. L. Fortescue

Institution of Electrical Engineers, South Midland Centre.

7 p.m. At the University, Birmingham. Chairman's Address by Dr. C. C. Garrard.

THURSDAY, Nov. 20th.

Institution of Electrical Engineers, Irish Centre.

7 p.m. At the Royal College of Science, Upper Merrion-street, Dublin. Discussion of Mr. C. H. Wordingham's Address.

FRIDAY, Nov. 21st.

Institution of Mechanical Engineers.

6 p.m. At Storey's Gate, St. James's Park, London, S.W. Paper on "The Present Position of Mechanical Road Traction," by Mr C. G. Conradi.

Junior Institution of Engineers.

7 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Annual General Meeting and a Paper on "The Limitation of Electric Tramways," by Mr. W. A. Tookey, M.I.Mech.E.

Institution of Electrical Engineers, Students' Meeting.

7 p.m. At the City and Guilds College, South Kensington, London, S.W. Opening Address by Mr. A. P. Trotter, M.A.

Institution of Electrical Engineers: North-Western Centre.

7.30 p.m. At the University, Liverpool. A meeting will be held to discuss the formation of a Sub-Section of the North-Western Territorial Centre in Liverpool.

Electro-Harmonic Society.

8 p.m. Concert at the Holborn Restaurant, London, W.C (Ladies' Night)

Aircraft Telephony.*

By Capt. B. S. COHEN, R.A.F.

Work on aircraft telephones was originally undertaken at the request of the Admiralty at the end of 1916 to meet requirements of the Royal Naval Air Service, and as a result of extensive research in the G.P.O. laboratories and in the air, telephone apparatus was designed for use in kite balloons, airships and heavier than air aircraft.

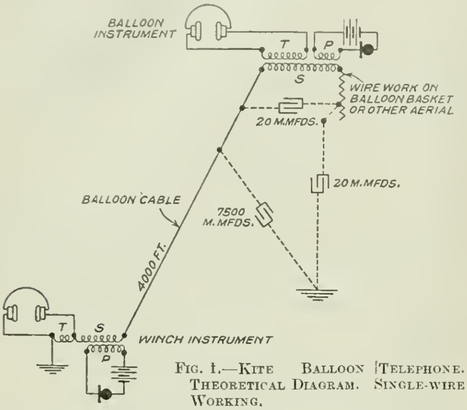

FIG. 1.—KITE BALLOON TELEPHONE. THEORETICAL DIAGRAM. SINGLE-WIRE WORKING.

The kite balloon observer has to be in continuous communication with the ground or ship's deck, as the case may be, at any height between several hundred feet and 4,000 ft. and at first it was essential to obtain communication for naval balloons over the balloon cable without a metallic return circuit. The main difficulty with a telephone core in the balloon cable is due to the fact that the latter has to withstand a normal pull of 1 to 2 tons and is wound up or released at speeds up to 250 ft. per min., with the result that the earlier telephone cores either broke if the conductors were at all tight or if slack the conductors were forced by the pressure when winding through the insulation and short circuited on the steel strands of the balloon cable. These difficulties have been overcome to a great extent, but it has always been found advisable to use a telephone capable of operating either over a metallic circuit or through the balloon cable, with a return circuit consisting of the capacity of the balloon basket to earth. This condition, of course, necessitates insulating the winch from the ground or ship's deck. Fig. 1 shows the electrical conditions to be met with in kite balloons flying at 4,000 ft. The capacity of the balloon basket to earth at that height is about 20 m.mfds. and this capacity is shunted by the much larger capacity of the balloon cable to earth, which is of the order of 7,500 m.mfds. The terminal impedances of the two ends of the circuit are vastly different being of the order of 10,000,000 ohms at the balloon end and 30,000 ohms at the ground end, and in consequence it was found advisable to design different instruments for use at the two ends.

Fig. 2 is the diagram of the connections used, the principle adopted being to employ a triple wound transformer with a low resistance, 300 turn primary joined to microphone and battery; a very high impedance secondary of 35,000 turns joined to line and a tertiary of 2,000 turns connected to the double head receiver. The step down to the receiver enables ordinary low impedance receivers (150 ohms windings) to be used. These figures are for the balloon instrument transformer. The transformer at the winch end has similar primary and tertiary windings but has a secondary of only 13,000 turns to suit the lower terminal impedance at the ground end. When operating on metallic circuits the secondary is disconnected and the tertiary takes its place; the change is effected

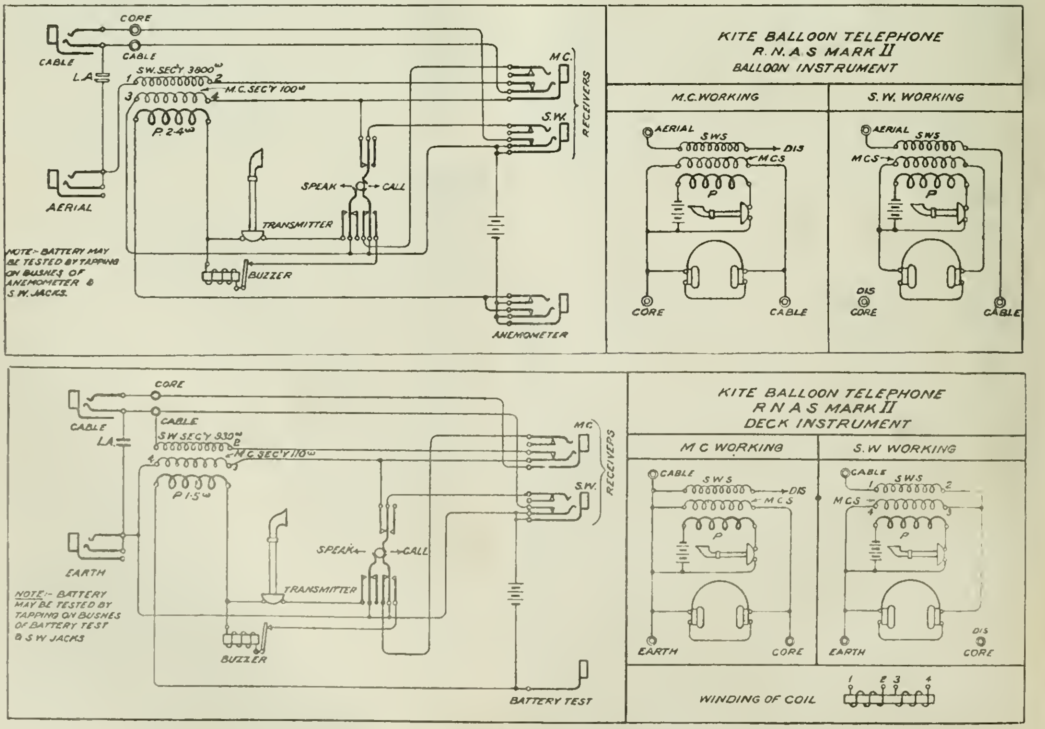

FIG. 2.—DIAGRAM OF CONNECTIONS USED ON KITE BALLOONS.

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* Abstract of a Paper read before the London Centre of the Institution of Post Office Electrical Engineers.

by a plug and jacks. The transmitter used is an inset and a speaking tube mouthpiece is supplied, which, however, need not be used for metallic circuit working as ordinary speech anywhere in the basket is picked up and transmitted efficiently to the ground. When working single wire the speech efficiency is approximately equivalent to standard talk over 35 miles of standard cable. The transmitter is operated by three dry cells embodied in the instruments. A lightning arrester, carbon block type, is included as the balloon cable is frequently highly charged during windy weather and sparks of ½ in. or more can be continuously drawn from it. A combined ringing and listening key is fitted which closes the transmitter circuit in the retaining position and operates a 2-ohm buzzer in the non-retaining position. A safety device is fitted so that the instruments cannot be packed away in their transport cases with the battery circuit closed. The equipment is completed in the case of the balloon instrument by an anemometer jack, which is used to connect a make-and-break operated by an anemometer fan to the balloon cable, so that wind velocity at any height can be read off electrically on the ground. Some thousands of these instruments have been in use in the R.A.F. throughout the war.

On an airship the standard telephone equipment includes the switchboard which is fitted in the navigating cabin and is operated by the navigating officer. This comprises drum indicator calling signals and combined ringing and listening keys. The out-stations include a 10-ohm howling receiver, a gas-tight switch-hook, a transmitter and pair of receivers. The system of operation is common battery and triple conductor line cable is used. The closing of the hand microphone switch at the out-station actuates the drum calling signal (which is painted with radium paint) and this closes a buzzer circuit and operates a 10-ohm howler. The depression of the ringing key on the control board also closes the buzzer circuit and actuates the howler at the out-station. The removal of the microphone from the switch-hook replaces the howler by a pair of headgear receivers, which, being wound to a high resistance, prevent the buzzer from operating if the key should be held depressed. The transmitter is mounted behind felt damping pads and an ebonite grid in a leather-covered box with a pneumatic edging to fit the mouth. A handle with switch is provided and is rendered gas-tight by a rubber cover. This form of transmitter, together with the double headgear receivers, is now being replaced by hand combination sets with throat microphones insensible to air-borne sounds. The control board is rendered gas-tight by covering the key fronts with rubber and completely enclosing the back of the key and indicator boards. The buzzer is also completely enclosed and a glass tube fuse G.P.O. pattern is used for protective purposes. The control board is mounted on anti-vibration rubber suspensions. The system is designed to work off a 12-volt supply, which is the standard lighting voltage on the ship. It has, however, recently been found advisable to fit a separate telephone battery of 5 to 10 ampere-hours capacity. The gas-tight switch-hook is an ingenious device designed by Capt. Toulmin Smith, and consists of a flat piece of bakelite operated by the switch-hook and sliding over three contacts in a barrel filled with mercury, the flat piece of bakelite merely squeezes the mercury away from the pair of contacts covered by it and thus disconnects them from each other. A suitable quad wire cable as regards weight and conductivity can now be obtained, however, which enables the switch-hook to be dispensed with and involves no increase of weight in the installation.

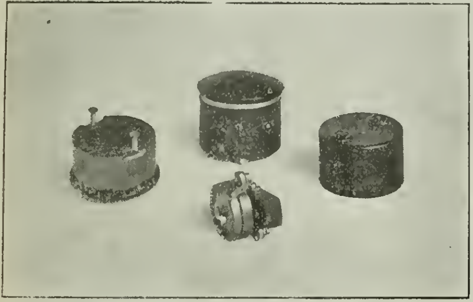
Fig. 3.—Form of Microphone used on Airships.

The noisiest positions in an airship are, of course, in the engine gondolas, where the engineer may be in very close proximity to a pair of the largest type of aero engines with a total output of nearly 1,000 H.P. running all out. In such cases the howl of the 10-ohm howling receiver will be inaudible and a high power Klaxon type horn is required as an audible signal. In such cases the 10-ohm howler is replaced by a single make relay in a gas-tight case and this closes a local circuit through the Klaxon horn, and the 12-volt lighting mains and also operates a switchboard lamp as a visual signal.

In connection with the development of aircraft telephones it has been found necessary to make a careful study of the nature of aircraft noises, and this has been done with the aid of the oscillograph and by other methods. From the point of view of intercommunication, engine exhaust is by far the most serious and accounts for between 70 and 80 per cent. of the interferences, although, strangely enough, the silencing of the exhaust does not much affect the distance at which a machine is audible to a listener on the ground.

Fig. 3 shows the final form of microphone designed for this purpose. This includes a novel feature in the method of transmitting the vibrations to the transmitter button. A mushroom-shaped piece of insulating material transmits the vibrations of the area on which it rests to the centre of the transmitter diaphragm and then to the microphone button. By the use of this device the damping action of the flesh when resting on the periphery of the diaphragm is done away with and all the vibrations are taken to the most efficient point on the diaphragm. The button which can be of any good type is insulated from the case of the transmitter. The diaphragm is of soft brass and is drawn in one piece with the case and planished; its thickness is 32 mils and diameter 1$\frac{3}{16}$ in. The best position for use is in the hollows on either side of the wind-pipe, and good results can be obtained over a fairly wide area of this part of the throat. The pressure should be only just enough to maintain the microphone steadily against the throat when the latter is in vibration. When the microphone is used in conjunction with head receivers it can be mounted either in a necklet, made of twill and chamois leather, or fixed in a handle with a press switch. The microphone can also be mounted in combination with a receiver, and as an all-round instrument this form is finding favour for use on large aeroplanes and in airships, &c. The articulation, whilst not so good as that of a good mouth-operated transmitter, is quite clear and distinct, and long lists of isolated words can be transmitted with very small percentage error. The instrument is practically unaffected by extraneous noises of large volumes, even when these are some thousands of times the volume of the transmitted speech, as in the case of high-powered unsilenced aero engines. The insensitivity of the throat microphone to extraneous noises renders it possible for use in any noisy situations other than on aircraft, as for example, in shipbuilding yards, stamping mills, &c. This transmitter is being manufactured by the Relay Automatic Telephone Co., who have rendered great assistance in its development.

(To be concluded.)

Electricity for Canning Operations.—According to the "Electrical World," the Department of Agriculture (U.S.A.) recently arranged with the New York Edison Company for a series of tests of electricity for canning and drying. A detailed account of the tests is to be published by the Department of Agriculture, but meantime some interesting facts have been established. Originally an electric range was used, in the same manner as a gas stove. The material results were good, but the energy consumption was unduly heavy. The next tests utilised the oven of an electric range, the sterilisation temperature being obtained by baking rather than boiling. This diminished the energy consumption by half, and by further omitting the water bath commonly used for canning a further decrease in consumption was achieved, making the cost of electricity only 4 cents (2d.) for two jars. The electric fireless cooker has proved extremely useful for this work. Jars were placed within this apparatus and the current turned full on until a temperature of 180° was reached; after this an expenditure of 40 watts is sufficient to keep the jars at the sterilising temperature, and the cost of the operation in this case is only 2 cents (1d.). This cost compares favourably with that of any other method of heating and suggests that there is a promising field for the electric fireless cooker for canning work. Drying of vegetables was also experimented upon, an electric fan being used to accelerate the process.

The Erith Works of the General Electric Company.

The tendency now-a-days is towards amalgamation. Firms which in days gone by worked happily in water-tight compartments or competed with one another for contracts have now as the result of round-table conferences agreed to sink their differences and fight together in the common cause. Among those who have taken part in this latest development of the electrical industry is the General Electric Company. No one can accuse this undertaking of lack of enterprise, and we feel sure that the policy in their case is likely therefore to have in it all the elements of success. One of the firms with which they have been in negotiation along the lines mentioned are Messrs. Fraser & Chalmers, who are well known not only as makers of machinery for metalliferous mines and metallurgical works, but also in the development of the Rateau turbine and in the manufacture of conveying, loading and other plant for handling goods, while they are also known in connection with the installation of dry gas cleaning plant for use with blast furnaces. During the war the business of the firm developed in all these directions, while a large amount of war work was undertaken for the Admiralty, War Office and Ministry of Munitions. This included the erection of Diesel engines and manufacture of buoys, trawler engines, pontoon boats, armoured cars, heavy gun parts, shell dies, cast-iron chemical shells, the erection and re-conditioning of guns and the supply of parts for the fitting up of a number of the earliest caterpillar tractors.

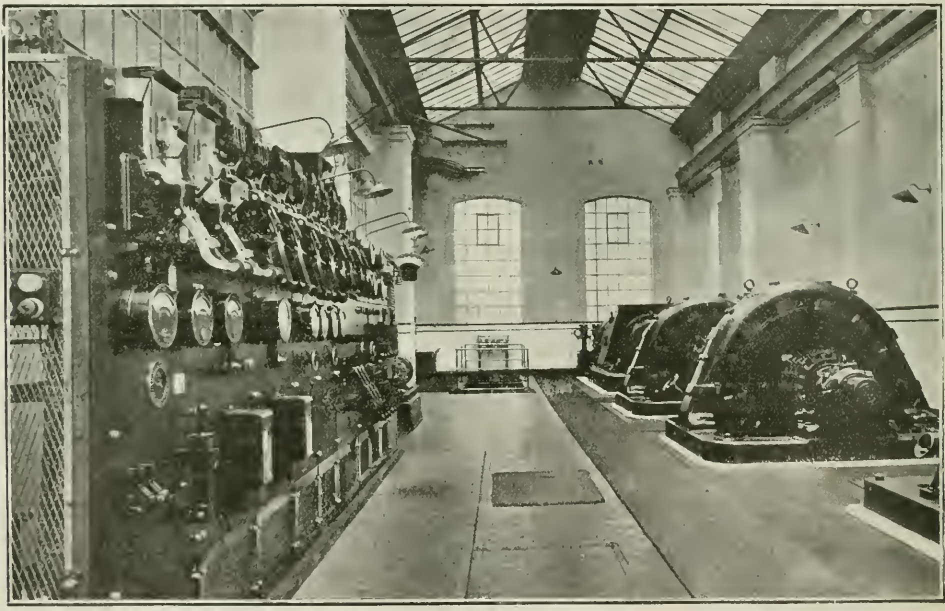

FIG. 1.—THE POWER HOUSE AT THE ERITH WORKS OF THE GENERAL ELECTRIC COMPANY.

Since the Armistice the firm has turned to more peaceful pursuits, and when we recently visited the works we found them as busy as the moulders' strike would allow on the construction and erection of steam turbine plant and of the other specialities mentioned above. We are glad to learn that the change-over from war to peace conditions was effected without it being necessary to discharge any of the hands.

The works cover an area of about 18 acres, close to the River Thames at Erith and within 14 miles of London. They are, therefore, excellently situated for both the inland and export trade, being within easy reach either by river, road or rail of all the principal London goods termini and docks. The shops comprise pattern shop, carpenters' shop, smithy, iron foundry, boiler and plate shop a large machine shop, which is given over to general engineering work, and a turbine machine shop devoted entirely to the steam turbine manufacture. The main offices are adjacent to the shops, and in normal times over 2,000 employees are engaged in the production of finished machinery, aggregating approximately 800 to 1,000 tons per month.

The works are, of course, electrically driven from a generating station in the works. The boiler house is equipped with water tube boilers fitted with chain grate stokers and working at 175 lbs. per sq. in. The coal is fed by an F. and C. belt conveyor into an overhead hopper, whence it automatically descends by gravity into the furnaces of the boilers. One turbo-set is installed, to which is coupled direct a "Witton" 1,500 kw. 3-phase 50 cycle alternator running at 3,000 revolutions per minute. The turbines are of Fraser & Chalmers manufacture. There are also two "Witton" rotary converters, which are coupled in parallel and running at 500 revolutions per minute, supply direct current at 440 volts. There is in addition a small motor generator set which is used for supplying the lighting circuits and an electrically driven air compressor for supplying the machine tools. The switchboard was supplied by the General Electric Company.

Turning to the shops, the smiths' shop is well equipped with steam hammers, sawing and cutting-off machinery, and is adjacent to the main general machine shop. This department has also an oil fired annealing furnace. The foundry consists of two main bays measuring 360 ft. by 155 ft., and is situated approximately in the centre of the works and adjacent to the main railway sidings. The entire length of these bays is covered by six 25 ton electrical overhead travelling cranes. The department is well equipped with large and small ramming machines, together with pneumatic moulding machines for repetition work. The whole of the sand mixing and other machines are electrically driven, and Piftin hot air mould drying machines are also installed. It has been the policy of the company to provide for high grade and difficult castings up to approximately 35 tons weight. The boiler and plate shop has been specially equipped for the manufacture of boilers, mining plant, gas cleaning and conveyor plant, structural work, furnaces, etc., and is fitted with pneumatic tools for caulking and rivetting in addition to the hydraulic presses and rivetting installation. It is also equipped with oxy-acetylene and electrical cutting and welding plants, together with special machines for dealing with perforated plates and tank work, such as heavy shears, rolls, etc. The general engineering shop is arranged for the manufacture

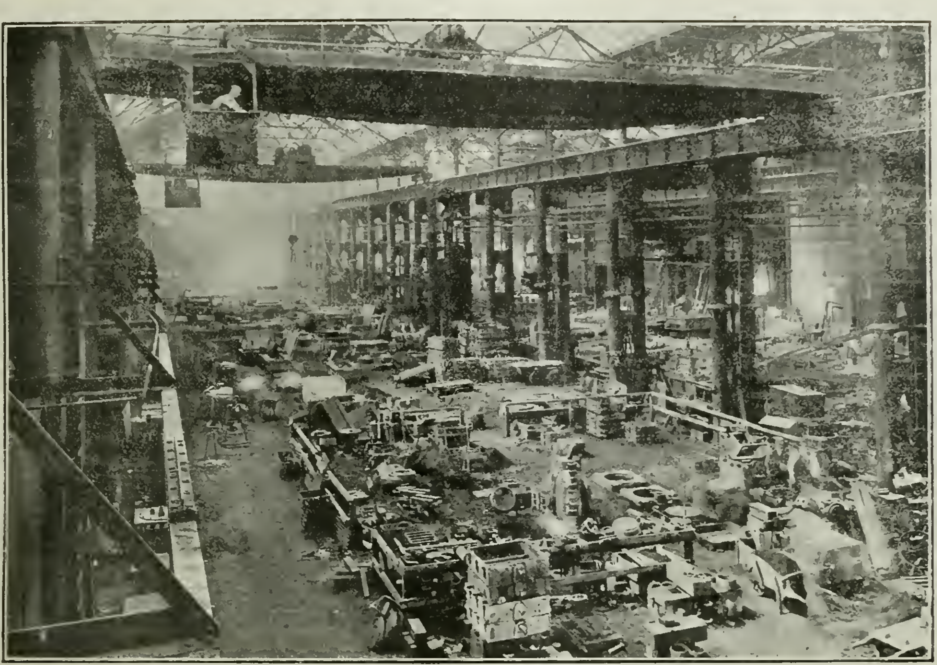

Fig. 2.—View in the Foundry at Erith Works of the General Electric Co.

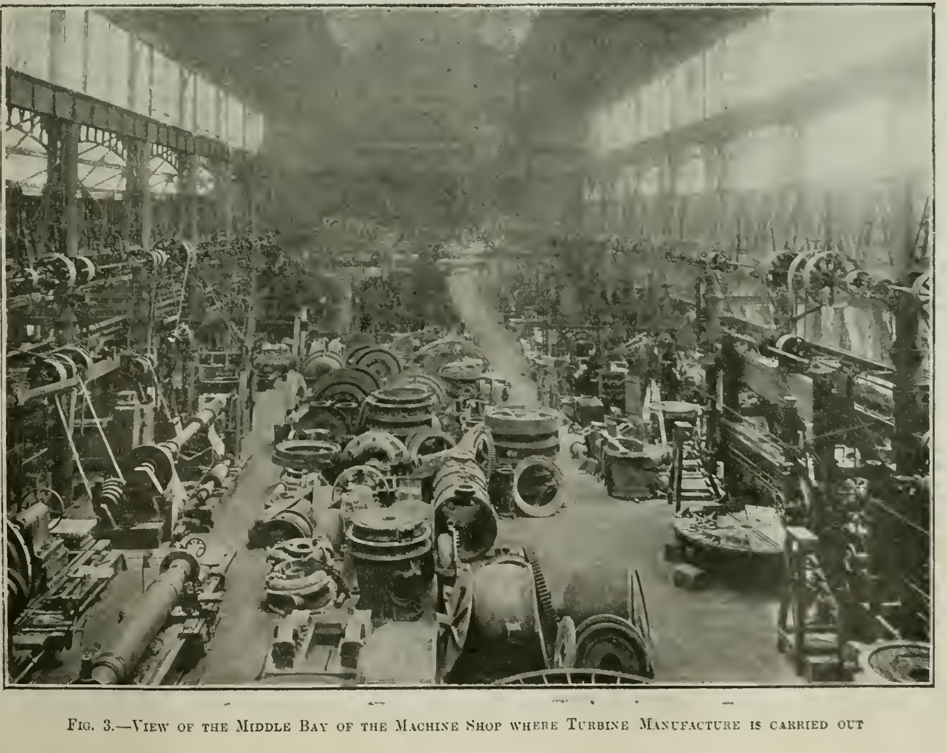

Fig. 3.—View of the Middle Bay of the Machine Shop where Turbine Manufacture is carried out

of large winding engines and air compressors, both steam and electrically driven, also for fixed large steam engines for mill and factory driving, and various classes of mining machinery and general engineering. It is well equipped with overhead cranes up to 25 tons as well as large boring, turning, planing and slotting machines. Adjacent to the department is the works tool room.

Perhaps the most interesting department of the works is the turbine shop. This shop has been specially designed and fitted for the manufacture of large steam turbines, turbo-blowers and turbo-compressors, and is equipped with such high-class machinery, as boring and turning mills, planing machines, lathes, presses—for forcing the shafts into the rotors of turbines—balancing machinery etc. During our visit there was a great deal of work going on in this shop, and we were enabled to see for ourselves the up-to-date character of the methods employed.

It is the firm's custom to erect and test every machine in this department before despatch. In order to do this satisfactorily a considerable number of test beds have been built with the necessary condensing plant underneath. On either side of this shop there is a gallery, one of which is entirely devoted to the manufacture of blades for turbines, which it is found most economical to machine from bars of rectangular section, though other and more obvious methods have been tried with less success. It will be seen the greatest possible care is exercised in regard to the material and the workmanship so as to produce a high-class article. This has involved a great amount of labour and expense, including an outlay on special machine tools, jigs, tools, etc. The other gallery is devoted entirely to the assembling, rivetting and finishing of wheels for turbines and blowers. On the completion of assembly the wheels are balanced and are then tested in a special machine at a speed of 30 per cent. above normal. Special electrical heating devices are installed in this department so as to ensure satisfactory rivetting of the bands on the ends of the blades, but electrical welding is not so far employed.

The wood working department is accommodated in a separate block of buildings, and comprises the carpenters' shop, pattern shop and pattern stores. The ground floor is occupied by the carpenters, and here is installed all machinery such as frame saws, planes, morticing and other machines necessary for the manufacture of mining and other plant. The pattern shop is on the first floor, and is adjacent to the drawing office. It contains labour-saving devices, such as a Wadkin pattern-making machine, disc grinder, band saws, circular saws and planing machines. In close proximity to this shop is the pattern store, which is fitted with a very complete arrangement of racks, the whole of which are numbered, and a complete card index file is kept of all patterns. The whole of the different working departments are fitted with sprinklers in the event of fire.

A separate department is installed in the works for the manufacture of conveyor and gas cleaning plant, and this department is fitted with the necessary tools and machines required for the manufacture of belt conveyors, grab transporters, gas cleaning plant details, and idlers for conveyors, the demand for which has necessitated a new shop adjacent to the existing building in order to cope with the demand.

Among the plant which we saw going through the shops on the occasion of our visit was a 15,000 kw. turbo-alternator with 23,500 kw. overload capacity. This machine will work on a very high vacuum. Divided flow is arranged on the low pressure stage for the Glasgow Corporation, and a turbo-compressor with a capacity of 20,000 cubic ft. a minute, thus making it the largest machine of its kind manufactured in this country.

Sir John Griffith on Engineering Progress.*

The Engineering Development of Ireland.

During the war members of all classes to the number of 3,127, or 30 per cent. of the Institution's numerical strength, were called to service in either the Navy, Army or Air Force, and every class is represented on the Roll of Honour. Over 10 per cent. of those mobilised laid down their lives, and amongst the 90 per cent. who survived many have been maimed or disabled. The unobtrusive work of those members whose age prevented them from going on active service is apt to be forgotten, but many of them placed their mature experience unreservedly at the disposal of the Government. Their greatest reward must be the knowledge that they have done their best to hasten victory and peace; and that the Institution is proud and grateful for their services. In reviewing the activities of the Institution, the valuable work done by some of the members on committees which have been appointed to deal with special subjects must not be forgotten. These subjects include the thermal efficiency of the steam engine, the standardisation of engineering materials, the use of reinforced concrete and the deterioration of structures exposed to sea action. The work of the Committee on the last-named subject is still proceeding, under the chairmanship of Sir William Matthews, and arrangements have been made for an extended series of experiments to be undertaken, the results of which will be of immense value to engineers engaged on marine works.

It is often asked what is the advantage of being a member of the Institution, and what compensation does a member receive for the payment of his annual subscription and for the trouble he has to take to obtain admission? How can the interests of engineers scattered all over the world be safeguarded by an institution which is controlled by a comparatively small number of engineers living near London? Speaking as a provincial member, there is no doubt that residence near London is a considerable advantage, and these advantages are recognised in the different rates of subscription paid by London and country members; but the proposal to widen the control of the Institution by the inclusion of provincial members might defeat the object aimed at, as country members on the Council are not able to attend regularly, and the result would be the placing of the real control of the Institution in the hands of a small minority resident in or near London. Regular attendance at Council meetings is indeed of great importance, and any large extension of provincial representation would only weaken the Council's influence and usefulness. It must be recollected that the field of our members' work is now world-wide. Membership of all classes had risen from 156 in June, 1828, to 9,000 just before the war, while the number of subjects dealt with have multiplied enormously. Means of communication and transport by roads, railways, tramways, steamships and aircraft have increased and advanced by leaps and bounds. The well-being of the great centres of population has called for the assistance of our greatest engineers for the water supply and drainage of towns. The need of improved intercommunication has led to the utilisation of electricity for cables, telephones and wireless telegraphy; while the demand for economic distribution of power has been productive of advances in hydraulic, pneumatic and electrical transmission of energy.

It stands to reason that, in the face of its numerical increase and the world-wide influence which it promotes, it is the duty of the Institution to endeavour to make itself as useful to its 9,000 members as its founders made it for their 156. If this view is accepted, the proposals of members put forward in what they believe to be the interest of our professional corporate life must be considered and carried out. Two questions of importance to our Institution and to our profession have thus come before the Council during the past year. The first is the desirability of forming local or provincial associations of corporate members for mutual intercourse, and the furtherance of their professional knowledge and interests. The second, whether the time has come for seeking legal recognition of the profession of the civil engineer and the registration of engineers. An influential deputation of members from the Midlands presented a case in favour of the formation of local associations. This desire appears to be a natural and reasonable development of the students' associations which have been formed in many of the large towns. The success of these associations is undoubted, but their usefulness is limited to the fact that the student must cease to remain a member of the association at the age of 26, and if he wishes to retain his connection with the Institution after that age he must seek admission as an associate member. It is therefore felt that the formation of associations for members of other classes and students would be a distinct gain to the Institution, especially as it would appear that at the present time the Institution is not sufficiently in touch with the work of its members, and that the formation of local associations would lead to the presentation of more Papers of special personal or local interest than is possible at the moment. The example of the Institution of Civil Engineers in Ireland, and of other local associations, should dispel any fears which may exist as to the formation of such associations being in any sense detrimental to the interests of the Institution, whose aim it should be to assist in the formation of federated societies in preference to completely independent institutions.

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*Abstract of the Presidential Address to the Institution of Civil Engineers.

Another problem with which we are faced at the present time is the legal status of the profession of the civil engineer. It is a problem which has been occupying the attention of the Institution for a considerable number of years, and as long ago as 1886 the annual report expressly discountenanced the use of the simple letters C.E. as not being founded on any qualification, and as being calculated to mislead. Recently the Council sent out a notice to members asking them whether they approved of the Institution taking steps to obtain statutory powers to prescribe the qualifications, to conduct examinations for admission to the profession of civil engineering, to keep a register of civil engineers, and to prevent persons who were not duly qualified from holding themselves out as members of their profession. Ninety-seven per cent. of the replies received were in the affirmative. This is viewed as a distinct direction to seek the necessary powers. It is not claimed that every qualified civil engineer must be a member of the Institution of Civil Engineers, but that no one should claim to be a civil engineer without being suitably and legally qualified.

In the twenty-fourth James Forrest lecture I considered some of the economical problems in connection with the handling of materials at ports and other large centres of traffic, and endeavoured to show that the term "labour-saving appliances" should be replaced by that of "labour-aiding appliances." This problem has now to be faced in an acute form. The increased cost of living due to the war has led to demands for increased pay. This increased pay has been granted broadcast, and with the declaration of the Armistice the out of work donation was invented. We must, therefore, not only see ourselves, but get all classes to see, that, unless we alter our methods, increase in wages means simply increased cost of production and increased cost of living, and that, unless the output is increased, we shall move in a vicious circle, and there will be no real permanent improvement in the condition of our people. The unrest which is so widespread is no doubt due to the suspicion that the workman is not getting a fair share from the revenue derived from industry. In the case of Ireland, for instance, the Act of Union, which abolished the Irish Parliament, led to the migration of the Irish landed proprietor to Westminster, where, in a spirit of emulation, they endeavoured to imitate the ways of living of the wealthy English aristocracy. The resident landlord became an absentee, and was replaced by the resident agent. Every improvement effected by the tenant meant an increase in rent, and the land war, with all its tragic misery, followed. For this the only remedy was the transfer of the land to the tenantry. Now in the industrial life there has also been a severance in the relations of masters and men. The old paternal government ceased with the introduction of the Limited Liability Companies Acts. Trade unionism followed, for the men had to look after their own interests. For this state of affairs the only remedy is a wide adoption of co-operation, co-partnership or profit sharing. In some industries this scheme has already been successfully adopted. It ought to be extended broadcast throughout our industrial system.

Turning to the question of what our profession has done in Ireland, the story of engineering achievements in that delightful land is one of the brightest spots in its sad history. If religious intolerance and political intrigue can be banished, and the land handed over to the guidance and control of engineers, what prospects would be opened up in industrial progress and contentment! It is a striking fact that this small island was the birthplace of the largest telescope, the largest ships, the largest sluices, the largest concrete blocks for harbour work and the most striking improvement of a dock harbour entrance by artificial scour, while the industrial factories in Ireland can claim the largest brewery, the largest linen, spinning and weaving works and the largest rope works, while in railways, tramways and lighthouses she also takes a high place. Ireland also takes the lead in tramway construction, and the Dublin United tramway system is one of the finest and best managed tramways in the United Kingdom. Its mileage exceeds 54 miles, and in 1918 it carried over 71 million passengers. The Giant's Causeway Electric Tramway was constructed over 38 years ago, when electric traction had hardly passed its experimental stage. The energy for working is obtained from a waterfall, and it thus forms the pioneer hydro-electric tramway of the world.

The coal panic of the past few years has drawn attention to the unused peat deposits in the United Kingdom, and in 1917 the Director of Fuel Research decided to set up a small committee to inquire into the utilisation of Irish peat deposits. This question has, however, been considered by the Bogs Committee in 1909, and the evidence then taken showed that practically all the large bogs of the country could be naturally drained without pumping, and that the effect of this systematic drainage would be to make them available for tillage and peat winning. The difficulties in the way were not physical, but were principally to be ascribed to the indeterminate nature of the boundaries between adjoining properties and the rights of turbary and grazing claimed by the tenantry. The effect of the Corn Laws agitation discouraged home agriculture, and no steps were therefore taken to reclaim the bogs of Ireland, so that the valuable work of the Commission has been shelved for more than 100 years. It is estimated that at the present time the Irish bogs contain between 3,500,000,000 and 4,000,000,000 tons of anhydrous peat, or 5,000,000,000 tons of air-dried peat. At present about 6,000,000 tons of peat are burned as fuel in Ireland per annum, and over 4,500,000 tons of coal are imported. If this coal were replaced by peat fuel at the rate of 2 tons of air-dried peat to 1 ton of coal, the total consumption of peat in Ireland would be about 15,000,000 tons per annum, and the peat deposits would be sufficient to satisfy the fuel and power requirements of the country at the present rate of consumption for more than 300 years. The reports of the Irish Peat Committee, dated February, 1918, and July, 1918, have been in the hands of the Government since September, 1918, and nothing further has been heard of them.

As regards water-power resources, a Committee was appointed in June, 1918, by the President of the Board of Trade, to examine into the water-power resources of the United Kingdom. A sub-committee was specially appointed to deal with Ireland. In this case Ireland is in the advantageous position that the Board of Public Works exercises control over several of the principal rivers and waterways, and its archives contain valuable information relating to them. This information has been placed at the disposal of the sub-committee. There are a great number of sources of power on the principal rivers; but here, again, there is a conflict of interests to be met, and there is little hope of dealing thoroughly and economically with such problems, unless there is some unified State control which can deal with them on broad lines of national utility. With the advances made in electrical transmission, however, it is hoped that there will be a linking up of the scattered water resources in Ireland to form a useful service to supplement our fuel resources.

At the present time economy is the cry, though there is danger that the word may become merely a party cry, and it is well to bear in mind that the mere stoppage of the expenditure of money may not be economy, but may result in real waste. It is not economy for a nation to save expenditure by not developing its resources; it is not economy to cultivate competition at the expense of a large expenditure of unremunerative capital. It is not economy to allow peat bogs to remain undrained and unclaimed when they might become a source of national wealth in food and fuel. It is not economy to allow our water-power resources to run to waste instead of utilising them to reduce our coal consumption, and delay the day, which is not far distant, when our coal supplies will be exhausted or unavailable, either by consumption or increased difficulty in winning.

We should look the approaching exhaustion of our coal supply fully in the face. It may be 100 years or 200 years distant; but year by year the difficulty of winning will increase, due to the increasing distances of the coal faces from the pit mouth, the longer time the men will take to get to their work, and the shorter time they will spend at the working face. Output under these conditions must decrease and price of coal rise.

The lessons of the war as regards Ireland are its isolation, the importance of its strategical position and the deficiency in harbours on its western coast. It was around the coast of Ireland that the submarine menace was chiefly felt, and if an hostile fleet had got command of the sea near her shores Ireland would undoubtedly have been used as a base against our overseas trade. If Germany had had Ireland in its possession it would become a second and more powerful Heligoland. At present the western coast between Berehaven and Lough Swilly is unprotected. It is thought that another naval base should be formed in Galway Bay, and a thoroughly equipped harbour built there which in peace time could be used as a deep-sea fishing station and as a final port for high-speed passenger and mail service between Canada or the United States and Europe. It is impossible to lay too much emphasis on the importance of keeping Ireland as a thoroughfare between America, Canada and this country. By combining these defensive and strategic requirements with a scheme which would be productive of great commercial advantage to the country much would be done to unite Nationalists and Unionists. Ireland is the landing place of several Atlantic electric cables, has been a principal station for transatlantic wireless telegraphy, has been the landing place for the first transatlantic direct flight, and it should be the principal bridgehead for the transatlantic mail traffic between America and Europe.

Recording of Eiffel Tower Time Signals for Determination of Clock Error.

By L. R. TURNER, M.A.

The experiments described in this Paper were instigated by a demand for wireless recording apparatus to be used in determinations of longitude for survey work in East Africa. They were carried out at the Signals Experimental Establishment, Woolwich; and I am indebted to Lt.-Col. Cusins, C.M.G., R.E., for permission to reproduce the photographs of apparatus and records. The chronographs and the astronomical clock used in the experiments were kindly lent by the Astronomer Royal. The precise determination of clock error being important in other places than East Africa, and not only in geographical surveys, it is thought that the matter will be of general interest.

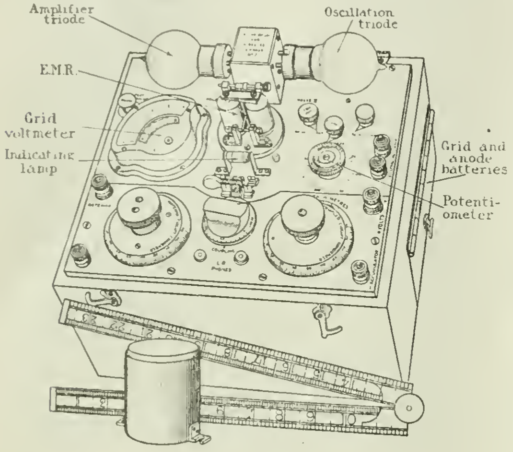
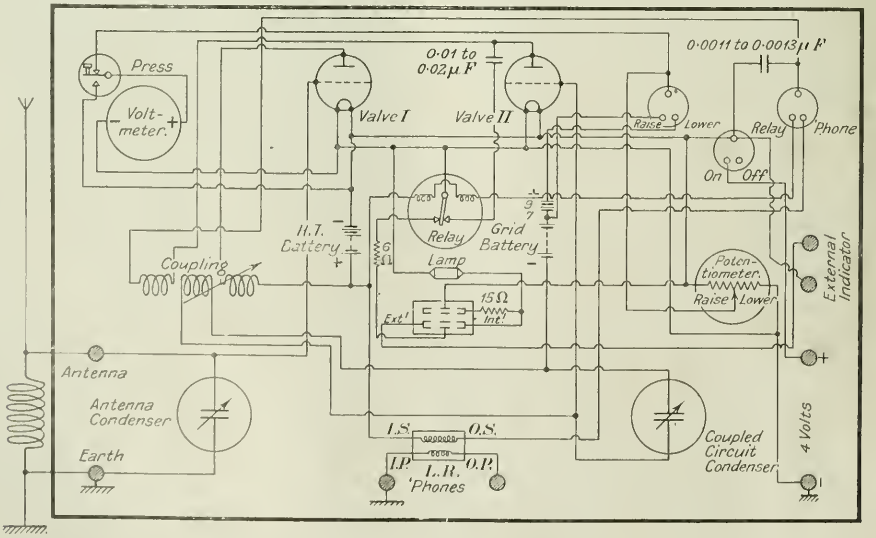


FIG. 1.

The Eiffel Tower sends out two time-signal services, viz. the "Ordinary" time signals in the morning and the "Scientific" time signals at night. The "Ordinary" signals consist of a code of dots and dashes, the elements of which are scheduled to begin and end at definite times between 9.58 a.m. and 10 a.m. (G.M.T.), on a wave-length of about 2,650 metres. The "Scientific" time signals consist of a series of 300 single sparks (with the 60th, 120th, 180th and 240th omitted for identification), equally spaced about 49/50 $^{\text{hs}}$ second apart, at about 11.30 p.m., on a wave-length of 2,000 metres. The times of the first and last sparks are signalled subsequently on a wave-length of about 2,650 metres. The "Scientific" time signals, besides being timed more precisely than is possible with the "Ordinary" time signals, allow the skilled observer to compare his chronometer with the Eiffel Tower to within a tenth of a second or so by the Method of Coincidences, without resort to any apparatus beyond a simple auditive wireless receiver.

Where greater precision is required, as in astronomical work, or where interference from atmospherics is so pronounced and continuous that the operator cannot instantly decide which of the many ticks heard are time signals and which are atmospherics, it is necessary to produce an automatic simultaneous record of the chronometer indications and the time signals. Subsequent study of the record enables one to discriminate between time signals and atmospherics, and to measure up time intervals to within 1/100 second or so. In places such as East Africa, prevalence of atmospherics combined with remoteness from the Eiffel Tower, seem to make the recorder method essential.



INSTRUCTIONS.

1. This valve relay is suitable for C.W. and spark signals of about 1,300-3,200 metres wave-length.

2. When tuning up, set switch to phones, raise grid potential (by switch and potentiometer) enough to cause Valve II. to generate and tune in for signals in phones, making final adjustment of antenna condenser with loose coupling.

3. Switch over to Relay, tighten coupling; and reduce grid potential until relay just ceases to chatter. Re-adjust coupled circuit condenser (very slightly only) and grid potential.

4. Minimise jamming by having loose coupling.

5. Change of coupling, but not of grid potential, may necessitate slight re-adjustme of closed circuit condenser, but not of antenna condenser.

FIG. 2.

RECORDING APPARATUS.

The simplest apparatus which can be used for recording wireless signals is the Oscillatory Valve Relay, and in this experiment the two-valve high-frequency Valve Relay shown in Figs. 1 and 2 has been used.[*] This, when tripped by a wireless signal, energises, through an ordinary Post Office relay, one indicating magnet of a double chronograph; the other magnet of the chronograph being energised at one-second (or other) intervals by an electric contact in the clock whose error is to be determined.[†] The circuits are shown in Fig. 3. Concurrent time records are thus obtained on a single paper slip, which may subsequently be scaled to determine with great accuracy the discrepancy between the two sources of time indications.

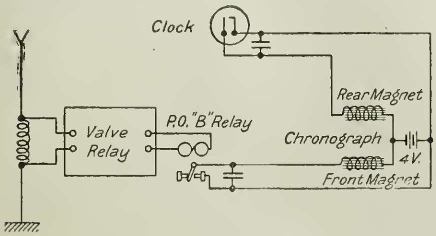


FIG. 3.

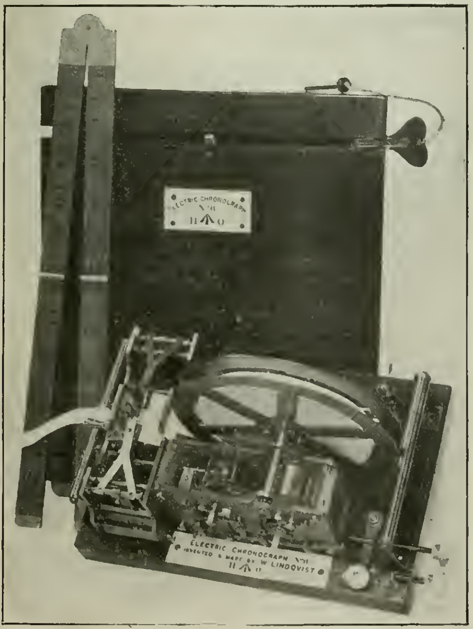


FIG. 4.

Two patterns of chronograph have been used; viz., the common astronomical Hilger chronograph, in which the two records are made by two fountain pens carried on the armatures of two electro-magnets; and the Lindquist chronograph in which the records are made by two sharp points which punture the slip at the beginning of the signal. The latter pattern, which is photographed in Fig. 4, is particularly suitable for survey work on account of its compactness and the avoidance of ink. It can be used while entirely enclosed in its case.

LAG IN THE WIRELESS RELAY APPARATUS.

It is obviously necessary that the time-lag in the wireless relay apparatus—*i.e.*, the interval between arrival of the wireless signal in the antenna and the closing of the contact which actuates the chronograph—must be either negligible, or constant and known. This lag is the instruments used has therefore been determined.

Fig. 5 shows the method adopted. When relay *P* is actuated by the clock, its tongue is deflected to the right, thereby suddenly changing the potential of the base of the antenna by the E.M.F. of the battery inserted in it. The antenna is thus set into oscillation and a signal is produced of about the same strength, if the battery is suitably chosen (in this case 4 volts), as the signals from the Eiffel Tower. The following observations are then made:—

(*a*) Measure mean lag of front record on rear record, say t_a.

(*b*) Interchange local circuits of relays *P* and *Q*. Measure mean lag again; say t_b.

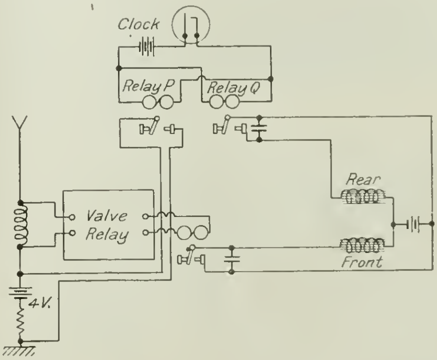


FIG. 5.

(*c*) Connect both magnets of chronograph to same relay *P* or *Q*. Measure mean lag again; say t^c.

Then total lag in the wireless relay apparatus is

$$\tfrac{1}{2}(t_a+t_b)-t_c.$$

Actual lag measurements made are shown in the table in seconds, nine successive records on the slip being measured up in each case.

t^a.	t_b.	t_c.
0·060	0·060	0·060
0·060	0·060	0·055
0·065	0·055	0·060
0·060	0·060	0·055
0·055	0·055	0·060
0·060	0·060	0·055
0·060	0·060	0·055
0·060	0·060	0·055
0·065	0·065	0·055
Mean =0·0605	Mean =0·0595	Mean =0·0567
Mean=0·0600		

Hence lag=0·0600−0·0567=0·0033 second.

A second determination (with a very different setting of grid potentiometer of the valve relay) gave a lag of 0·00610 sec. Thus we may take the lag as probably about 1/200 sec.; certainly less than 1/100 sec.; and therefore generally negligible.

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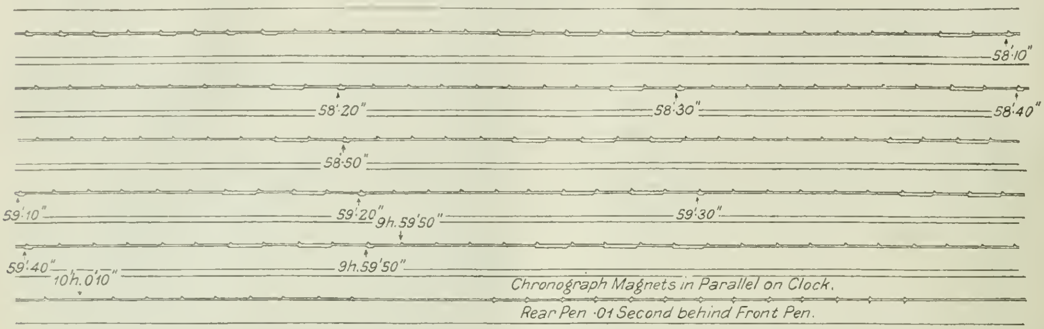
[*] More fully described in "The Oscillatory Valve Relay: A Thermionic Trigger Device," a Paper read by the author before the Institution of Electrical Engineers on June 30, 1919.

[†] If the clock, or chronometer, is not provided with an electric contact mechanism, the chronograph may be actuated by the sound or jolt of the tick acting upon a microphone supported on the clock. Considerable complication of apparatus is entailed thereby.

EXAMPLES OF RECORDS.

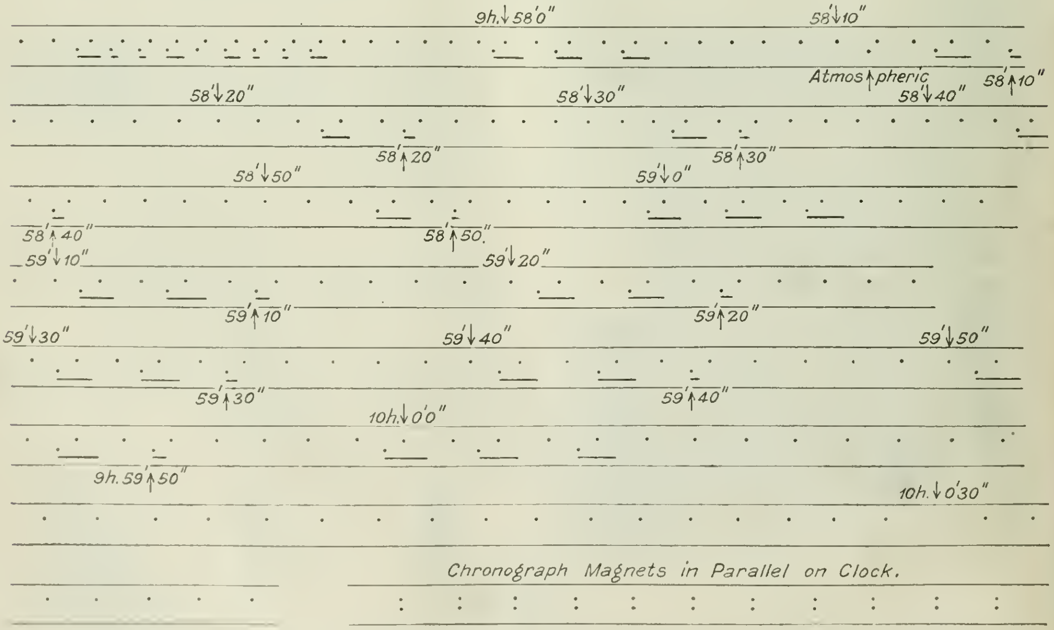
Figs. 6 and 7 are examples of records, taken with the Hilger and Lindquist chronograph respectively, to determine clock error from the "Ordinary" Eiffel Tower time signals. In the Lindquist record, the puncture marks have been inked in by hand to make them more easily visible; and as only the beginnings of dots and dashes are automatically recorded, the dots and dashes have been made more recognisable by short and long lines drawn in below the puncture marks.* It is obvious that the determinations could have been made with the "Scientific" time signals equally easily, and presumably with greater accuracy.



Clock Error (Mean of 10 Readings at Times marked) = −1·04 Seconds.

FIG. 6.—DETERMINATION OF CLOCK ERROR. HILGER CHRONOGRAPH.
Rear Record: 1-second impulses from clock. Front Record: Wireless signals from Eiffel Tower.

Upper Dots mark One-Second Impulses from Clock;
Lower Dots mark Beginnings of Wireless Signals.



Clock Error = +4·59 Seconds (Mean of 10 Readings).

FIG. 7.—DETERMINATION OF CLOCK ERROR BY MORNING TIME SIGNALS RECEIVED FROM EIFFEL TOWER. LINDQUIST CHRONOGRAPH RECORD.

Fig. 8 is a record of a part of the "Scientific" signals taken on a night when atmospherics were prevalent, and with the valve relay so adjusted as to be sensitive to them (small potentiometer "margin," and tight coupling between valves). Although the jamming is very bad in places, and would have made the determinations by ear difficult or impossible, it is here scarcely even an inconvenience; for the separate time signals are distinguishable from the atmospherics by measurement, or bad periods may be disregarded in favour of moments when the jamming is less severe. There are six available points of departure in the series of signals—viz. the beginning, the end and the four omitted dots—and unless jamming were so bad as to make it impossible to disentangle any two, the determination of clock error would not be prevented.

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* The records were prepared for reproduction by cutting up the whole slip in 6 lengths and pasting these on a sheet of paper. It is regretted that tracings had to be made, photographic reproduction not being feasible here. The well-known Morse X, O, N, O, G, O cycle of the "Ordinary" time signals will be easily recognised.

ADDITIONAL WIRELESS APPARATUS REQUIRED.

In these experiments, an antenna about 200 ft. long and 50 ft. high was used. With this the Eiffel Tower signals could be made to give as much as 2 or 3 volts on the grid of the oscillatory valve—say 10 times as much as necessary. Hence the valve relay as shown in Fig. 1, with only a 4-volt battery and an ordinary telegraph relay as auxiliaries, would suffice to record on any chronograph the time signals received on any quite small antenna in this country. At greater distances from Paris, in particular at East Africa, larger antennæ and (or) powerful high-frequency amplifiers between the antenna and the valve relay will be necessary. The apparatus might well take the form of a valve relay very similar to that of Fig. 1, but including the auxiliary Post Office relay; a standard or special multi-valve high-frequency amplifier in a separate case; a Lindquist chronograph; and a chronometer fitted with electric contacts.

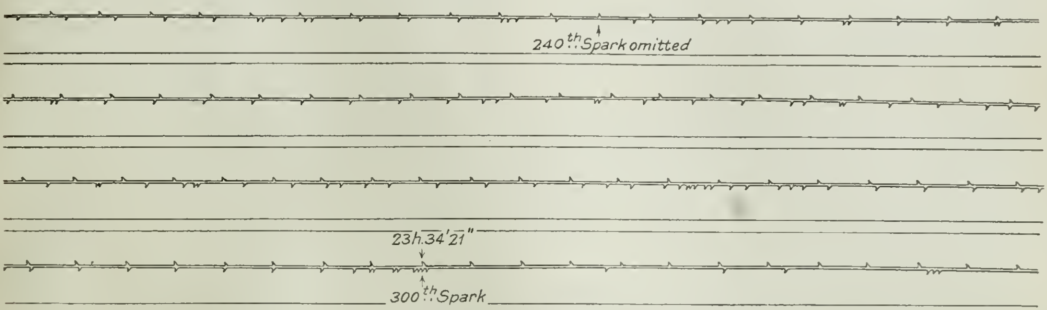

FIG. 8.—"SCIENTIFIC" TIME SIGNALS AND ATMOSPHERICS. HILGER CHRONOGRAPH.
Rear Record: 1-second impulses from clock. Front Record: Wireless "Scientific" Time Signals from Eiffel Tower, and atmospherics.

Automobile Exhibition at Olympia.

One cannot help wishing that there had been the same enthusiastic attendance at the recent Shipping and Engineering Exhibition as is to be found daily at the present Motor Exhibition. Whatever allowance is made for the factor of popular appeal due credit must be given to the Society of Motor Manufacturers and Traders for the manner in which they organise an exhibition and employ suitable methods to ensure an adequate attendance. There was, of course, the usual last minute scamper to get things ready, but opening time found the exhibition in good order, and but few stands were behind time in the end. A general survey reveals but little tendency on the part of manufacturers to compromise in design and sacrifice the ultimate in efficiency and convenience with a view to reducing prices to a lower level. Numerous examples of high-priced cars are to be found, in which no stint has been made on the score of cost, so long as the result is as efficient and luxurious a car as possible. Only 2 per cent. of the cars exhibited are priced at £300 or under, whilst 20 per cent. are between £300 and £400; 40 per cent. between £500 and £1,000; and 25 per cent. exceed £1,000 in price. Under present conditions one naturally expects prices to be on the high side, but there is coming a time when the artificial spending power of the moment will have passed, and the demand for a serviceable car at reasonable cost will remain.

The most curious factor of the whole exhibition is that the public may examine the many models exhibited, but to buy is another matter. Order forms are signed, but delivery is an estimated quantity. However, though outputs are sold it does not follow that buying at the exhibition is the best plan, because many existing orders were booked by makers or agents, and the latter may not have sold their stock order. That is, it is quite possible that cars will be obtainable more quickly from agents than from manufacturers. One noticed many newcomers to the trade in the shape of firms who have changed over from the aeroplane and shell industries to the motor industry. Their designs show that they start unfettered by prejudice and existing standard types, which is all to the good of the future development of the industry.

So far as the moderate priced cars are concerned, and naturally also the high-priced cars, electric lighting and engine starters are practically universal. The days of dirty acetylene generators seem to be numbered, and the advent of the lady driver has naturally led to the more general use of electric self-starters. We hope that no tendency will arise to use either electric lighting or ignition systems of poor quality, a factor in the past which has often been the cause of creating prejudice against electrical apparatus. It is unfortunately so easy to cover over poor insulation so that only use reveals the hidden defects. The wider use of engine-driven dynamos for lighting purposes and consequent continual charging of the batteries probably accounts for the fact that many makers have employed coil ignition in place of magneto ignition. It certainly is not quite a war cause, because thoroughly sound and efficient British made magnetos can now be obtained.

The war has evidently driven home the lesson of the air-cooled engine. The many types of light car exhibited, a large proportion of which are made by firms new to the industry, nearly all employ this method of cooling. It is cheaper, lower in weight and free from radiator trouble.

Messrs. C. A. VANDERVELL & COMPANY, LTD., had a very representative display of car lighting equipment for pleasure cars, commercial cars, and public service vehicles; also electric starters and their now well-known magnetos. The finish and general design of the products of this firm leave nothing to be desired, and we were particularly attracted by their holophase lighting fittings for enclosed cars. Further, their literature calls for a word of praise. Not only are the various pamphlets attractively prepared and printed, but care is taken to explain to the user the functions of the apparatus and how it should be used. Messrs. JOSEPH LUCAS, LTD., are showing a variety of electric lighting and starting apparatus, and the number of cars in the exhibition which are fitted with Lucas appliances being sufficient evidence of the reliability of this firm's products. One naturally expects to find a high standard of design and workmanship from a firm which originally developed from the cycle industry, but that does not detract from the pleasure of realisation. Generally speaking, there is nothing particular in magneto design in advance of that already described in special articles in our columns.

Despite the fact that the demand for cars is at the moment greater than the supply (which fact caused a considerable amount of criticism on the advisability of holding an exhibition), we think it is just as well that the opportunity should have been given to the public to see the latest models, even though it may be a case of "See and Wait." Whether once the present abnormal demand caused by four years of war production, has been satisfied there will come a slump is mainly a question dependent on the possibility of supplying cars reasonable in price by manufacturing standard models on a parduction basis. At the moment there are only about eight cars obtainable under £300, which, assuming the value of a sovereign to be half in comparison with 1914, becomes £150. The majority of these are offered by new firms, a significant fact which seems to indicate that the older firms are not out to develop the possibilities of bulk production of a cheap car.

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A Municipal Supply "Scheme."

Now that the Electricity Supply Bill has nearly run its course in Committee, we can take it that it has assumed its final form, at least as regards the main lines. All undertakings now know exactly how they stand, and it is for them therefore to make the best possible use of the opportunities given them by the provisions of the new Bill. This is more important, as in many cases the fortunes of the supply undertakings are in their own hands.

Under the Bill there are broadly three courses open to the undertakings, whether municipal or privately owned, in any particular district. The first is, honestly to sink all private differences and jealousies and combine as a Joint Electricity Authority to devise a practical working scheme, which shall be for the good of all concerned. In their secondary capacity as a Joint Electricity Authority for the area they will have almost unlimited scope for doing this. The second course is to form a Joint Electricity Authority as a subterfuge, that is to put forward a paper scheme which shall be covertly obstructionist, and whose main idea will be frankly to preserve the existing state of things. The third course is for the Undertakings to meet and squabble and come to no agreement and at the same time to hinder persistently any section of the community that does put forward a scheme, thus hoping to exhaust the patience of the Commissioners until the latter is forced willy-nilly to use its powers to form a District Board.

Now it will be agreed that for the general good one of the paramount duties of the Commissioners will be to scent out cases where the second of these courses is being followed, and to give the culprits short shift. We hope, however, that the number of such cases will be few, and that in a short time we may see a number of schemes put forward for various parts of the country. At the moment, however, except for some long-standing and tentative proposals, the only concrete scheme that has been outlined under the new Bill is the Municipal scheme dealing with Greater London. This scheme so far as it has been made public contemplates the linking up and working out of the economical life of the existing municipal stations, at the same time gradually supplementing the supplies from the larger stations, and when the time is ripe, and then only, proceeding to erect a super-station. It will be noted that the scheme is purely a municipal one, and that its avowed intention is to avoid the over-capitalisation which "buying out" involves. The companies are not to be represented on the central authority, for the reason that their interest in the question is a diminishing one, in view of the approach of 1931. The central body which will be formed under this scheme would take over the existing powers of the London County and Borough Councils as regards purchase and would appoint four divisional boards for the four districts into which it is proposed the area should be divided. The companies would be represented on these boards, and possibly retain their present position as distributors, but the majority of the representatives would be from the local authorities. This concession to the companies is made to avoid "buying out," the proposal being simply to let the companies die out.

The scheme proposes that ancient palliative—that obscure operation known as "linking-up." It does not believe in bulk supply stations "immediately." "If a big bulk supply station were put down immediately," the report naively remarks, "it might happen that with the advance of electrical science in the meantime the new superstation would be dead before it was born."

We can only gasp in astonishment. Is it supposed by the promoters of this scheme that all the work of the Government Committees together with the huge labour involved in the new Bill is to be swept aside by such an *a priori* consideration, by an argument which indeed is equally fitted to stifle enterprise in 10, 20, or 100 years' time? Again, the proposals in the scheme as to dealing with the existing companies have surely been formulated in error. The report wishes to avoid the "possibility of buying out," and suggests as an alternative, "let the companies die out." We agree, in the words of a popular author, that this would be "a good idear" if only the companies would contentedly die out, but we feel sure they won't in 1931 any more than at the present day. They will have to be bought out then as now. To postpone the operation is no solution, one way or another. We have merely mentioned these points to indicate the incoherent nature of the scheme as at present drafted. But, indeed, the proposal, as it now stands, cannot be called a "scheme" within the intention of the present Bill. Still, after all, it may be meant merely as a *ballon d'essai*. In the meantime we hope that other and better schemes will be propounded both for London and elsewhere.

Review.

The Elements of Telephony. By A. CROTCH. 2nd edition. (London: E. & F. N. Spon, Ltd.) Pp. 114. Price 2s. net.

A book which covers the ground a little way on either side of the boundary dividing the telephone man from the telephone subscriber, cannot be easy to write. To give accurate and sufficient technical information, however elementary, for the one, and yet sustain the interest of the other, must be almost impossible. Mr. Crotch's booklet is a praiseworthy attempt. After an introductory chapter dealing with the principles of sound, electricity and magnetism, the operation of the telephone and auxiliary apparatus is explained. A description of exchange working from small magneto boards to large central battery equipments follows, and a final chapter on the automatic exchange is included. The explanations are lucid and the diagrams clear. The different circuits are shown as they exist in each stage of a call, a helpful feature for those whose experience with telephone circuits is commencing. Yet the desire for simplicity and anxiety lest the non-technical reader should be confused, has led to the omission of the important variations of even the fundamental (that is, line and cord) circuits, and to the description of automatic circuits which are long ago obsolete. There is scope for a book about telephones written entirely for telephone users; such a work could include some account of the line plant, of transmission and traffic matters of which the present volume contains nothing. Even the commercial side of telephony might be dealt with.

There is one very numerous class to whom Mr. Crotch's book should be of use—namely, the telephone operators. Without burdening them with more technical information than they need, it reveals in clear and simple language something of what lies behind the switchboard at which they work.

The matter has been carefully prepared, but some confusion has arisen from a revision of terms which has been only partially made. For example, "peg" and "plug," "bush" and "socket," "clearing" and "supervisory" are used indiscriminately. No distinction is made between "signal" and "indicator." Misprints are practically absent, and the type and figures, including the half-tone blocks, are beautifully clear. W. H. GRINSTED.

Mr. Arthur Ellis on Electrical Matters*

In the period prior to the war, whilst it will be readily admitted that the electrical industry made a certain amount of progress, such progress was not such as was desirable, owing to lack of interest on the part of those in authority, and it was not until some time after the outbreak of war that we had an opportunity of realising that the resources of this country had not been developed to the extent that they should have been.

A matter in which all those connected with the industry are very much interested at the present time is the introduction of an Electricity Supply Bill, as a result of which we may achieve those objects which we all have had in view for so many years past. To my mind it is regrettable that we should have waited so many years to learn what the great war has taught us, before the Government have really taken the matter into their consideration. Had it not been for the many restrictions imposed by Government Departments and others upon the operations of electricity undertakings, such a Bill as that now being promoted in Parliament might never have become necessary. The powers conferred by the Bill upon the Commissioners, if carried into effect in the right spirit, will be of undoubted advantage to the whole community, and it is satisfactory to note that the formation of District Boards will be suspended for the time being in order to give those interested a fair opportunity of devising schemes suitable for such areas, failing which, District Boards will be set up to take over control. This was one of the objectionable features of the Bill when originally presented, for it was generally felt that District Boards might be composed of individuals having no knowledge whatsoever of the electrical industry. A District Board, comprising the technical representatives of the various undertakings in an area, is a good solution, if they enter into the business with an entirely open mind; for they ought to be able to devise a scheme such as they would devise if they were financially interested.

A particularly good feature in the Bill is that relating to wayleaves. The effect of this restriction upon the undertakings of which the speaker has had control has been bad. Practically the whole of the industries of Cardiff are situated upon what is private property. These industries comprise chiefly ship repairing, shipment of coal, engineering work and flour mills. To-day there is no general supply of electricity available upon this property, as the authorities controlling this area have not afforded such supply themselves, nor will they permit the local authority to undertake the work, except under restrictions as would render successful administration practically impossible, with the result that important firms are to-day still dependent upon obsolete steam plant, and yet are only too anxious to equip their works electrically. Another good feature of the Bill is that relating to existing areas, which in the past have suffered as a result of being too restricted, not only in regard to lighting and power supplies, but also in regard to transport facilities. Considerable thought will have to be given to the effect that will ensue as a result of scrapping machinery and plant already existing, the cost of which will have to be taken into account in connection with new stations that might be erected, controlling, as it will do, the prices chargeable to consumers, such costs necessarily involving transmission lines with consequent loss in transmission, transforming and conversion.

The proposed super-power stations are not going to be set up in a day or two, and yet something must be done to supply the increased demands. It would seem therefore that some form of linking-up stations, not far remote one from the other, would be easy of arrangement. In this connection there is another matter of considerable importance, viz., the attitude of the individual who would desire to take a public supply, and yet, in the meantime has to install his own plant. The result is that there must be a large number of plants installed which will not comply with standard requirements, and so make the work of connecting up to the public supplies difficult. During the period of the war everybody requiring plant had to obtain a permit from the Ministry of Munitions. The Board of Commissioners might continue this principle of control during the development of the larger scheme and thus ensure all private installations being put in in such a way as to be capable of being coupled up to the general scheme of supply, without any substantial alterations being necessary. The question of frequencies, voltages and systems of supply in different areas ought also to be settled without delay. Present day price of plant is a very serious matter, and, rightly or wrongly, the policy of having too many eggs in one basket is a dangerous one. There is a lurking danger in having the whole of the electricity supplies controlled from a too limited number of super-power stations. The possible attitude of labour in the future must be taken into account, as, how easy it would be for those employed in a particular station supplying an extended area, to dislocate the entire industrial world of that area by the adoption of methods such as those of which we have recently had experience in other branches of industry.

There is another feature in connection with the Bill, which requires some clearer definition, viz., the clauses relating to charges for bulk supplies, which present certain difficulties. Due allowance ought to be made for stations, the owners of wihch have been waiting for the termination of the war, to carry into effect alterations and extensions of plant, in order to reduce their cost of production, all of which might be done without any appreciable expenditure of capital. It is hoped that such facilities will be readily afforded. Further, it is hoped that under such an arrangement as covered by these clauses, one district will not be made to subsidise another.

We have to realise that the electricity supply industry is about to be placed upon a proper footing, and will be given those opportunities which, for political reasons, have been denied it in the past, and if any attempt is made to spoil the scheme by any individual or group of interested parties, it will only have fatal results to themselves. It is considered by some that the operations of municipal authorities, in the development of the electrical industry during past years, have been disastrous. It is quite true they have been compelled to supply in restricted areas, but surely the fault in this respect lies more particularly with the Government. Many of the municipal undertakings would have willingly extended beyond their areas if they had been allowed to do so, but Government departments have been too apt to listen to the pleadings of smaller Councils than they have to the pleadings of the larger authorities. This is substantiated by what the Government now propose to do as a result of the Bill. A fair comparison between company and municipal undertakings was not made when evidence was submitted to the various committees set up by the Government to inquire into this important matter, and the conditions relating thereto are very different in the two cases. In the one case, provision for proper depreciation and obsolescence of plant is sometimes disregarded, in order to obtain dividends and maintain the market values of shares, and satisfy those who have invested their money, but in the other case there is no option. The total capital debt has to be liquidated within a given period of time. In order to make a comparison that would be fair to both, it is considered that gross profits in each case should be shown after allowing for management charges, &c., and then how such profit has been disposed of, when it might be shown that the amounts set aside by municipal undertakings, as interest on loans and for redemption of capital, by means of sinking fund instalments, would exceed the amounts distributed in the form of dividends by companies.

During the course of these proceedings a great deal was said about the position existing in the north-eastern area, controlled particularly by companies, and I would advise those of you who have not read it, to obtain a copy of a Paper written by Mr. Andrew Gemmell, from which it will be gathered that the much-advertised sale price of 0·5d. per unit would appear to be a myth, and the statements made by him in his Paper have still to be refuted by those controlling these undertakings. It is thought by many that the north-east coast companies generate electricity at the rate of 1½ lb. of fuel per unit, but this is entirely misleading if due allowance is not made for all production resulting from the use of waste heat gases. The waste heat stations ought to be excluded and those only taken into account where coal is actually used, and then the total consumption of coal divided by the actual units generated or sold, in order to arrive at a fair figure representing the actual consumption per unit in pounds of coal. If this is done, then it is quite possible that it might be found that the average consumption is nearer 2½ lb. than 1½ lb. Further, again, the comparison, to be entirely fair, should take into account the actual coal consumption and also losses in transmission, conversion, &c., arriving at a price per unit actually delivered to the consumer.

There is one matter which appears to be perfectly clear, and that is the impossibility of standardising one frequency. It may, therefore, be necessary merely to standardise in different areas; no doubt in consequence of the enormous amount of capital already expended in such areas, not only in generating plant, but in substations and upon consumers' premises.

The setting up of a ministry to control transport is an important step in the right direction, though there may be objections to giving

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* Abstract of an Address delivered before the Institution of Electrical Engineers, Western Centre.

carte blanche to so enormous a department as this is likely to be; but, after all, transport directly affects the trade of the country, and it is essential that all forms of transport should be properly co-ordinated. The many instances of companies competing with local authorities will have to be removed and all agree to work together for the good of the industry generally. Many of us are conversant with the difficulties regarding interchange of running, where two systems of tramways adjoin one another, and the feeling of jealousy as between one authority and another, whether municipal or company, which has been allowed to prevail in the past. Further, the Ministry of Ways and Communications will be of advantage to those responsible for the provision of transport facilities in local areas. When powers were originally sought for the construction of tramways in the city of Cardiff, clauses restricted us to the operation of tramways alone. The system, as such, has been developed to the greatest possible extent, but we have arrived at that stage where considerable additional traffic could be catered for by means of the motor omnibus, working in conjunction with the tramways. But we are not allowed to defray the cost of such omnibuses out of moneys put aside for this and other purposes, for the sole reason that such powers are not embodied in the Bill. It is hoped these restrictions will all be removed and also those where the city boundaries extend along the centre of roadways, preventing not only the operation of tramways, but also the extension of electric lighting cables, to those houses just outside the boundary, with the result that many residents within a few feet of the mains are unable to enjoy the advantages of the supply merely because they are in the area of another authority. The development of tramways and other forms of transport will certainly be necessary in connection with housing schemes, to enable the working classes to obtain better enjoyment out of life by living more remote than they do at the moment from their centres of work. Such extensions will have a direct effect upon the development of factories and works, which must necessarily be set up, if we are to prevent ourselves slipping back into those hateful conditions which prevailed prior to the war. There is no object in talking about the scarcity of house accommodation, and the provision of them away from the centres of cities and towns, if those intending to take possession of them are not provided with the necessary facilities for getting to and from them. We have to realise that the working people of this country to-day are better off than they ever were before, and are likely to remain so, and it is certain that they will not remain content by living under the same conditions as those under which they have been accustomed to live. The extension of tramways, light railways and other forms of transport will surely tend towards the development of extensive areas of land now lying dormant. I think we can reasonably look forward to seeing at some future date towns and cities generally, both large and small, inter-connected in this way. Not only so, but that the time must come when important tramway undertakings will have to be linked up by means of sidings, to works connected with important industries, so that during many hours of the 24 when the transport of the ordinary passenger is not required the lines and equipment can be used for the transport of goods. All this will undoubtedly tend towards conserving coal supplies for more important purposes. If the setting up of a ministry such as this does nothing else but remove the red tape which has previously prevailed it will have done a very good work. The urgent necessity for better and greater development in road transport has been prominently brought to the notice of the public during the recent railway strike, and whilst we all agree that there was no real suffering, owing to the steps taken by the Government, to deal with the situation, it does not require much imagination to realise what can still be done to eliminate any possibility of either suffering or inconvenience.

Now, in regard to this particular Bill, the electrification of railways is a very important feature, distinct entirely from what I have reason to think will take effect in course of time, viz., the construction of special transport roadways which will be looked upon as main arteries throughout the country for the rapid transport of goods. Roughly speaking there are some 21,000 miles of railway in the United Kingdom, and a very low estimate, based upon pre-war figures, would show that at even £20,000 per mile, the cost of electrification would not be less than some £400,000,000 sterling. Upon this basis it is not difficult to imagine what the present-day cost is likely to be. Wherever such costs might be, however, it must necessarily include proper provision for power houses, railways, sub-stations, transmission lines and all other work incidental to the operation of railways electrically, and when it is borne in mind that the railway capital at the moment is approximately £1,300,000,000 sterling, and is not now productive of dividends owing to advances in wages and cost of material, the addition of more than one-half to this amount must necessarily be a very serious matter. It is assumed, however, that as a result of electrification, considerable economies will be effected in the operation of our railways, which will have the effect of counteracting the increased capital expenditure to some extent.

The report of the Committee set up by the Ministry of Reconstruction to deal with the question of trusts, in February 1918, is a very interesting one. It was appointed to consider the probable extension of trade organisations and combinations, and the methods of safeguarding the public. The report itself indicates that there is a clear and increasing tendency towards combinations. Such combinations will, no doubt, have a very good effect if and so long as they are not abused. Public authorities which control public money invariably invite tenders from all well-known makers of any particular commodity, such tenders being delivered under seal are opened before the Committee and after which it is hoped that a fair and proper selection is made. But in one particular industry at any rate all the tenders with one exception, quote the same amount, whilst the one exception will be, say, 2½ per cent. less, the intention being, that all tenders—being based on the same specification with the work to be given out will go to one particular firm, which means, of course, that all our requirements are supposed to be supplied by this one firm, making the invitation of tenders almost farcical. It is merely a case of the elimination of competition. I am no believer in cut-throat competition—which simply means that manufacturers must lose their money—the quality of materials depreciate, and, generally speaking, the purchasers suffer.

As regards coal, it is now felt that it would be a national calamity if the coal industry were to be nationalised. One cannot help but feel that this was a case of the worker holding the hatchet over the head of the employer, making demands altogether unreasonable, and threatening the use of the strength and power of their trades union organisation to effect their desires. The attitude of labour generally in regard to the matter has been unreasonable, resulting in suffering by the community in general. We need not anticipate that coal will ever get back to the normal price or anything like it, and it will not come down in price until such time as the worker realises that it is to his disadvantage as well as that of others to continue his present tactics. An industry of such importance as this is better left in the hands of private enterprise, if and so long as proper means are provided whereby fair wages and reasonable conditions of employment are secured to the workers. The undertaking with which I am connected we are to-day paying 33s. per ton for coal for which we paid 13s. prior to the war. It is not a difficult matter to appreciate the effect that the price of coal has upon the cost of production, and the necessary increases in charge paid for supplies, and yet we talk about the development of the use of electricity generally throughout the country. The electrical industry almost exclusively depends upon ample and cheap supplies of coal. The price of coal affecting as it does the electrical industry, affects also every other industry. The restricted output thus caused has also made it impossible to put in hand those works which are so necessary after the conclusion of the war, owing to the heavy dilapidations that have taken place during the period of the war. Is it altogether surprising that in some cases we find orders being placed abroad?

Research work is a matter which is deserving of the most serious consideration. A very interesting report has been submitted by a Committee of the Privy Council, dealing with scientific and industrial research. There is a common idea that the discoveries and inventions which tend to facilitate generally, manufacture, and to augment the conveniences of daily existence, come by chance. The fact is, that even where the element of fortune enters into the case, the mind of the discoverer has been prepared for its revelation by prior study and active interest and that the usual avenues of discovery and invention lie through patient work in the laboratory or experimental workshop. These augmentations of learning are augmentations of public wealth. In the view of many, the persons who produce these results are the chief benefactors of the species. In some instances the exploitation of discoveries and inventions was deprecated, in the public interest in past years, but these days are past. Competition compels the manufacturer to avail himself of every improvement in production which offers itself, and in many instances the manufacturer employs experts for no other purpose than research work. If the competitive system were displaced by a system of State monopoly, then the incentive to research and the exploitation of discoveries and inventions would vanish. There is no time when the need for research work was greater than at present. We need more economical use of coal. The discovery of new sources of heat and power, better utilisation of national sources and waste products. There is the need of having our industries placed more generally upon a scientific basis, and we have need to produce and employ a much greater number of efficiently trained workers for both production and research. Whilst Germany has been beaten on the field of battle, she is not going to remain content by any means and has put forward every effort to recover her position commercially, and, if possible, strengthen same. There is no doubt that in Germany an enormous amount of research work must have been carried on, resulting in most wonderful improvements in war machinery, which have been so freely used, and it is satisfactory to know that the Institution of Electrical Engineers is against any scheme placing research work and invention under State control, and it would be distinctly satisfactory if those engaged upon research work could make known their discoveries to all others, in order that they might have the advantage in some cases of some particular discovery that was of no commercial value to the individual discovering it.

Research work has not had that amount of encouragement in past years which it has deserved. I turned up a cutting recently, taken from The Electrician and dated April 4, 1914, where attention is drawn to the remuneration paid to men who are supposed to be highly skilled, possessed of university degrees, &c., and who were to be responsible for the training of the minds of younger people, and to whom a salary of £150 per annum, rising to £240, by experience and qualification, was offered. The gentleman responsible for the article referred to very aptly compared this princely salary with the wages paid to a non-skilled individual, sweeping streets in London and in receipt of at least £3 5s. per week. Yet this salary was offered by a wealthy concern. It will be agreed that no salary can be too high for such an individual if the right one can be found, as it is impossible to estimate his worth at its true value. It is extremely gratifying that these matters have been kept in a prominent position, and taken into the serious consideration of the Institution. But our system of education, good as it is, must be improved and made to compare more than favourably with that of any other country.

In conclusion, there is the question of the salaries of technical staffs. Local authorities and employers generally have not appreciated the members of their technical staffs at their true value. This has resulted in these people organising themselves in the same way as the ordinary employees have done, and instead of graciously granting the additional remuneration, more fairly representing the value of these people, authorities are now forcibly compelled to do so. This is a misfortune in more ways than one. At one time, whilst the employees had the full amount of war bonus or war wages conceded to them by Government departments, it was generally found that the technical members of the staffs were in receipt of a very much less bonus and their positions in regard to the employee was not maintained at the same relative value as previously. The formation of the Electrical Power Engineers' Association is welcome, although it was most unfortunate that such a thing should have been necessary. It is in cases of trouble that we have to fall back upon our technical staffs, and there are many instances where employees, dissatisfied with their conditions, have not hesitated to withdraw their labour, and the responsibility of keeping things going has been undertaken by the technical staff. In such cases as these even their services have not received that amount of recognition which they have deserved. There is another reason why the formation of the Electrical Power Engineers' Association has been welcomed as it has been. Certain trades unions have threatened a withdrawal of labour unless the members of the staff join their unions. If such a thing had been left possible the results would have been lamentable. We have had some instances during the war, and since, of the value of the E.P.E.A., one of the most important of which was the power placed in the hands of public authorities for averting a strike on the part of the members of the E.T.U., who have, on more than one occasion, threatened to put London in darkness, and would have carried out this threat if it had not been counteracted by the representatives of the staffs remaining loyal to the community through the influence of their Association.

Heating and Cooking Notes.

New Cooking Appliances for the Bakery and Restaurant.

In connection with dough mixing electric power has long been utilised in bakeries, but the use of electric appliances for cooking purposes has not proceeded so quickly. Given suitably designed apparatus there is no reason why bakers should not obtain the advantages of cleanliness, certainty of heat control, absence of fumes, and coolness of kitchens, which can be gained by using electricity as the heating agent. Those contractors or supply engineers who are in touch with bakers sufficiently go-ahead to profit by modern developments, can obtain suitable apparatus from Messrs. Benham & Sons, Ltd. In Fig. 1 we illustrate a dough proving oven made by this firm. It is constructed of wrought steel, and mounted on cast iron legs, being designed to take 19 trays, each tray measuring 24 in. by 20 in. The heating elements are fitted in the base of the oven, and there heat control is provided for by means of a rotary snap three heat switch. The switch, a fuse, and a pilot lamp are mounted on a wood board suitable for wall mounting, and connecting leads between the oven and the switchboard are carried in flexible metallic tubing. The consumption on high heat is 1,000 volts, sufficient heat being obtained thereby to keep the dough at the correct temperature during the proving process.

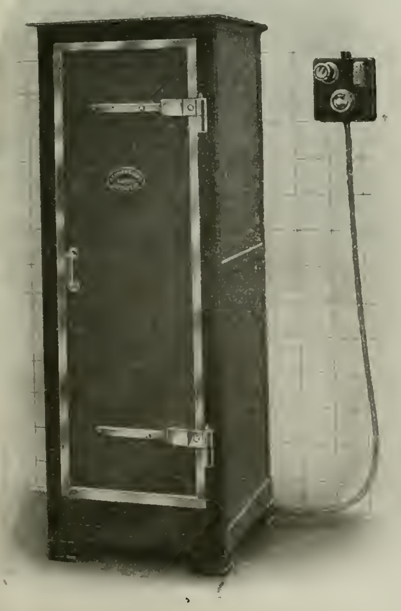

Fig. 1.—Electric Dough Proving Oven.

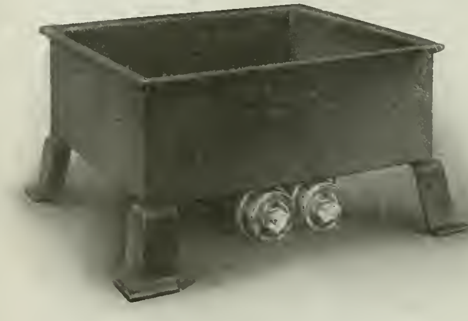

Fig. 2.—Electric Doughnut Cooker.

An electric doughnut cooker is shown in Fig. 2. This really resembles in design a fish fryer, the process being a similar one, viz., frying in hot fat. The inside of the frying tank measures 20 in. by 18 in. by 4½ in. deep. The heat control is provided by means of two rotary snap switches mounted at the base of the apparatus, or if preferred the switches will be supplied separately mounted on a board together with a pilot lamp and fuses. Other additions supplied when desired, are an inner wire basket to carry the doughnuts and a draining cock to facilitate removal of the oil or fat.

So far as restaurant apparatus is concerned this firm manufacture ovens, grills, hot cupboards, carving tables, urns, etc. We illustrate in Fig. 3 a double cooker consisting of two ovens combined with a hob containing six hotplates, and separately mounted control boards. The cooker is constructed of cast iron and mild steel, and will be made to any size to suit the requirements of hotel and boarding house use or for messrooms in factories, etc. The boiling plates are mounted flush with the hotplate top. There heat control is provided for ovens and hotplates by rotary snap switches, and pilot lamps are used to indicate the apparatus on circuit. The ranges can be used as single, double or treble units, or any number can be mounted in a block placed back to back.

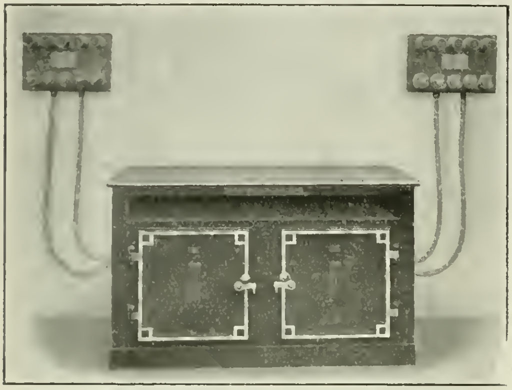

Fig. 3.– Double Electric Oven.

The urns are constructed of copper, heavily turned on the inside, and provided with wooden lifting handles, draw-off cock and lid. The elements are mounted at the base of the urn, and heat control is obtained by means of two tumbler switches also mounted at the base, simmering and boiling heats being obtainable. Various sizes are made, ranging in capacity from one to ten gallons. For milk warming a glazed earthenware inner vessel is provided.

The grill shown in Fig. 4 is constructed of cast iron and wrought steel and radiant type elements consuming 4 kw. are mounted at the top of the grill and underneath the hot plate. These grills are made in varying sizes, from 12 to 20 4 in. in width, and with either single or double compartments.

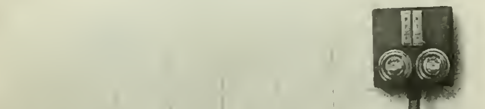

Fig. 4. Electric Grill.

A substantially constructed metal grid rack is provided, and this slides in grooves, the height of the grid being variable according to the grooves selected. A drip tray is also supplied. The elements are controlled by rotary switches, either mounted on the side of the grill, or on a board suitable for fixing to the wall.

All the apparatus here described is well finished and soundly constructed.

Retirement of Mr. Thomas Clark.

The many friends of Mr. Thomas Clark, who is so well known throughout the whole submarine cable world, will be interested to learn that he has lately retired from the service of the Telegraph Construction and Maintenance Company, with which Company he has been connected as electrician for over 54 years. In the first year of his service he was appointed to the electrical staff of the s.s. "Great Eastern," thus taking part in the laying of the 1865 Atlantic cable. Since that time, until he gave up sea duty in 1913, he was, as electrician, almost continuously occupied in the laying of submarine cables, and, in that capacity has visited practically every country to which cables have been laid. Mr. Thomas Clark occupies the unique position of having taken an important part in the laying of more submarine cables, and of visiting more countries in the carrying out of that duty, than any other man. His friends, both here and in every quarter of the globe, will cordially wish him many years of happiness in his well earned retirement.

Industrial Courts Bill.

The Committee stage of this Bill was concluded in the House of Commons on Wednesday. The Bill establishes an Industrial Court and Courts of Inquiry in connection with the trade disputes, and also continues for a limited period certain of the provisions of the Wages (Temporary Regulation Act), 1918.

Sir Robert Horne explained that it was proposed to have panels of assessors drawn from employers and employed, appointed in consultation with the trade union and employers' organisations. If a case were reported to the Minister and he regarded it as a case which required to be dealt with by some method of conciliation he could, with the consent of both parties, refer the matter to the industrial Court, which might sit with assessors, to a single arbitrator, or to an arbitration board, on which there would be an independent chairman and representatives of both employers and employed selected from the panels. Where means of settlement already agreed upon were operating, the Minister would not have recourse to the means described until the ordinary means of conciliation had failed.

To Clause 2, which provides for the reference of disputes to the Industrial Court or to arbitration, an amendment was made, giving a free choice as to the method for dealing with disputes, either by conciliation or by arbitration; and also an amendment providing that there was in existence any arrangement made by agreement for the settlement of disputes between employers and workmen the Minister should not refer any dispute for settlement or advice unless there had been a failure to obtain a settlement under the agreement.

The proposal to apply the provisions of the Arbitration Act, 1889, was excluded, and other amendments of the Bill were also made; and Sir R. Horne said he was looking with great hope to the setting up of the National Industrial Council, and to the prospect of getting advice from it upon all the matters with which it was competent to deal. There might, however, be topics which would be more easily dealt with by the Industrial Court, and he thought it was better to keep open the door for obtaining advice where it might be required.

Electric Vehicles at Sheffield.

An inquiry was held at Sheffield on the 7th inst. into the application of the Corporation for sanction to borrow £14,200 for the purchase of electric vehicles and accessories. Evidence in favour of the loan was given by Councillor Kaye, chairman of the cleansing sub-committee, who said the system of collecting refuse by electric vehicles was started in 1915, when one electric tipping vehicle was obtained. The Corporation now had 12 electric vehicles, and the result of their work was satisfactory. The scheme when completed would be a large one. The present application only referred to an instalment of it.

Mr. J. A. Priestley, cleansing superintendent, said the £14,200 could buy eight electric motor wagons, one petrol wagon, a petrol locomotive, a motor generator and switchboards. When the Corporation purchased their first electric vehicle the department had 156 horses, but the number had now been reduced to 82. The present electric vehicles worked day and night shifts, and each replaced between five and six horses. The night work, which was the quickest, was now covered, and the new vehicles would be employed on days only. The vehicles had been bought by tender, and the order had been divided amongst three firms, so as to tecure quick delivery and to test the different makes. They could remove all classe of house refuse more cheaply by electric than by any other means of transport that they had tried. Last year's cost of the removal of bin refuse collected in the daytime) was 8s. 8½d. per ton by horse labour, and 8s. by electric. On the basis of present day wages and other costs, the figures would be 10s. and 9s. 7·9d. respectively. If the work done by electrics last year had been done by the horses, it would have cost £1,800 more. There would be a greater saving this year, as the cost of horse-keep had gone up considerably. They had tried petrol wagons on the work, and found that the cost was 12s. 1d. per ton, while the steam wagons cost was 11s. 5·7d. They removed 450 tons of refuse per week. The night work done last year cost 5s. 8d. per ton by horse and 3s. 11·7d. by electric. On present costs, those figures would be increased to 7s. 11·2d. and 6s. 1·4d. respectively.

Electricity Supply Schemes.

Several drafts of electric supply schemes under the Electricity (Supply) Bill have been drawn up or are in course of preparation. We have already published abstracts of schemes for the North Midlands and the Hereford areas, and representatives of local authorities in North Lancashire and South Westmorland had a preliminary meeting at Lancaster last week in order to consider a proposed scheme. Major G. C. Milnes, borough electrical engineer at Lancaster, pointed out that many plants were now operating individually, and it was proposed to substitute economical boundaries for the present geographical boundaries and to give greater facilities for giving a supply to the consumer. A suggested area would extend to and include Kendal in the north to Garstand in the south. A committee was formed to report as to a probable scheme, representatives being suggested from the Corporations of Lancaster, Morecambe and Kendal, the Lancaster, Garstang, Lunesdale and South Westmorland Rural Councils, the Heysham and Carnforth Urban Councils, the Midland and Furness Railway Companies, and other large users in the district. Major Milnes was appointed secretary to the committee, which will also consider the possibility of utilising the large plant at the National Projectile Factory, Lancaster.

Our contemporary "Municipal Journal" has published an outline of a projected scheme for the Greater London area, which is the outcome of a series of conferences of local authorities owning electricity undertakings. It is proposed to link up and work out the economic life of existing stations, then gradually to supplement the supplies from the more powerful stations, and, when the time is ripe, to put down a big bulk supply station. The main idea is to avoid over-capitalisation which would result if the buying-out process were adopted, while at the same time if a big bulk supply station were put down immediately it might happen that with the advance of electrical science in the meantime the new super-station would be dead before it was born. The area will be virtually that of the Metropolitan Police area, with an extension eastward on the south side of the Thames to the river Medway. The reason for this extension is that development on a large scale is taking place in the area, and it is considered that the demand for current can be met by a supply from the London area.

It is proposed to create an *ad hoc* body on the lines of the Metropolitan Water Board for administrative purposes, but the companies will not in all probability be represented on the central authority unless subsequently the Government Department concerned compels their inclusion, because it is contended that their interest in the matter of electricity supply is a diminishing one. The central body will take over the purchasing powers now held by the London County Council and the borough councils, but it will be required to appoint divisional boards. London may be divided either into two or four areas, one for the north and the other for the south of the Thames, or two for the north—north-east and north-west—and two for the south—south-east and south-west. The divisional boards will be composed of representatives of local authorities, authorised undertakers (including the companies), and large consumers, such as railway companies, and they will have the practical supervision of electricity in their areas, and will submit their proposals for dealing with the supply of electricity to the central body. The majority on the divisional boards will always be of local authorities. It is possible that the companies will retain their present position as distributors in their authorised areas, because the question has not been settled whether the local authorities or the divisional boards will take over distribution. It may be that the distribution in an area now held by a company will be continued, if the company desire it, until, say, 1932, but the company will not be allowed to obtain cheap current from the divisional board or central authority and make a huge profit out of it, because its scale of charges will be subject to the approval of the central authority. The idea in making this concession is to avoid the possibility of buying out, because it is contended that there is no advantage in pursuing this course. The proposal is to let the companies die out, and as they do so the central authority will be in a position to throw in a supply of current from one of the other stations in the area or from a central station. The central body will exercise supreme control over the questions of plant and extensions. The scheme affects some 50 local authorities, including 16 metropolitan boroughs, and has been drawn up by a committee of the Conference of Local Authorities presided over by Ald. Duncan Watson, of St. Marylebone, with Mr. F. Tait, of the Poplar Electricity Works, as hon. secretary.

Electricity (Supply) Bill.

Standing Committee B, of the House of Commons, has continued the consideration of this Bill during the week.

Clause 14 was passed without amendment, but to clause 15, which gives power to District Boards to abstract water from any river, stream, canal, &c., Mr. Neville Chamberlain proposed that one of the conditions should be payment on the usual terms where payment was a portion of the revenues of the inland navigation authorities concerned.

Other amendments for the protection of docks and harbours and inland waterways authorities were proposed. The Home Secretary submitted an amendment that where water was abstracted from a canal, inland navigation dock, or harbour, regulated by Act of Parliament, or where existing rights of riparian owners would be affected, the order authorising the abstraction should be a special order. This was accepted and other amendments consequently dropped. Some verbal alterations were made, and an important amendment by the Home Secretary, which provided that purposes for which the Board might be authorised to acquire land compulsorily should include the development of water power for generating of electricity, was accepted. Clause 15 was then passed, and on Clause 16, which deals with the exercise of powers by district boards, Mr. Dawes moved to omit the words "or through a company established for the purpose," contending that the local authority or the district board should do the work themselves.

Mr. Shortt opposed, but the amendment was carried by 12 votes to 7.

Mr. Dawes proposed to leave out Sub-section 2 of Clause 16, which read: "For the purposes aforesaid a district electricity board may lease their undertaking to any such undertakers or company upon such terms and for such period as, subject to the approval of the Electricity Commission, they think fit."

Mr. Shortt intimated his willingness to agree to the deletion of the sub-section, but Sir F. Hall hoped the subsection would not be interfered with. He believed that competition brought about the most efficient and economical working.

The amendment to delete was carried by 17 votes to 5.

On Tuesday Mr. G. Balfour moved to leave out of Clause 25, which deals with the limitation of prices and profits, the proviso that prices should be such that receipts on income account would be sufficient to cover expenditure, with such a margin as the Commissioners might allow.

Mr. Bridgeman accepted the amendment, and remarked that it was refreshing to see that the Committee were now appreciating the advisability of giving the Commissioners wider scope.

On Wednesday the Chairman said it was hoped to complete the Committee stage by Thursday.

On the motion of Mr. Waddington, the words "but where money is borrowed for the construction of works at a time when the cost of labour or materials is abnormally high, regard shall be had to that fact in fixing the period for repayment" were deleted from section (2) of Clause 30.

On the motion of Mr. Shortt, the following words were added at the end of Clause 31: "A district electricity board may, with the consent of the authorised undertakers, discharge the whole or any part of the purchase price payable under this Act (otherwise than by way of annuity) to any authorised undertakers in respect of any generating station or main transmission line vested in or acquired by the Board under this Act, or of any undertaking, or part of an undertaking, transferred to the Board under this Act, by the issue to the undertakers of such amount of stock created under this section as may be agreed upon or determined in manner hereinafter provided to be the equivalent in value to the whole or part of the purchase price in respect of which the stock is issued, and if any difference arises as to the amount of stock which is so equivalent in value it shall be determined by the Railway and Canal Commissioners."

Mr. Shortt proposed that in Clause 30 (line 4 of section 2) the words "their gross receipts" be omitted, and the words "the number of units of electricity generated by or on behalf of those boards, authorities and undertakers respectively" be inserted. The amendment was adopted.

Mr. Dawes proposed, and the Committee adopted, the addition of the words "(except in the case of the London County Council)" after the word "exercised" in the last line of section 1 of Clause 32. This reserves to the L.C.C. power to lend money or give other financial assistance to an electricity board without the consent of the Ministry of Health.

Slight alterations were then made to Clauses 37 and 39, and Clauses 28 to 39 were added to the Bill.

Commercial Topics.

Capital Issues.

It is announced that the Board of Trade, acting on behalf of the Treasury, have granted a general licence under Defence of the Realm Regulation 30F permitting issues of capital for which a licence from the Treasury is required under that regulation.

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Electrical Supplies for Czecho-Slovakia.

H.M. representative at Prague reports that electric lamps, dynamos and transformer parts, electricity meters, oils, shellac, rubber and other goods are urgently required in Czecho-Slovakia. Among the articles for which import licences are granted are electric lamp bulbs, copper, magnetite, rubber and vulcanite goods, oils, acids, &c.

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The Vickers-Brown Boveri Arrangement.

We understand that the working arrangement recently made between Messrs. Vickers, Ltd., & Brown, Boveri & Co. (referred to in our last issue) covers not only British business but also the British colonies and certain European countries. Messrs. Vickers have acquired the sole British and colonial rights in all the patents of Messrs. Brown, Boveri & Company, Ltd., and the latter undertake to conduct no direct business in any part of the British Empire. In addition direct combination is to take place between the subsidary undertakings of both companies in France and Italy. Vickers, Limited, have also purchased shares in the Brown, Boveri Company, to the amount of £280,000, for which a sum of £350,000 has been paid. The arrangement will lessen the risk of competition by Continental firms, as there are now only two neutral manufacturers who are capable of building large generating sets such as those required by Edinburgh Corporation.

* * * *

Imports Into Australia.

It is notified that a Proclamation has been issued prohibiting the importation into Australia of various goods and manufactured articles without a licence. This procedure will greatly interfere with British exports and will militate against the development of Imperial trade and business. The prohibited articles include steel car wheels and axles for tramways and railways, Muntz or yellow metal, German silver and Britannia metal sheets, bronze and gun metal bars, rods and ingots, anti-friction and plastic metals, etc.; brass and copper angles and tees, bars and rods, pipes and tubes plate sheet and strip, wire, phosphor copper bars, rods and ingots, zinc and spelter bar and ingot), railway and tramway materials, including rails, fish plates and fish bolts, tie plates and rods switches, points, crossings and intersections, etc.; also accumulators or storage batteries, cotton-covered electric wire; pig iron ingots, blooms, billets, bar, rod, angle, tool, high speed tool steel bars, rods, and ingots, etc.

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Trade Catalogues for South Africa.

H.M. Senior Trade Commissioner in South Africa (Mr. W. G. Wickham), whose headquarters are now at Johannesburg (P.O. Box 839), desires to receive from United Kingdom manufacturers' copies of post-war catalogues for filing in his commercial room. He states that he has received a considerable number of inquiries recently for such catalogues, and that American manufacturers and publishers of trade journals are extremely active in sending their publications to South Africa. Mr. Wickham would also be glad to be informed whether manufacturers are in a position to offer delivery within a reasonable time, or whether they are entirely occupied with the home and European markets.

A Model Homes Exhibition is to take place at Cape Town early next year. A shortage of houses is being experienced in South Africa and several housing schemes are under consideration in various parts of the Union, so that there should be a good demand for electric light fittings, cables, wires, meters, domestic apparatus, &c. H.M. Trade Commissioner at Cape Town would be glad to receive appropriate catalogues, which he will bring to the notice of the Committee of the Exhibition.

* * * *

Electrical Supplies for Mauritius.

The immediate prospect for the electrical industry in Mauritius is decidedly rosy, and manufacturers and exporters should watch developments. The scheme for the adoption of electric traction on all the railways of Mauritius, which was recommended in 1904 by Major G. McAlpine, who was then Electrical Adviser to the Government, has recently been brought forward for re-examination. A committee has been appointed to consider the question, but owing to the popular feeling in favour of the change, its recommendation is a foregone conclusion. It is computed that one of the waterfalls that of Tamarind —will suffice to provide the power required to supply the whole of the island with electricity for lighting, power and traction. Already eleven of the 132 villages and towns of the colony are lighted by electricity, and authority has just been given by the Legislative Council to extend the to seven other towns. Difficulty has been experienced by the two local electrical undertakings as well as by the municipality of Port Louis, in getting supplies of electric cables and wires, lamps and metres from England. Inquiries have, however, been made in the United States by a newly-established firm in Port Louis to meet the demand, which cannot, apparently, be met by British exporters.

Electricity Supply.

Ballymoney Urban Council decided to light the town with 80 electric lamps at a cost of 50s. per lamp.

Weardale Rural Council has instructed an electrical engineer to report upon the probable cost of lighting the town by electricity.

Cannock Urban Council has decided to engage an electrical engineer to prepare a report on an electric supply scheme for the district.

Leeds electricity department has 1,000 second-hand electricity meters for sale. Offers to the manager, Mr. C. Nelson Hefford.

The question of adopting an electric lighting scheme for Portadown has been referred to the Street and Footpaths Committee for consideration and report.

The salary of the Tynemouth borough electrical engineer, Mr. Chas. Turnbull, has been increased to £620, rising by annual increments to £720 per annum.

Hull Licensing Committee insist that every hall holding a music licence and lit by electricity must have a secondary system of lighting before next Sessions.

An inquiry was held at Aldershot last week into the application of the Urban Council for sanction to borrow £12,750 for extensions of the generating plant and supply mains.

An inquiry was held on Tuesday into the application of Hastings Corporation for sanction to borrow £14,219 for extensions of electric generating plant, mains and services.

Ashton-under-Lyne Electricity Committee recommend the Council to apply to the Ministry of Health for sanction to borrow £6,000 and £3,000 for the provision of additional mains and transformers.

Stoke-on-Trent Corporation has applied for sanction to borrow £20,000 for prospective expenditure upon mains and services. Sanction has recently been received to loans of £9,606 and £3,768.

Worksop Urban Council has increased the wages of mechanics employed at the electricity works from £3 to £4 5s., and of labourers from £2 2s. to £2 10s., per week. An assistant electrical engineer is to be appointed at £150 per annum.

Torquay Corporation has authorised the Electric Light Committee to make the necessary investigation for a site for a new electric generating station, if possible, in connection with the Government scheme. The present station is badly located and it is impossible to make extensions.

The Electricity Committee of Hackney (London) Borough Council has appealed to consumers to economise in the use of electric current for lighting, as the scheme for the extensions of the plant and mains has been delayed by the industrial situation.

The Tuam Electric Lighting Company recently undertook to erect an electric supply station, but owing to strikes the directors were unable to get the necessary material in time, and steps have been taken to continue gas lighting.

The accounts of Bolton electric supply department for the year ended March 31 show revenue £138,671 (compared with £109,230 in previous year), leaving gross profit £47,048 (£47,292). Interest, income tax and repayment of loans required £39,866 (£36,386), leaving a surplus of £10,558 (£11,613) or £4,432 (£3,375) after providing for allowances to employees on H.M. service, depreciation, contributions to capital expenditure, etc. Total cost per Kelvin sold, including capital charges was 1·041d. (0·898d.). Units generated were 29,030,900 (28,025,429), and sold 23,715,040 (3,186,516).

In the course of the recent inquiry at St. Helens into the application of the Corporation for sanction to borrow £57,100 for extensions of the electricity works, the Borough electrical engineer (Mr. B. T. Hawkins) stated that with all the present machinery running they were able to supply the full demands, but there was no spare plant. They desired to put in sufficient plant to supply all the industries in the borough. Manufacturers were desirous of obtaining larger supplies of power, and they anticipated large demands for the out-districts, but before they could properly supply these they would have to wait until their district was linked up with the Liverpool or Mersey generating stations that were to be erected under the national scheme.

It was announced at the last meeting of Belfast Corporation that the demands for electrical energy by Messrs. Harland & Wolff and Messrs. Workman, Clark & Company had risen to such an extent that in the near future the proportion taken by them would be the whole amount of electricity that the new machinery at the harbour station could produce. A new station would have to be erected at East Bridge Street to keep pace with the existing demand. The demands made by manufacturers would have to be met, and it would be impossible to meet them for more than a year after the start of the present station.

In the course of the inquiry which was held at Bath last week into the application of the Corporation for sanction to borrow £30,400 for additional generating plant, etc. (including a 1,500 kw. turbo-generator) the Chairman of the Electricity Committee, Sir Harry Hatt, stated that they had no stand-by plant, and that they had nothing ready to meet the annual increases in the maximum demand. They had considered all possible alternatives, including a supply from Bristol, but the best terms offered by Bristol would have resulted in the current costing the Bath Electricity Department rather more than 1d. per unit above the figure at which they could generate their own under the system which they were suggesting. The price offered was slightly more than the cost of generation at Bath. Considerable delay would have also resulted because of the difficulty of getting cable and the fact that the distance between the two towns was 12 miles.

Electric Traction.

YORK Corporation has requested the City Engineer to report on suggested new routes to complete the city tramways system. The total cost of the four extensions is estimated at £143,517.

The Board of Trade has extended the period for the completion of the tramways authorised by the Dewsbury Corporation Act, 1915, by one year from July 29, 1920.

WHITEFIELD Urban Council has decided to invite the Tramways Departments of the Salford and Bury Corporations to inaugurate a through service of tramcars between Manchester and Bury.

In order to be able to give a better tramcar service on the ABERDEEN sea beach route next summer, the Tramways Committee recommended that a new power cable be laid between Union-street and the beach.

SOUTHPORT Council has decided to discontinue the inner circle of trams. The costs per car-mile are 1s. 6d. against 9d. or 10d. before the war. Last year the running of the section resulted in a loss of £5,812.

The PORTSMOUTH tramways accounts for the year ended March 31 show revenue £177,647 (compared with £153,086 in previous year), and working and general expenses £109,439 (£80,289). Interest and repayment of loans required £39,860 (£39,860) and income tax £9,450 (£7,016), leaving a surplus of £21,010 (£27,269).

The system of railless trolley tramcars between MIDDLESBROUGH, NORTH ORMSBY, SOUTH BANK and GRANGEMOUTH was inaugurated on Saturday last. The line, which runs through districts of iron and steel works and to the Cleveland ironstone mines, was opened by Councillor W. G. Grace, chairman of the Joint Board of Management of the undertaking.

The accounts of MAIDSTONE Corporation light railways fund for the year ended March 31 show revenue £15,412 (compared with £13,476 in previous year), and working expenses £10,131 (£8,569). After providing for capital charges, the net profit was £692 (£269). Traffic revenue for car mile was 15.503d. (11.778) and working costs were 10.567d. (7.813d.) Passengers carried were 3,162,535 (2,897,801), and car miles run 229,864 (263,215).

The Hastings and District Electric Tramways Company proposes to apply for power to use the overhead trolley system of traction on the HASTING'S Front. The company recently applied to the Ministry of Transport and obtained an order for increasing the fares by which twopence should be charged for any distance exceeding half-a-mile, as from Nov. 10. The Council now threaten to apply, in the event of the imposition of increased fares, for an injunction.

The accounts of the EAST HAM tramways department for the year ended March 31 show, receipts £84,848 (compared with £71,237 in previous year), and working expenses £85,691 (£63,916). Interest required £4,652 (£4,817) and sinking fund and repayment of loans £5,679 (£5,880), the net result being a deficit of £11,174 (£3,376). Revenue per car mile was 14.76d. (11.85d.) per car mile, and working costs were 14.91d. (10.63d.). Passengers carried were 17,068,833 (16,744,998) and car miles run 1,379,511 (1,442,436).

The accounts of the ILFORD tramways department for the year ended March 31 show revenue £54,353 (compared with £41,962 in previous year), and working expenses £39,079 (£31,097), leaving gross profit £15,272 (£10,864). Instalments of principal repaid and interest required £9,036 (£9,035), and the surplus, £6,793 (£2,386) has been placed to reserve and depreciation account. Revenue per car-mile was 16·14d. (12·2d.), and working expenses, including power were 11·62d. (9·03d.). Passengers carried were 10,049,740 (9,281,273) and car-miles run 751,616 (765,099).

A deputation from the London County Council has waited upon the Ministry of Transport in connection with the important scheme of TRAMWAY EXTENSIONS which the Council is promoting. Already some of the Borough Councils, as well as the City Corporation, have disclosed their hostility to the proposed new tramways, and will no doubt exercise their existing right of veto. It is, however, suggested by the London County Council that the Ministry should erect some independent authority for the purpose of considering tramway schemes for London as a whole.

At the meeting of the LONDON COUNTY COUNCIL on Tuesday, the chairman of the Highways Committee stated that the experience gained in connection with the issue of tramway season tickets to certain officials did not incline them to favour the issue of such tickets to the public.

The total revenue of the MANCHESTER tramways undertaking for the half-year ended Sept. 30 was £806,499 (20·307d. per car-mile) and the expenditure £682,171 (17·177d.), leaving a surplus (excluding provision for renewals) of £124,328, compared with £127,941 for the corresponding period of last year. The car-miles run were 9,531,447 (9,366,929), and the passengers carried 141,884,761 (128,448,547).

The estimates for the financial year ending March, 1920, show an anticipated surplus (excluding renewals) of £201,890. Of this sum it was proposed to transfer £111,890 to the city fund in aid of rates and to place £90,000 to renewals account. During the next half-year the cost of the additional war bonus granted to the employees under the recent award of the Court of Arbitration (about £20,000) will have to be met, and it is doubtful whether the estimated surplus for the year will be realised. The renewals fund at the end of March was £446,479. For the half-year ended September the expenditure on renewals was £71,543, and probably double that sum will be expended in respect of the whole year. The revenue of parcels department for the past half-year was £12,517 and the expenditure £11,747, leaving a surplus of £770.

Imperial and Foreign Notes.

NARRARRI (N.S.W.) Council propose to borrow £7,500 for an electric lighting plant.

The steam trams at NEWCASTLE (N.S.W.) are to be displaced by electric cars.

TOWNSVILLE (Queensland) Municipality is seeking authority to intro- electric supply, and an engineer is to be engaged to draw up a scheme.

A proposal to instal an electric generating plant for the town, at a cost of about £12,000 is under consideration by the GLEN INNES (N.S.W.) Council.

The "Industrial Australian and Mining Standard" states that MARYBOROUGH (Queensland), is to possess electric supply works, and £25,000 is to be borrowed.

FORBES (N.S.W.) ratepayers are urging the Municipal Council to light the town electrically. An obstacle in the way is the fact that the council operates the local gas works.

There is also a demand for electricity as an illuminant in FREELING (South Australia), where the towns-people have asked the Council to employ an engineer to prepare a scheme.

A recently issued Customs Circular states that the import duties, under the AUSTRALIAN COMMONWEALTH TARIFF, upon temperature measuring instruments consisting of glass thermometers filled with mercury or other liquid are 20 per cent. under the preferential and 25 per cent. under the general tariff, but other temperature measuring instruments, both direct and recording, including electrical resistance thermometers and pyrometers, platinum type; thermo-couple thermometers and pyrometers; calorimeters pyrometers; radiation pyrometers; and optical pyrometers are duty free.

It is reported that CHILE will shortly sign a contract authorising the Western Union Telegraph Company to lay a submarine cable between Africa and Panama.

A new submarine telephone cable has been laid between the GERMAN and SWEDISH coasts, which will give communication between Berlin and Hamburg and Stockholm.

Owing to the difficulty in procuring coal, several FRENCH electric supply undertaking have had to limit or to suspend their supplies for lighting and power, and the Western Electric Company of Paris has been obliged to suspend its supply of electricity to about 3,500 factories.

According to a recent decision, the duty upon parts for electric counterweight lamps (consisting of a flat porcelain piece with brassed iron clamp and axle, with a porcelain pulley, and an oviform porcelain counterweight with iron fitting to carry a porcelain pulley) IMPORTED INTO DENMARK is 32 ore per kilog (17s. 7d. per cwt.).

Miscellaneous.

In consequence of an order made by the Minister of Labour on Oct. 29, the Trade Board Acts 1909 and 1918 now apply to the manufacture from metals by stamping or cold pressing of fittings for gas or electric light.

The Court of Arbitration has awarded an advance of 5s. per week in the wages of employees in the ENGINEERING and SHIPBUILDING trades, and also to railway shopmen, heating and domestic engineers and explosive trade workers.

The ROADS AND TRANSPORT CONGRESS AND EXHIBITION (1919) will be held at the Royal Agricultural Hall, Islington, London, N.1, from No. 20 to 27 inclusive. A number of Papers on road construction and maintenance, motor transport, &c., will be read and discussed.

The arrangements made last month for inter-communication by WIRELESS TELEGRAPHY BETWEEN SHIPS in ports of the United Kingdom have been withdrawn, and the previous regulations under which the use of wireless telegraphy by ships in harbour is prohibited, except with the written permission of the Postmaster-General, are again in force.

At the Enfield Police Court on Monday a youth of 18 was sentenced to two months' hard labour for the larceny of electrical fittings from the Edison-Swan Electric Company. It was stated that for three days in succession the lad, who had only been employed for a short time by the company, stole all sorts of articles.

It is announced that from Jan. 1 next the new inland PRESS TELEGRAM rates, which were sanctioned in 1916 and postponed until conditions became more normal, will be put into force. The present charges are 1s. for every 75 words between 9 a.m. and 6 p.m., and 1s. for every 100 words between 6 a.m. and 9 a.m., with 2d. extra per 75 or 100 words for each additional address. The new rates reduce the number of words af a day telegram to 60 and of a night telegram to 80, and increase the additional address charges to 3d. in either case.

The ROYAL NAVAL DIVISION SIGNAL COMPANY REUNION DINNER, which was held on the 5th inst. at the Holborn Restaurant (London) was very successful, and it is hoped to make the event an annual one. Mr. A. C. Branch presided over a good gathering, including Messrs. H. A. Edgar, G. Allingham, R. C. Martin, T. H. Soloman, H. S. Housden, E. Barlow, C. S. Williams, S. H. Freeman, G. F. Boxall, E. J. New, B. H. Leeson, C. F. Monks, R. D. Binnie, D. S. Wallis, A. G. Hilling, &c., E. A. Gordon (hon. secretary), &c. The dinner was followed by a discussion and a musical programme.

The report of the NITROGEN PRODUCTS Committee will be published shortly, and will no doubt give interesting information as to the future development of the fixation of atmospheric nitrogen in this country. During the war the Ministry of Munitions commenced the erection of a factory at Billingham-on-Tees; but as it was not completed at the date of the armistice work was suspended pending further consideration of the scheme. The Government has now decided that further development should be left to private enterprise, and the Minister of Munitions is prepared to consider offers for the partly constructed factory. We hope to give a full account of the work and the conclusions arrived at by the Committee in an early issue.

The President of the Board of Trade, the Parliamentary Secretary, Permanent Secretaries and the staffs of the following departments are now installed in their new offices in Great George-street, S.W. (provisional telephone numbers, Victoria 9800 and 9160): Commercial Relations and Treaties; Industries and Manufactures; Power, Transport and Economic Marine; Secretariat of the Board of Trade Council; Board of Trade "Journal" and establishment. The Public Utilities and Harbour Department, the Legal Department and Library are still at 7, Whitehall-gardens, but it is hoped to remove them to the new offices in the course of the next week or so.

The headquarters of the Statistical Department, the Controller of Trading Accounts, the Capital Issue Committee and the War Insurance Acconnts Branch will remain at Gwydyr House, Whitehall, S.W.1; the Finance Department will remain at Whitehall Gardens, S.W.1; and the Bankruptcy Department will remain in Horse Guards-avenue, S.W.1 (telephone number, Victoria 3840).

The West Midlands Branch of the Electricity Supply Commercial Association held a social evening on Saturday the 8th inst. at Rodway's Restaurant, Birmingham. Over 80 members and their friends were present. The first portion of the evening was devoted to progressive whist, at the conclusion of which light refreshments were served. During the refreshment interval the prizes were distributed by Mrs. Newbold, of Coventry. The third part of the evening's proceedings was given up to an excellent concert, which was presided over by Mr. D. Mills, the chairman of the branch. The general arrangements were carried out by Mr. S. H. Evans, the energetic secretary of the West Midlands Branch, and it is proposed to hold meetings of a similar character at intervals during the coming winter months.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during September, 1919, and (*b*) the aggregate figures from Jan. 1 to Sept. 30, with increase or decrease compared with corresponding periods of 1918:—

Electrical machinery, (*a*) £66,635 (increase £26,750), (*b*) £493.234 (decrease £40,813); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £42,236 (increase £22,864). (*b*) £187,086 (increase £59,651); and electrical machinery unenumerated, (*a*) £24,399 (increase £2,886), (*b*) £306,148 (decrease £100,464); telegraph and telephone cables other than submarine, (*a*) £1,527 (increase £51), (*b*) £9,992 (increase £6,580); telegraph and telephone apparatus, (*a*) £33,156 (increase £27,821), (*b*) £213,128 (increase £173,522); other electrical wires and cables, rubber insulated, (*a*) £70 (increase £70), (*b*) £4,495 (increase £3,838); with other insulations, (*a*) £1,569 (decreaae £1,029), (*b*) £12,411 (increase £9,053); carbons, (*a*) £5,802 (increase £5,617), (*b*) £24,966 (decrease £2,251); glow lamps, (*a*) £112 (decrease £29,048), (*b*) £213,622 (increase £103,575); arc lampa and electric searchlights, (*a*) nil, (*b*) £31 (increase £31); parts of arc lamps and searchlighta (other than carbons), (*a*) £5,017 (decrease £8,563), (*b*) £58,014 (decrease £18,557); primary and secondary batteries, (*a*) £4.322 (decrease £492), (*b*) £34.608 (decrease £79,250); meters and measuring instruments, (*a*) £3,650 (increase £1.937), (*b*) £29,549 (increase £10,348); awitchboards, (*a*) nil (decrease £142), (*b*) £1,142 (decrease £1,131); electrical goods and apparatus unenumerated, (*a*) £37,902 (increase £14,551), (*b*) £330,009 (decrease £55,703). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £93,121 (increase £9,773), (*b*) £931,967 (increase £200,055).

Exports.—The exports of electrical machinery, material, &c., *a*) during September, 1919, and (*b*) from Jan. 1 to Sept. 30, with increase or decrease compared with corresponding periods of 1918, were as follows:

Electrical machinery, (*a*) £178,071 (increase £87,713), (*b*) £1,197,956 (increase £407,436); including railway and tramway motors, (*a*) £5,789 (increase £2,319), (*b*) £61,788 (increase £32,257); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £115,797 (increaso £52,579), (*b*) £692,146 (increase £210,236); and electrical machinery unenumerated, (*a*) £56,485 (increase £33,424), (*b*) £444,022 (increaso £164,943); telegraph and telephone cables, submarine, (*a*) £24,380 (decrease £20,834), (*b*) £447,691 (increase £2,721); other than submarine, (*a*) £64,790 (increase £24,224), (*b*) £326.273 (increase £90,619); telegraph and telephone apparatus, (*a*) £35,049 (increase £22,068), (*b*) £279,400 (increase £136,759); other electrical wires and cables, rubber insulated, (*a*) £74,207 (increase £65,384), (*b*) £553,661 (increase £498,548); with other insulation, (*a*) £108,960 (increase £88,565), (*b*) £678,954 (increaso £598,973); carhons, (*a*) £719 (decrease £1,267), (*b*) £6,845 (increase £473); glow lamps, (*a*) £14,283 (increase £10,188), (*b*) £112,017 (increase £51,149); arc lamps and searchlights, (*a*) nil (decrease £293), (*b*) £6,924 (decrease £9,342); parts of arc lamps and searchlights (other than carbons, ((*a*) £22 (decrease £369), (*b*) £7,830 (decrease £5,887); primary and secondary batteries, (*a*) £16,985 (increase £8,579), (*b*) £325,615 (increase £237,330); meters and measuring instruments, (*a*) £29,358 (increase £15,897), (*b*) £177.914 (increase £85,607); transformers, (*a*) £14,202 (increase £7,802), (*b*) £58,566 (increase £31,162); awitchboards, (*a*) £6,116 (increase £4,627), (*b*) £37,875 (increase £14,390); electrieal goods and apparatus unenumerated, (*a*) £83,715 (increase £60,135), (*b*) £841,039 (increase £535,513). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £474,786 (increase £284,706), (*b*) £3,860,604 (increase £2,268,015).

Tenders Invited and Accepted.

Dublin Electricity Supply Committee require tenders by Nov. 26 for supply of 20,000 yellow flame arc lamp carbons (7·5 mm. × 25½ in.).

The directors of the Sligo, Leitrim & Northern Counties Railway, Company invite tenders (by Dec. 1) for Stores, including Electric Telegraph Materials. Tenders to the Secretary, Enniskillin.

Dundee Corporation require tenders by Nov. 20 for the supply and erection of steel work at Carolina Port generating station. Forms of tender, &c., from the General Manager of the Electricity Department.

The Cheshire Lines Committee require tenders by 10 a.m. Nov. 26 for one year's supply of stores, including telegraph materials, carbons, oils, &c. Specifications from the Stores Superintendent, Warrington.

Croydon Corporation invite tenders for the supply and erection of an electric motor and pump at the sewage disposal works, South Norwood Farm. Specifications from the Borough Engineer's Office, and tenders to the Town Clerk, Town Hall, Croydon, by 11 a.m. Nov. 17.

Manchester Rivers Committee want tenders by 10 a.m. Dec. 1 for the supply and erection of three 30 h.p. three-phase induction motors, with rheostats, &c. Specifications from the Secretary, Rivers Department, Town Hall, Manchester.

The directors of the Great North of Scotland Railway Company require tenders by 10 a.m. Nov. 27 for six or 12 months' supply of various stores and materials, including telegraph material, ironmongery, &c. Forms of tender from the Stores Superintendent, 80, Guild-street, Aberdeen.

The Guardians of the parish of St. Pancras invite tenders for the supply and erection of an electrically-driven lift at their south infirmary, Pancras-road, N.W. Tenders to the clerk, Mr. J. E. P. Hall, Town Hall, St. Pancras-road, London, N.W.1.

Walthamstow Urban Council invite tenders for the supply and delivery of c.i. circulating water pipes, e.h.t. and c.t. cables and an engine-room crane. Specifications from the electrical engineer (Mr. G. R. Spurr), and tenders to the Clerk by 5 p.m. Nov. 26.

Southampton Corporation invite tenders for the supply and erection of heating apparatus at its motor omnibus garage at Shirley Depot. Specifications from the General Manager and Engineer of the Tramways Department, 161, Above Bar-street, tenders to Town Clerk by Nov. 22.

Merton and Morden Urban Council invite tenders for the supply of two 2-ton electrically-driven dust vans and the installation of a motor-generator at their depot. Forms of tenders, &c., from the engineer and surveyor, Mr. G. Jerram, A.M.I.C.E., and tenders to the clerk of the Council (Mr. C. J. Mountifield), Council Offices, Kingston-road, Merton, S.W.19, by noon Nov. 28.

Tynemouth Corporation invite tenders for the supply of some three-core insulated lead-covered cable for 6,600 volts, four pair paper-insulated lead-covered telephone cable and three-core cable carrying conductors for Merz-Price protective gear. Specifications, &c., from the borough electrical engineer, Mr. C. Turnbull, and tenders to the town clerk, Mr. Stanley Wilson, by Dec. 1.

Hammersmith (London) Borough Council invite tenders for the supply of static transformers, e.h.t. and l.t. cable, h.t. oil-break switches, black and galvanised corrugated iron sheets, and steam piping. Forms of tender from the borough electrical engineer, Mr. G. G. Bell, 85, Fulham Palace-road, W.6. Tenders by 4 p.m. Nov. 20 to the town clerk, Mr. Leslie Gordon, Town Hall, Hammersmith, W.

Manchester Electricity Committee invite tenders for the supply, delivery and erection at their Barton Power station of two 25,000 kw. and two 1,000 kw. three-phase turbo-alternators, with condensing plants; four 1,000 lb. water-tube boilers for a working pressure of 375 lb. with steam economisers, air heaters, induced and forced draught plants, chimneys, flues, coal chutes and ash hoppers, pipe work and valves; coal and coke handling and conveying plants and waggon tippers. Specifications and forms of tender from the Secretary of the Electricity Department, Mr. F. E. Hughes, and further particulars and information can be obtained from the Chief Engineer and Manager, Mr. S. L. Pearce, Dickinson-street, Manchester. Tenders, addressed to the Chairman of the Electricity Committee, must be delivered at the Town Hall by noon of Dec. 24.

Croydon Corporation has placed orders with Messrs. Bruce Peebles & Company for the supply of a 500-kw. inverted rotary converter at £3,191 and a 1,000-kw. converter at £5,925.

Belfast Corporation has placed an order with the Metropolitan Vickers Electrical Company for the supply and erection of two additional h.t. feeder panels at East Bridge Street station at £1,912.

Educational.

The Institution of Engineers and Shipbuilders in Scotland have decided to mark the Watt centenary by founding two additional chairs in engineering at Glasgow University to be named after Jamea Watt.

A chair of physical chemistry has been established at the Bristol University by the generosity of Lord Leverhulme. Capt. J. W. McBain, lecturer in physical chemistry in the University, has been appointed to the chair.

The Manchester and District Armaments Output Committee has decided to devote its surplus assets (£16,000) to the foundation of Scholarships for boys who show promise of development in the Engineering Industry. The sum will be expended during the next 10 years.

Appointments Vacant and Filled.

A test room assistant is required for the Stepney (London) Borough Council electricity department. Applications to the Engineer and Manager, 27, Osborn-street, Whitechapel, E., by Nov. 18.

A competent electrician is required for a tin mine in Northern Algeria. Salary £50 per month. Applications to O.L., care of Messrs. Charles Barker & Sons, White Lion-court, Cornhill, London, E.C.3.

Telegraph inspectors and electrical mechanicians are wanted by the Posts and Telegraphs Department in the occupied territory of German East Africa. Applications to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1.

A mains foreman is required for the Birmingham electric supply department, wages £4 10s. per week, plus 12½ per cent. Application forms from the Secretary of the department, 14, Dale End, Birmingham, and applications by Nov. 17,

A professor of physics and electrical engineering is required at the Municipal Technical Institute, Belfast. Salary £600 per annum. Forms of application from the principal, Major Rupert Stanley, and applications must be in by Nov. 18.

A grade II. lecturer and demonstrator in electrical engineering is required in the Faculty of Engineering of the University of Liverpool. Commencing salary £300, increasing by yearly increments of £25 to £400. Applications to the Registrar.

An assistant lecturer in engineering is wanted at the Swindon and North Wilts Technical Institution. Application forms, &c., from the principal (Mr. G. H. Burkhardt, M.Sc.), to whom applications must be sent by Nov. 25.

Applications are invited for appointments as schoolmasters to carry on the higher education of boys and men in the Royal Navy. Salary £175 per annum (during preliminary course), rising to £383 as Lieutenant-commander. Further particulars from the Secretary of the Admiralty, Whitehall, S.W.1.

The Corporation of the city of Cape Town invite applications for the position of station engineer. Salary £600 per annum. Applications by noon Jan. 3, 1920, to the town clerk, Mr. J. R. Finch, City Hall, Cape Town. The Corporation also invite applications for the position of temporary assistant engineer in the electricity department, salary £60 per month. Applications to the town clerk (Mr. J. R. Finch) by Jan. 10, 1920. British candidates, who must not be over 40 years of age, must send in applications to the London agents, Messrs. Davis & Soper, Ltd., 54, St. Mary Axe, E.C., by Nov. 15.

Mr. James Townley, acting borough electrical engineer at Barnsley, has been appointed chief assistant electrical engineer to the Sunderlann Corporation electricity department, at £522 per annum, in succession to Mr. S. R. Windle, who was recently appointed borough electrical engineer at Doncaster.

The London County Council has confirmed the appointments of Mr. H. S. May and G. W. Knight, who have been acting as rolling-stock superintendents since July, 1917. The salary is £450 per annum, rising by annual increments of £25 to £600 per annum. Mr. H. E. Blackiston has also been appointed sub-station superintendent, and Mr. J. R. Davison charge shift engineer at Greenwich power station at £250 per annum, rising to £300 per annum in each case.

Business Items.

Messrs. R. H. Barker & Company, Rutland Mills, Wakekeld, have for sale a 400 kw. turbo-alternator with condenser, etc.

Major A. E. Levin, T.D., R.E. (T), who was for some years associated with Mr. W. M. Mordey and his late partner (Mr. R. A. Dawbarn), has now returned from overseas military service, and has joined Mr. Mordey as partner. The firm will be known as Mordey & Levin, and will carry on practice at 82, Victoria-street, Westminster, S.W. 1.

The "Kwik-Lok" patent electric shade carrier has recently been placed on the market by Fuller's United Electric Works, Ltd., of Woodland Works, Chadwell Heath, London, E. The carrier seems to be a useful labour-saving device. It is easily fixed or removed; it saves time and trouble in taking off and fixing electric lamp shades, and acts as a locking device for preventing the theft of lamp bulbs.

The London Electric Stores, Fulwood House, High Holborn, W.C.1, have been appointed sole agents for the British Empire for Messrs. Cegeme, of Brussels, manufacturers of fans and motors. The fans are made from 10 in. to 18 in., both d.c. and a.c., and the small motors from 1/100 to 2 H.P., both a.c. and d.c. Stocks will be held in London shortly, and interested firms can obtain copies of a list which they hope to have ready within the next two to three weeks. The Stores have also been appointed sole London agents for the Silverdale hot-plate, which is well known for its efficiency and cheapness. A list will be sent on application. The firm have issued their price list of iron-clad switch and fuse gear.

Messrs. Johnson & Phillips, Ltd., of Charlton, London, S.E.7, have issued their revised PRICE LIST (No. 30) of RUBBER INSULATED CABLES. The list has been issued in order to embody the revised standards of the Engineering Standards Association, and particulars and prices are given of the various grades of association and non-association cables, flexibles, bell wires, jointing materials, &c. The manufacture and tests of the cables listed are effected in accordance with the recommendations of the Engineering Standards Committee and the specifications of the Cable Makers' Association. In addition to rubber insulated cables the firm also manufacture paper-insulated lead-covered cables for power transmission and telephone work, vulcanised bitumen cables for mines, &c., cable junction boxes, distribution pillars and accessories, insulating tapes and compounds, but these form the subject of separate catalogues.

Companies' Reports, &c.

The Rt. Hon. Lord Herschell, K.C.V.O., has been elected a director of Marconi's Wireless Telegraph Company, Ltd., and the Marconi International Marine Communication Company, Ltd.

The directors of Fullers' United Electric Works, Ltd., have declared an interim dividend on the preference shares for the past six months at the rate of 8 per cent. per annum.

The West African Telegraph Company has declared an interim dividend at the rate of 4 per cent. per annum for the six months ended June 30, free of tax.

The gross revenue of the Amazon Telegraph Company, Ltd., for the year ended June 30, 1919, amounted to £83,037, and the working expenses to £33,413. After providing £2,579 for income tax, £337 for depreciation of investments, £11,658 for debenture interest, £11,241 for sinking fund, and placing £16,000 to general reserve, the directors recommend payment of a dividend of 4½ per cent. (less tax) on the share capital, leaving £6,775 to be carried forward. Communication between Para and Manaos has been maintained throughout the whole year.

Applications are invited by the British, Foreign and Colonial Corporation for 300,000 £1 ordinary shares of the Edison-Swan Electric Company, Ltd., at 21s. 6d. each. Applications for 110,000 of the shares have already been received from business friends of the Edison-Swan Company and will be accepted in full. Various extensions and developments of the Company's business have recently been made, and the proceeds of the new shares will be employed in further extensions and the provision of additional working capital, which the company requires owing to the large expansion of its trade. The list will be closed on or before the 15th inst.

The directors' report of Messrs. Drake & Gorham, Ltd., for the year ended June 30, last states that after payment of all charges, including bonuses due to staff, and making provision for contingencies, the net profit is £27,136. 10s. 11d. With £6,702. 1s. 9d. brought forward, the total is £33,838. 12s. 8d. It is proposed to pay a dividend at the rate of 10 per cent. for the year (£12,500), to write down goodwill by £5,000 and to carry forward (subject to deduction for excess profits duty) £16,338. 12s. 8d. The turnover shows a considerable increase on that of the previous year which was itself a record, and although a number of war contracts were cancelled the work in hand on June 30 compared favourably with that of the previous year. The business of the wholesale department continues to expand as well as the sphere of its operations. This branch has since been transferred to a separate company, registered as Drake & Gorham Wholesale, Ltd. The Rockingham Works, Newington Causeway, has been fully occupied and shows satisfactory profits. The directors have voted £1,621. 5s. 1d., being part of the extra remuneration to which they are entitled under the Articles of Association, towards the staff bonus account. Mr. Holbrook Gaskell, O.B.E., until lately chief engineer of the United Alkali Company, has accepted a seat on the Board since the last annual meeting.

Presiding over the annual meeting of the Electric Supply Corporation, Ltd., last week, the chairman (Mr. J. G. B. Stone) said that the past year's gross revenue was £7,238 more, but the sum taken into net revenue account was £939 less than the corresponding figure in 1918. At the last meeting he had pointed out that unless they were given power to increase their charges to consumers the increasing cost of coal, wages, &c., would deprive shareholders of any return on their investments, and that was what had happened. Other companies carrying on a similar business were in a like position. The pre-war dividend upon which that calculation had to be based was the average of the years 1911, 1912 and 1913. in their case only 2 per cent., they being in course of development and their plant not fully employed. Unless, therefore, the authorities would agree to revert to the procedure under the Electric Lighting Acts on which the capital had been subscribed they were debarred from earning a proper return on their money and deprived of the means of extending their operations to fulfil their statutory obligations. In most of their undertakings they had an agreement with the local authority, fixing the maximum rate to be charged, irrespective of the rate authorised by the Order. Although those maximum rates appeared in the old days to be fair and reasonable, they were under present conditions much too low. Certain local authorities were willing to meet them, but it would probably be necessary to proceed under the Courts Emergency Powers Acts in order to get that hardship removed in all cases.

At an extraordinary general meeting of the Anglo-Portugese Telephone Company, Ltd., on the 6th inst., it was decided to increase the capital of the company to £500,000 by the creation of 300.000 new shares of £1 each. The chairman (Mr. H. Allen) presided, and pointed out that the business of a sound telephone undertaking never stood still, and he was glad the time had arrived when the directors felt justified in bringing forward proposals for meeting the capital requirements of the next three or four years. The company dated back to 1887. and their sphere of operations embraced the city of Lisbon, with a population of over 700,000, and the surrounding country within a radius of 30 km., also the city of Oporto, with a population of about 350.000 and a radius of 20 km. In the first year the number of subscribers was 1,423, the gross income £4,934 and the net profit £1,695. By 1918 the installations had increased to 12,410, the gross income to £103.957 and the profit to £37,468 which was reduced by loss on exchange to £20.114. From 1916 to 1918 they lost on their remittances about £55,000, but for which, instead of paying 6 per cent. dividends, they could, whilst making the same appropriations to reserve, have paid 18 per cent. Every rise or fall of 1d. in the Lisbon exchange on London made a difference of over £1.000

in their net profits, and they would have little occasion to remit moneys from the other side with a heavy capital expenditure going on. The directors would issue 250,000 of the new shares. Much of the outlay contemplated represented work held up in the four or five years of the war, and which must now be energetically prosecuted without further delay. At Lisbon they were increasing the capacity of the north exchange from 3,000 lines to 7,000, and they were erecting an entirely new exchange with a capacity of 10,000 lines. Altogether they would more than double their present capacity at Lisbon, whilst at Oporto they were replacing the present exchange, with 3,000 lines, by a new exchange with a capacity of 10,000 lines. Already they had about 3,000 new subscribers waiting for installations, representing an income of about £25,000 a year. There was no finality in the telephone business, and he personally had always held the view that the prospect of further capital expenditure in undertakings of that kind was a subject for congratulation.

New Companies.

BALL WIRE-ROPE TRANSMISSION GEAR, LTD. (160,061).—Private company. Reg. Oct. 28, capital £7,000 in £1 shares, to carry on the business of engineers, manufacturers of wire-rope, couplings, transmission gearing, &c. First directors are J. W. Cann, A. I. Pidduck and F. C. Walter (all permanent). Solicitor: A. I. Pidduck, 31, Cannon-street, E.C.

COMPRESSION STARTER & SWITCHGEAR, COMPANY, LTD. (160,220) Private company. Reg. Nov. 1, capital £12,000 in £1 shares. Objects: To carry on the business of manufacturers of and dealers in motor starters, dynamos, motors, switchgear, motor cars, electrical cars and electrical accessories of all kinds, general, electrical and motor engineers, &c. First directors are R. Lonan, G. B. Morton and T. N. Robinson (managing director). Reg. office: Pennyton, Lancashire Hill, Stockport.

EYQUEM SPARKING PLUGS, LTD. (160,253)—Private company. Reg. Nov. 3, capital £10,000 in £1 shares, to carry on the business of manufacturers of and dealers in sparking plugs and all component parts, magnetos, electric generators, &c. Reg. office: 2, Gerrard-place, W.1.

LESCO, LTD. (160,193)—Private company. Reg. Oct. 31, capital £20,000 in £1 shares, to carry on the business of manufacturers of electric lamp-holders and other electrical and mechanical sundries, &c. First directors are V. Hope, T. M. Kirkby, J. Mossulam, F. A. Hilton, J. W. Flohr, W. O. Ingham and C. H. Ingham. Sec.: J. W. Flohr. Reg. office: Lloyd's Bank-buildings, King-street, Manchester.

MARCONI SCIENTIFIC INSTRUMENT COMPANY, LTD. (160,228)—Private company. Reg. Nov. 1, capital £12,000 in £1 shares, to carry on the business of electricians, engineers, manufacturers of telegraphic apparatus, &c. First directors are H. W. Allen, W. W. Bradfield, W. W. Drury, C. Mitchell and A. W. Ward. Sec.: A. W. Ward.

VICKERS-BRAZIL, LTD. (150,367)—Private company. Reg. Nov. 6, capital £10,000 in £1 shares. Objects: To carry on the business of engineers, shipbuilders, electricians, &c. Reg. office: Vickers House, Broadway, Westminster.

VICKERS-ARGENTINA, LTD. (160,309.)—Private company. Reg. Oct. 31, capital £10,000 in £1 shares. Objects: To carry on the business of manufacturers of and dealers in steel, iron, brass and metals of all kinds, shipbuilders and electricians, &c. Reg. office, Vickers House, Broadway, Westminster, S.W.

Prices of Metals, Chemicals, &c.

Tuesday, Nov. 11.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£112 0 0	—	£1 0 0
Electrolytic bars ...	,,	£117 0 0	—	£1 0 0
H.C. wire basis......	per lb.	1s. 3$\frac{3}{16}$d.	—	$\frac{1}{8}$d.
Sheet	,,	1s. 4d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 7$\frac{9}{16}$d.	—	$\frac{1}{8}$d.
Brass 60/40—				
Rod, basis	,,	0s. 11$\frac{1}{4}$d.	—	$\frac{1}{8}$d.
Sheet, basis	,,	1s. 2$\frac{5}{8}$d.	—	—
Wire, basis	,,	1s. 2$\frac{1}{2}$d.	—	—
Iron—				
Cleveland Warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	£32 10 0	—	—
Lead Pig—				
English	,,	34 10 0	£1 10 0	—
Foreign or colonial	,,	33 12 6	£0 17 6	—
*Tin—*Ingot	,,	279 10 0	£6 15 0	—
Wire, basis	per lb.	0 3 5$\frac{1}{2}$	1d.	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Ton £22 10s.

,, (Roll Brimstone).—Per ton £22.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40.

Boric Acid (Crystals)—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6d.

Shellac.—480s. December delivery 477s. 6d. to 480s.

Rubber.—Para fine, 2s. 6$\frac{1}{2}$d.; plantation 1st. latex 2s. 5d. lb.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W. T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From The Electrician, Nov. 11, 1882.]

The Military Reorganisation of Egypt.—According to the "Standard's" correspondent at Alexandria, the British authorities have fixed on seven permanent miltary stations, all of which have been connected with each other by telephones.

A New Cable.—The Eastern Telegraph Company has just completed the laying of a short cable manufactured by the Telegraph Construction & Maintenance Company for the Italian Government. The cable joins the two largest of the Lipari Islands, off the coast of Italy.

Electric Lighting of Canterbury Cathedral.—A contract has been entered into by the South Eastern Brush Electric Light Company with the Dean and Chapter of Canterbury to illuminate the Cathedral by the electric light for a period of three months.

Electric Lighting in the City.—The special meeting of the Commissioners of Sewers to give effect to the resolution passed as to apply for a provisional order or licence to enable the Commissioners to become undertakers for the supply of electricity under the provisions of the Electric Lighting Act, 1882, will be held on Tuesday, November 21, in order to comply with the Act of Parliament requirement to give one month's notice.

Brighton and the Electric Light.—At a special meeting of the Brighton Town Council on Monday last it was resolved to apply to the Board of Trade for a provisional order under the Electric Lighting Act, authorising the Corporation, as the Urban Sanitary Authority for the borough, to supply electricity for public and private purposes within their district. The Council had previously resolved to oppose all applications for the licences by companies.

Kant.—De Quincey, in his essay on "The Last Days of Kant," says that a sign of his (Kant's) mental decay was the weakness with which he began to theorise. He accounted for everything by electricity. A singular mortality at this time prevailed among the cats at Vienna, Basle, Copenhagen and other places widely remote. Cats being so eminently an electric animal, of course he attributed this epizootic to electricity. During the same period, he persuaded himself that a peculiar configuration of clouds prevailed; this he took as a collateral proof of his electrical hypothesis.

The Lighting of Hell Gate.—At a recent meeting of the Lighthouse Board, Washington, a report was received from the special committee on the lighting of Hell Gate by electricity, recommending Hallett's Point as the best available site for the electric light tower: also suggesting that a tower be constructed of iron, with a height of 250 ft., to contain lights of 20,000 c.p. to be displayed from sundown to sunrise. The report was adopted, and it was ordered that the necessary plans and specifications for the tower and machinery be prepared at once. Proposals for the work will be advertised for as soon as the necessary papers can be prepared. It was also decided that all the machinery to be employed in this tower be duplicated, so that in case of accidents to any part of the machinery it can be immediately replaced.

Electric Light Accident.—Much disappointment, says the "Standard's" Vienna correspondent, was created by an accident at Brünn, on Sunday night last, where a new theatre was to have been opened, illuminated with the electric incandescent light. It was found that the lead connected with the conducting wires had mostly been melted by the current. A large and fashionable crowd had assembled at the doors of the new building, whom the Burgomaster had to inform that the performance would not take place in consequence of the failure of the electric lights. For a moment a panic was threatened, but this was averted and ultimately the crowd separated unhurt, but grumbling at the disappointment. It would have taken at most two minutrs to have put in another piece of "lead," so we cannot accept the "Standard's" dictum as to the cause of postponing the performance.

Lectures to Women on Physical Science.—*Place:* A small alcove with dark curtains. The class consists of one member. *Subject:* Thomson's Mirror Galvanometer.

> The lamp-light falls on blackened walls,
> And streams through narrow perforations,
> The long beam trails o'er pasteboard scales,
> With slow-decaying oscillations.
> Flow, current, flow, set the quick light-spot flying,
> Flow, current, answer light-spot, flashing, quivering, dying.
> Oh, look! how, queer, how thin and clear,
> And thinner, clearer, sharper growing,
> The gliding fire! with central wire,
> The fine degrees distinctly showing.
> Swing, magnet, swing, advancing and receding,
> Swing, magnet. Answer, dearest, what's your final reading?
> O love! you fail to read the scale
> Correct to tenths of a division.
> To mirror Heaven those eyes were given,
> And not for methods of precision.
> Break, contact, break, set the free light-spot flying:
> Break, contact, rest thee, magnet, swinging, creeping, dying.

The above is taken from Campbell and Garnett's "Life of Clerk Maxwell."

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Notes.

The Influence of Condensing Water on Super-power Stations.

WITH the passing of the Electricity Supply Bill into an Act of Parliament, an event which will probably take place at no distant date, we may expect attention to be drawn from a discussion of its provisions to a consideration of how these provisions can best be carried out. Among the most interesting of the problems to be faced will be the design and lay-out of the super-power stations, whose erection will thus be authorised. The design of such stations has been an interesting paper question for some years, and it as for as long been considered that the most economical site which could be chosen would for many reasons be one as close as possible to the pit mouth, the advantages of cheap fuel outweighing the increased costs of transmission. Recent attacks on the problems have, however, shown that there is a more important factor than even cheap fuel. This is an adequate supply of condensing water. The efficient employment of modern steam turbine plant necessitates the use of a high vacuum in the condenser, and this high vacuum can best be obtained when the cooling water is drawn from such natural sources as a tidal river, where the considerable volume of water running to many millions of gallons per day drawn in and returned has little effect on the normal temperature of the source of supply. To use a canal for this purpose is undesirable, owing to the temperature rise which quickly takes place, while the employment of cooling towers is at best a costly and inefficient arrangement, for the reason that not only is the coal consumption increased, but the evaporative losses are large. Looking at the problem from this point of view, it has been found that the number of sites available for super-power stations in this country is exceedingly small, and as might be expected, these sites are not geographically the best from the power supply point of view. It would, therefore, seem once again to be a question of compromise to discover how far the demands of a certain area shall determine the site of the station to supply that area, and how far increased operating costs can be set off against a saving in capital expenditure. These are problems which the new Electricity Supply Commissioners will have to tackle, without delay, for on their right solution will depend that supply of cheap power which we all hope is going to be one of the first results of the new Act.

The Misuse of Half-watt Lamps.

As was generally anticipated, the termination of the war and the relaxation of lighting restrictions has been followed by a general adoption of the gas-filled or so-called "half-watt" lamps. Unfortunately, possibly as a result of the reaction from the gloomy obscurity of the streets during the war period, these lamps do not appear to be wisely used in many instances. The desire for brilliancy has led many shopkeepers to instal the lamps indiscriminately, without any effective shading, in their windows—a method which was condemned as regards ordinary tungsten lamps: but is still more objectionable in the case of the much more brilliant gas-filled lamps. This danger was foreseen by the Illuminating Engineering Society during the war, and the practice of using unscreened lamps in shop windows has often been the subject of adverse comment at its discussions. The leading manufacturers of lamps and lighting appliances, to do them justice, also insist on the need for effective shading. Yet the practice continues. One class that has undoubtedly a responsibility in this matter is the electrical contractor, who could do a great deal to influence consumers, but while a consumer is free to purchase lamps and place them haphazard in an unsuitable fitting, often projecting from a shallow and badly devised reflector, the glare from these lamps will continue to vex our eyes. It deserves consideration, therefore, whether some restrictions could not be imposed by public bodies, or Government Authority. It has been remarked, we believe by Mr. LEON GASTER, that anyone who distresses the auditory nerves of the public by a strident noise is quickly brought to book. There is apparently no legal remedy for an offence to his visual apparatus. One possible chance of action is afforded by the well recognised distracting effect of these bright lights on drivers of vehicles, and their inconvenience to traffic. Alternatively, as has been suggested in connection with flashing sky-signs, &c., it might be possible for local authorities to frame regulations on the ground that the exhibition of brilliant unscreened lights is a public nuisance: it is also undesirable on æsthetic grounds.

Physical Tests of Irregularities in Steel Structure

In all the manifold processes in which steel is used there is a great need for some really accurate and expeditious method of testing deficiencies in structure. Steel parts commonly form a vital part of the structure in which they are used, and failure is dangerous. Accordingly, what is needed is not merely a test on a certain percentage of samples; ideal conditions would involve the testing of *every* part to whose failure under working circumstances would be dangerous. Mechanical tests on this scale are usually out of the question. Too much time is involved, and a severe test would often deform the material. It remains to be seen whether materially some form of physical test can be devised. Very great interest was taken in the discussion early in the present year on the application of X-ray methods to the detection of flaws, blow-holes, &c. At present this method has obvious limitations. It can only be used for small samples and, so long as the actual taking and development of a photograph is necessary, it can hardly be termed sufficiently expeditious. If, however, by using more powerful sources of X-rays, and very much more sensitive responding material, the fluorescent screen could alternately be substituted for photography a great step forward would be made. The other most obvious alternative is magnetic testing. Grave mechanical irregularities in structure would reveal themselves under a magnetic test. The difficulty is to distinguish these from other forms of non-uniformity revealed by a magnetic test, but possibly involving no mechanical breakdown. The problem is one on which little has been done, and seems to deserve investigation.

The Federation of British Industries.

The combination of those who like to call themselves the proletariat into unions and associations for the maintenance and enforcement of what they suppose to be their rights, soon caused a similar movement to take place among the employers of labour with more or less success. The scope of such combinations was widened a few years ago by the formation of the Federation of British Industries, whose activities are well known to our readers. We are glad to see from the annual report of this Association, which has just been published, and by the Presidential Address of Sir Vincent Caillard, that the development of the Federation has been increasingly satisfactory during the past year. Sir Vincent pointed out that there were two ways in which the Federation could help industry. The first was as a central and representative body of all industries, and the other was by rendering services of varied kinds to individuals or groups. In the former capacity the Federation has brought its influence to bear upon obtaining concessions likely to be of use to traders in the provisions of the new Ministry of Transport Act, and in the Electricity Supply Bill. In spite of their successes in this direction it seems, however, that the Federation is not yet satisfied with what it has done. It still regards the Transport Act as unsatisfactory, though a great improvement on the Bill originally introduced, while the Electricity Bill, as originally drafted, is considered as dangerous to industrial efficiency and likely to increase instead of reduce the cost of power. This is a view with which we can hardly be expected to agree, though it is fair to point out that the Federation considers that the amendments it has secured in the Bill will counteract its original danger. In the second capacity the Federation has undoubtedly done useful work, chief amongst its activities in this direction being the establishment of a Commissioner Service of its Overseas Organisation to form a channel whereby overseas buyers can get rapidly into touch with British manufacturers. This is a line ripe for development, and the results will be watched with interest. The Federation of British Industries is an organisation of the right kind, but while we consider such organisations most necessary for the development of industry, we wish to sound a note of warning regarding their multiplication. One large efficient organisation with a definite policy is worth more when it comes to obtaining concessions, than ten small ones, each with a policy of its own, and differing from that of its neighbours.

* * *

"Motor Equipment for Main Drive of Rolling Mills."—*Erratum.*—In the particulars given under this heading in our issue of September 26th, page 370, we gave the Whitecross Company's rolling mill of motor horse power as 4,700; this should be 2,000. The drive was given as rope and gear, but this should read ½ direct and ½ rope and gear.

Wireless Society of London.—The next general meeting of this Society will take place at the Institution of Civil Engineers, Great George-street, Westminster, on Wednesday, the 26th inst., at 6 p.m., when Mr. J. Scott-Taggart will read a Paper on "A System for the Reception of Continuous Waves," which will afterwards be discussed.

Royal Society Awards.—The following awards have been made by the President and Council: Royal medal to Mr. J. H. Jeans for his researches in applied mathematics; Davy medal to Prof. P. F. Frankland for his distinguished work in chemistry, especially that on optical activity and on fermentation; Sylvester medal to Major P. A. MacMahon for his researches in pure mathematics, especially in connection with the partition of numbers and analysis; and Hughes medal to Dr. C. Chree for his researches on terrestrial magnetism.

Wireless Telegraph Licences.—The Postmaster-General announces that he is now prepared to consider applications for permission to use transmitting apparatus for experiments in wireless telegraphy. Applicants, who must be of British nationality, must show that they have in view some definite object of scientific value or general public utility, and that they possess the necessary technical knowledge and operative skill. It is proposed to charge small fees to cover clerical expenses, cost of inspecting the stations, &c. Full particulars can be obtained from the Secretary, General Post Office, E.C. 1. Permits are already being issued under simpler conditions for stations limited to receptions.

Physical Society.—The meeting of the Physical Society which will be held on Friday, November 28th, at 5 p.m., in the Imperial College of Science, South Kensington, is to be devoted to a discussion on the subject of "Lubrication." The physical characteristics of a good lubricant have long eluded definition. It is expected that the discussion will lead at least some way towards the solution of this problem, and that it will serve to create a wider interest in the subject. Amongst those who will take part will be the following: Messrs. L. Archbutt, R. Mountford Deeley, W. B. Hardy, F. W. Lanchester, H. M. Martin, S. Skinner and T. E. Stanton, F.R.S. The meeting is an open one, and all who are interested in the subject are invited to attend.

British Engineering Standards Specifications.—We have received copies of the specifications relating to the following subjects, which have recently been issued by the British Engineering Standards Association: Instrument Transformers (No. 81), Indicating Ammeters, Voltmeters, Wattmeters, Frequency and Power Factor Meters (No. 89), Recording (Graphic) Ammeters, Voltmeters and Wattmeters (No. 90), and Rolled Sections for Magnet Steel (No. 107).

In the first of these, two classes of current transformers and one class of potential transformers are dealt with. Limits of error for ratio of phase angle are specified, and high-pressure tests, ratios of transformation and rated outputs are dealt with. The standard sizes of current transformers range from 5 to 5.000 amperes, with a secondary current of 5 amperes in each case, and the standard sizes of potential transformers range from 110 volts to 33.000 volts, with a secondary pressure of 110 volts in each case. Appendices deal with the use of transformers in general, the use of transformers with electricity meters and single-turn current transformers respectively. The report is issued at the nominal price of 1s. 2d. post free.

The second specification is a revision of specification No. 49, which was issued in 1908. It now includes a number of definitions and clauses relating to types of enclosure, limitation of the number of scales, marking polarity of terminals, insulation, shunts, &c. For the purpose of dealing with the question of accuracy, all instruments are divided into three classes—namely, sub-standard, first grade and second grade respectively. Appendices deal with methods of marking scales, accuracy of which various types of instruments are capable, method of erecting shunts and damping. The report is issued at 1s. 2d. post free.

Specification No. 90 is the first British standard specification dealing with recording instruments. In addition to the requirements in regard to accuracy, the specification includes a number of definitions and clauses relating to chart ruling, insulation, external shunts and marking polarity of terminals for both direct-current and polyphase current instruments. Appendices dealing with the accuracy of different types of recorders, chart, speed and shunts are included. The report is 1s. 2d. post free.

Specification No. 107 includes a symmetrical series of 60 sections for general purposes, 26 of which it is recommended should not be used unless it is impossible to use any of the remaining 34 sections, and a supplementary list of 10 special sections for ignition magnetos. A table of tolerances on the dimensions of the rolled sections, and two plates showing all the sections, are included in the specification. The report is issued at 1s. 2d. post free.

Institution of Electrical Engineers' Opening Meeting.—The first meeting of the new session took place on Thursday, the 13th inst., at the Institution of Civil Engineers, Westminster. The retiring president, Mr. C. H. Wordingham, presented the premiums and scholarship cheques earned by members and students during the past year, particulars of which were given in the annual report of the Council (abstracted in The Electrician in June last). A number of the winners did not attend. The new president, Mr. Roger T. Smith, then took the chair amidst acclamation.

Mr. W. M. Mordey, in proposing a vote of thanks to the ex-president, said the members had welcomed the incoming president. It was his pleasant and honourable duty to speak of the past president. They would all part with Mr. Wordingham as president with great regret. He (Mr. Mordey) would like to condole with their new president in having to follow Mr. Wordingham, whose great ability and tremendous energy and activity would be very difficult to emulate. During the two years Mr. Wordingham had been president he had, perhaps, done more than any former president to increase the usefulness of the Institution of Electrical Engineers. Perhaps some of them could not follow him altogether in his extensions of the activities of the Institution that he had inaugurated and carried into effect; but those who did not altogether agree with him in those respects felt that they were in the minority, and were probably wrong. At any rate, the Institution, instead of confining itself as hitherto to the discussion of questions of engineering and science, covered now a much wider field of activities. Mr. Wordingham's work spoke for him more eloquently than anything he (Mr. Mordey) could say.

Mr. W. B. Woodhouse said he had great pleasure in seconding the resolution. Mr. Wordingham's work during his tenure of office stood on record in the "Journal," in the growing membership of the Institution, and in the wider and wider recognition of the Institution which it was receiving from all quarters. He thought when they looked back in a few years they would realise more fully than they did to-day how very valuable Mr. Wordingham's work had been.

Mr. Wordingham, in reply, said the work of a president was very heavy—far heavier, probably, than those who had not actually filled the office could realise; but it had been essentially a labour of love, and an intense source of satisfaction to him to be able to serve the Institution of which he was so proud. He would like to say one word of thanks to the two Councils with which it had been his privilege to work. They had supported him splendidly in every way. He must also say a word of gratitude to Mr. Sparks for the way in which he supported him when he (Mr. Wordingham) took over the reins of office. The position of past-president was one of difficulty and delicacy, as he must not drop what he had been doing, and, on the other hand, he must not be unduly obtrusive.

Mr. Roger T. Smith then delivered his presidential address, an account of which will be found on p. 572.

A vote of thanks to the president for his address was proposed by Mr. C. P. Sparkes and seconded by Mr. J. S. Highfield.

Obituary.

It is with deep regret that we record the death of Mr. Julius Benn, which took place at his residence at Ealing, on Friday, November 14, at midnight. Julius Taylor Benn, who was one of the founders and at the time of his decease a director of Benn Brothers, Ltd., was the second son of the Reverend Julius Benn. He was born on November 14, 1852, and his passing away thus took place on the anniversary of his birth, 67 years ago.

Mr. Julius Benn first entered the City of London as an office boy in Mincing-lane. Starting thus at the bottom of the ladder he worked his way through the various grades of clerkships until, at the age of 30, he had acquired a wide experience of the import and merchandising of the products of Asia Minor and Eastern Europe. Meanwhile, his elder brother, now Sir John Benn, had commenced in 1880 the publication of the first of the series of trade newspapers, of which this journal now forms one. Mr. Julius Benn then joined him and thus brought his financial and business experience to the development of the publishing enterprise. He at once established a printing works in Olivers' Yard, City-road, together with an engraving plant and lithographic department, all of which he controlled with ability for 20 years. This printing works, in addition to producing Benn Brothers' publications, achieved a reputation for the design and printing of trade catalogues, and Mr. Julius Benn was alone responsible for the production of some of the most important trade lists that had up to that time appeared. Notable among these were the comprehensive Whiteley catalogues, which he personally arranged for many years in succession. At that time also a great many important catalogues for Colonial houses were produced under his supervision at the works which he established.

When in 1889, Sir John Benn relinquished the active control of the business for public and political work, Mr. Julius Benn became the responsible head of Benn Brothers, Ltd. Under his guidance the business expanded to a remarkable degree, and though he ceased from active daily participation in business affairs some 30 years ago, he was a regular attendant at the monthly Board meetings of the Company, and to the end remained an inspirer of its policy and a critic of its administration. The funeral took place at Golder's Green yesterday.

Personal.

On the 8th inst. Mr. Horace Field Parshall was married at American Holy Trinity Church, Paris, to Mary, daughter of Mr. and Mrs. Edgar Sutton Blackwell, of New York and Paris.

Mr. E. E. Bradley, assistant superintendent of the Central Telegraph Office, London, has been promoted to the rank of superintendent.

Ald. Dudley Stuart, chairman of the Electric Lighting Committee of Wimbledon, has been elected Mayor of the borough.

Arrangements for the Week.

FRIDAY, Nov. 21st (to-day).

Institution of Mechanical Engineers.

6 p.m. At Storey's Gate, St. James's Park, London, S.W. Paper on "The Present Position of Mechanical Road Traction," by Mr C. G. Conradi.

Junior Institution of Engineers.

7 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Annual General Meeting and a Paper on "The Limitation of Electric Tramways," by Mr. W. A. Tookey.

Institution of Electrical Engineers, Students' Meeting.

7 p.m. At the City and Guilds College, South Kensington, London, S.W. Opening Address by Mr. A. P. Trotter, C.B.E.

Institution of Electrical Engineers: North-Western Centre.

7.30 p.m. At the University, Liverpool. A meeting will be held to discuss the formation of a Sub-Section of the North-Western Territorial Centre in Liverpool.

Electro-Harmonic Society.

8 p.m. Concert at the Holborn Restaurant, London, W.C. (Ladies' Night)

MONDAY, Nov. 24th.

Institution of Electrical Engineers. (North-Eastern Centre.)

7.15 p.m. At Armstrong College, Newcastle-on-Tyne. Lecture on "Wireless Telegraphy in the Mercantile Marine," by Mr. W. D. Owen.

TUESDAY, Nov. 25th.

Illuminating Engineering Society.

5.30 p.m. At the Royal Society of Arts, 18, John-street, Adelphi, W.C. Address by the President on "Lambert and Photometry," Report on Progress, and Exhibits of Developments in Photometry, High Candle-power Incandescent Lamps, &c.

Institution of Electrical Engineers. (North Midland Centre.)

7 p.m. At Victoria Hall, Sheffield. Discussion on "The Use of Electrical Machinery in Goods Stations and Yards," to be opened by the President, Mr. Roger T. Smith.

Institution of Engineers and Shipbuilders in Scotland.

7.30 p.m. At, 39, Elmbank Crescent, Glasgow. Discussion on a Paper entitled "Photo-elastic and Strain Measurements of the Effects of Circular Holes on the Distribution of Stress in Tension Members," by Prof. E. G. Coker, F.R.S., Mr. K. C. Chakko, M.Sc., and Mr. Y. Satake. Paper on "The Cruiser Stern," by Mr. P. A. Hillhouse, B.Sc.

WEDNESDAY, Nov. 26th.

Royal Society of Arts.

4.30 p.m. At John-street, Adelphi, London. W.C. Paper on "British Trade in China," by Dr. H. B. Morse.

THURSDAY, Nov. 27th.

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. Paper on "Carbon Arcs for Searchlights," by Messrs. C. C. Paterson, O.B.E., J. W. T. Walsh, A. K. Taylor and W. Barnett.

FRIDAY, Nov. 28th.

Stoke-on-Trent Association of Engineers.

7 p.m. At the Council Chamber, Town Hall, Hanley, Stoke-on-Trent. Lecture on "Notes on Theory and Practice of Lubrication," by Mr. J. P. Hamer.

Physical Society.

5 p.m. At the Imperial College of Science. South Kensington, London. S.W. Discussion on "Lubrication," to be opened by Dr. T. E. Stanton, F.R.S.

Mr. Roger T. Smith on the Future of Electric Traction.*

The war has taught us that no man has the right to be only a specialist, and some of the present unrest is due to the refusal of the wage-earner to be a specialist for so large a part of each day that he cannot be anything else. Good citizenship is as important as a man's trade or profession, and just now good citizenship is essential both for our present and for our future. It is the custom of Britains to decry their education and to compare it unfavourably with that of some other nations, but only the few spend time and thought and money to remedy agreed defects. Expensive education at public schools and univeristy may cost anything from £1,500 to £3,000. If considered only as a financial investment it may appear a poor one, since boys with one-tenth of the expenditure on their education can obtain as good or better positions in the professions, in commerce, or in industry. But those who have enjoyed the privilege of the expensive British education realise what an opportunity it gives for forming personal character and lasting friendships. But when the country realises how much of its capital is spent, the number of boys for whom expensive education is possible will be fewer, whereas what this country requires is that more and more boys should be able to imbibe something of the advantages of our public schools and of the university atmosphere of Oxford and Cambridge. It may be possible so to cheapen university and even college life, that the traditions and teachings of the old universities may be available for men who cannot now afford them. The Government has undertaken to set up commissions to inquire into the present position of both Oxford and Cambridge Universities. Relative to this inquiry the Education Committee of the Parliamentary Labour Party has asked that it may extend to a more economical utilisation of university and college funds so that by decreasing the cost of living in college, poor men with brains may have as good a chance as rich men without brains to profit from the advantages of a university career. It is essential to this Institution that our systems of education shall produce men capable of electrical research. We possess a Government Department of Scientific and Industrial Research with a grant of £1,000,000 and a budget for the present year of £56,000. It is earnestly to be hoped that throughout the country our universities will qualify for substantial grants.

In the United States the cost of university education is somewhere about in the ratio of dollars to pounds sterling. In this country a far greater proportion of the cost of university education is paid for by students' fees, and nine American universities have each individual incomes exceeding the sum total of the parliamentary grant to the whole of the corresponding universities and institutions in the United Kingdom. It is said that university grants are to be increased. It is obvious that students' fees cannot pay for research, and for our industry research is essential and workers in research need long and specialised training. It is one of the duties of the duties of this Institution to see that our universities and technical schools are encouraged by suitable grants to promote original scientific research. From these trained scientific research workers must be drawn men capable of efficient industrial research. There is little in the science-teaching in the public schools to stimulate in boys a taste for research, and for the present we must look chiefly to our State-aided secondary schools to provide research workers. It is significant of the widespread understanding in the United States of the importance of research in industry, that last July the American Federation of Labour issued a manifesto on scientific research in which they called on the Federal Government to foster and support scientific and technical research as essential to the well-being and progress of industry. The fear of Government support for research in this country is the application to the research worker of these official methods of control which obtain in Government departments subject to the Treasury. It is to be devoutly hoped that our research workers are not going to be turned into civil servants. The ordinary research worker can only specialise in one subject at a time, and if he successfully specialised in civil service he would lamentably degenerate in research. The increase in the age up to which compulsory education is to be given opens out profound possibilities to our race as well as to our industry, but its effect will not be felt for many years to come, and it is with the immediate demand for research workers that the Institution is now concerned.

The war has shown that among the great assets possessed by the British race is the sporting instinct. Our public school system probably develops this instinct to its highest degree; but our citizen army was as full of the sporting instinct as the German army was conspicuously without it, and I think there are ample signs in recent industrial events, not excepting the railway strike, that in the difficult and perilous times present and to come, British common sense and the sporting instinct, if properly appealed to, will lead to a permanent working understanding between Capital and Labour.

But before the sportsman in the wage earner can be appealed to, it is essential that the employer should set the example. All business is founded upon a system of profit and loss, and one of the reasons why profit-sharing schemes are unsatisfactory is that the wage-earner without capital cannot afford to lose, and the system is one-sided. A man cannot be a real partner in business unless he can afford to lose. The ability to lose as well as the ability to win, is the essence of the sporting instinct, and in business the capable employer learns both as part of his daily routine. In dealing with trade unions employers do not always remember that although a delegate at the conference table may appreciate the justice of an employer's view of the men's claim, he may see no possible way of convincing those who sent him to make the claim that it is not fair. The ability to lose cheerfully is not learnt so readily in our primary as in our public schools, where it is the essence of school games, and yet sportsmanship seems always waiting to show itself if suitably encouraged.

There is no doubt that electrical engineers employing labour have been absorbed in the past in dealing with things, and have given an undue proportion of their time to the solving of all the material problems. Some electrical engineers have neglected to study the essential relationship between employer and wage-earner. We are reaping the reward of this neglect, which in many cases results in the engineer now having to give all his time to dealing with people and none of it to things. Apart from any higher moral code, if in dealing with the wage-earner the employer develops his own sporting instinct to the highest possible degree and endeavours to work upon the same instinct in those with whom he deals, it is certain that with patience and time the labour problem in our industry will be solved. The present tendency is towards decentralisation rather than the other way, and that collective bargaining for the wages of a large industry throughout the country is bound to be modified almost as soon as made through the varied interpretation of such a bargain to suit differing local conditions. Is it too much to hope that the working of industrial councils, or if they are not adequate, some other organisation of the same sort may in due time put an end to the hundred years' industrial war in the new society which we have all to help construct ? Time and sportsmanship are on the side of common sense, but it is to be feared that no system of instruction can be expected to teach common sense. If it could, our industrial labour problems would be quickly solved. Unfortunately, some academic learning is directly opposed to common sense, and the modern habit of delegating everything requiring thought to large committees does not lead to common-sense results. The gift of common sense is much more general than I once thought it to be. Its great enemy is personal vanity, and the possession of personal vanity in either employer or wage-earner, or often in both, is a very frequent obstacle to the settlement of disputes, as well as the prime cause of most of them.

After referring briefly to the need of an Electrical Proving House, and to the new Patent Bill and to the co-operation of the Institution with other bodies, the President turns to the discussion of electric traction problems. The new conditions arising from the Ministry of Transport Act and the Electricity Bill, when it becomes an Act, obviously affect the use of electricity by railways, both for traction, for power, and for lighting. Electrical development on railways there is bound to be, not only on account of its advantages, but because the use of electricity for many purposes is becoming the fashion. Should the amount of electrical engineering carried out by the railways increase considerably, it is of importance that such work should be carried out and maintained by electrical engineers of standing in the profession. No engineer ought to be responsible, in fact, for carrying out work involving many hundreds of thousands or even millions of pounds, unless he is also responsible in title. The work ought not to be wholly designed and carried out either by a consulting engineer or by the designing staff of a selected contractor.

Sir John Aspinall a year ago in his address as President of the Institution of Civil Engineers expressed the view that the pressing question to be faced on British railways was that of the increase in the structure gauge. The structure gauge determines the loading gauge which fixes the greatest cross-section of the rolling stock and anything it may carry. Sir John Aspinall also urged that it was a national matter and that the structure gauge should be increased throughout the country at the national cost. Should this matter be undertaken by the Ministry of Transport it is hoped that provision for the overhead equipment of railways for electric traction will not be overlooked.

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* Abstract of the Presidential Address to the Institution of Electrical Engineers.

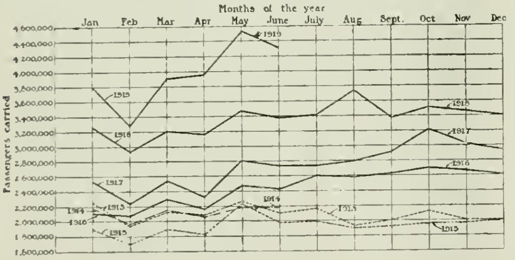
The electrification of railways crossing mountain ranges in the United States and elsewhere have shown the ability of the electric locomotive to haul heavier mineral and goods trains up grades at higher speeds and with fewer locomotives than with the steam locomotive. In this connection a matter of great importance is the decision under the Ministry of Transport Act to acquire traders' wagons, which roughly form half of the 1,250,000 wagons in use on our railways. Draw gear is supposed to be tested to 50 tons and to be worked at 12½ tons and to be maintained at that strength, but the frequent breaking of couplings at much lower draw-bar pulls show that this is not done. If heavier goods trains and especially mineral trains are to be hauled by electric locomotives at increased speeds, the strength of the draw gear on all wagons must be increased, while continuous brakes must be fitted to the fast mineral trains. Within the limitations of the present structure gauges and the strength of bridges the greatest dimensions of the steam locomotive, which determine hauling capacity have been reached, but that capacity on at least one railway amounts on the level to a 1,600-ton load (inclusive of wagon weight) at a high speed. Should the structure gauge be increased, the power of the steam locomotive could also be increased and the limitation of weight of train which could be hauled would be more emphatically than it is now the strength of the wagon draw-gear and not the capacity of the steam locomotive. There is a further limitation to the maximum length of mineral or goods trains which could be hauled in the length of lay-by and reception sidings, and it is earnestly to be hoped that in laying out new reception sidings the importance of accommodating trains of at least 100 wagons or more in length will be recognised. Small-capacity coal wagons limit the train load very greatly, but very few collieries have screens high enough to take more than the 10 or 12 ton wagon. Enough has been said to suggest that in this country, unlike the United States, many things have to be changed before electric traction can assert its full advantage in hauling heavier goods trains, though increased speeds could be obtained at once. And these changes will take years to carry out.

If, then, mineral and goods traffic is to be hauled electrically under present conditions of size of wagons, strength of draw gear and capacity of sidings, it must be because it is more economical in the cost of haulage, and the same applies to passenger traffic. There is, however, an exception to be made to the above statement in the case of mineral traffic down valleys where gradients are steep. The steam locomotive which can haul 1,600 tons on the level cannot haul one-third of this load up a gradient of 1 in 50 at a convenient speed, while within the same load gauge an electric locomotive can be made to haul the 1,600 tons up 1 in 50, or if need be double this load, provided the draw-gear is strong enough.

In discussing the economics of electric traction on railways only the locomotive and the train it hauls are considered, and the analysis of its running costs with steam to see if electricity can introduce such economies in working costs as to warrant its use. Traffic costs will be taken as unaltered. When supplied by electricity from central stations using modern large turbo-alternators enjoying such diversity of load that the power factor is above 30 per cent. the coal burnt in the furnaces of the boilers to produce a given hauling effect on the railway by means of an electric locomotive is at most 40 per cent. of the coal burnt in the furnace of a steam locomotive to achieve the same result. It has been roughly estimated that to electrify all the railways in Great Britain would cost some £300,000,000, and if coal ever rose to 45s. per ton the saving of 7,000,000 tons per annum would of itself pay 5 per cent. on the investment. If the working costs per steam locomotive are compared for several large railways running more than 12,000 passenger, goods and mineral train-miles for each mile of route over which the locomotives work, it is found that these costs are very similar. Average costs for one typical main-line railway are therefore a rough indication of the costs for the others. The figures in the analysis which follows have little intrinsic value in themselves but indicate only tendencies. The cost of running a passenger locomotive in 1913 averaged over the year and the railway was £1,240. Of this coal and water amounted to £460, which is 37½ per cent. of the whole. The average number of passenger-train miles hauled by each locomotive per annum was 27,000 and the cost per train-mile for coal and water was 4d. and for the other items 7d., making a total per train mile of 11d. The cost of running a goods locomotive in 1913 averaged over the year and the railway was £1,020. Of this amount coal and water accounted for £250, which is 24½ per cent. of the whole. The average number of goods-train miles hauled by each locomotive per annum was 10,000, and the cost per train-mile for coal and water was 6d., and for the other items 1s. 7d., making a total per train-mile of 2s. 0½d. The present working cost of the train-mile for passenger service is 2s. 0d. and for goods and mineral service 4s. 8d. Experience in America and elsewhere has shown that the annual passenger-train miles per locomotive would be increased from 27,000 with steam to at least 40,000 with electricity, and the annual goods-train miles per locomotive would be increased from 10,000 to at least 20,000. Taking these minimum increases and asuming also that the total of all the working costs other than coal and water were the same as for steam, which is not in favour of the electric locomotive, these items come to 10d. for the electric locomotive passenger-train mile and to 1s. 8d. per electric locomotive goods-train mile. Subtracting these costs from the total steam-train mile costs of 2s. 0d. and 4s. 8d. respectively for passenger and goods service there is left per electric locomotive train-mile, 1s. 2d. for passenger service and 3s. 0d. for goods service to pay for electricity and also to pay interest on the cost of the electric locomotives and of the electrical equipment. Mr. F. W. Carter estimates that with high-pressure direct-current equipment the cost of electrifying a railway where, as in Great Britain, there is on the average one steam locomotive per mile of route is approximately double the cost of the electric locomotives required. He also states that the cost of an electric locomotive is 2½ times the cost of the steam locomotive for equal draw-bar pull and speed. The average capital cost this year of a steam locomotive may be taken as £7,000, so that for each electric locomotive required on the railway its capital cost together with that of the electrical equipment of the line exclusive of power house and high-pressure transmission, will to-day be some £35,000. In that figure no credit has been taken for displaced steam locomotives, nor on the other hand does it include anything for structural alterations which it has been already urged should be made at the cost of the State, since much larger interests than electrification are involved. If the revenue earned by the train mileage hauled by each electric locomotive has to pay interest at 5 per cent. on the capital cost of the equipment, then each passenger locomotive hauling 40,000 train-miles per annum must earn 10½d. per train-mile and each goods locomotive hauling 20,000 train-miles per annum must earn 1s. 9d. per train-mile to pay interest on electrical equipment, including locomotives. The earnings for both interest and electricity were per passenger train mile 1s. 2d. and per goods-train mile 3s.; consequently each passenger electric locomotive has 3½d. and each goods electric locomotive has 1s. 9d. left per train-mile for electricity. Where in this country railways generate their own electricity the annual one-hour load factor does not exceed 40 per cent. except in one instance. If, however, railways can obtain electricity from power stations with great diversity of load reaching a maximum value of not less than 50,000 kw. it may be possible to generate with a load factor of about 50 per cent. and under these conditions, even at recent prices, electricity for traction should be able to be bought for ½d. per kw.-hour at the generating station. At this price the 3½d. and 1s. 3d. available respectively per passenger and goods electric locomotive will provide 7 kw.-hours per passenger-train mile and 30 kw.-hours per goods-train mile. Assuming 40 watt-hours per ton-mile as an average for passenger service, the average weight of passenger train, including the locomotive, would be only 175 tons. Assuming 30 watt-hours per ton-mile as an average for goods service, the average weight of goods train, including the locomotive, would be 1,000 tons. The assumptions made in this analysis are numerous and doubtless controversial, but for the type of railway taken they are the same for the passenger and for the goods electric locomotive with the exception of the annual train-miles worked. In order to earn the present revenue per train-mile the average passenger train, including its locomotive should be more nearly 275 than 175 tons, while the goods train of 1,000 tons, is of course much heavier than is hauled in this country as an average. It may be claimed that basing the working costs of each kind of locomotive, steam and electric, on the average train-miles hauled in a year, and placing the known increase in train-miles hauled by an electric locomotive at reasonable figures for passengers and goods respectively, the passenger electric locomotive might have difficulty in earning sufficient revenue to meet all present charges and have enough to spare to pay for electricity and for interest on the electrical equipment, while the goods locomotive could much more than do so, provided in both cases electricity is bought or produced by the railway at ½d. per kw. hour at the generating station. All that the figures show, however, is that in a typical case for the same working expenses now incurred by steam traction, electrification is more in favour of goods haulage than of passenger haulage, and among the railway economies necessary to pay the enormously increased working expenses the electrification of goods and especially of mineral lines ought to receive due consideration.

With the exception of the 18 route miles of mineral line all the electrified railways in this country are of the suburban type, the feature of which has been first to restore a decreasing traffic and then to increase the traffic. Some particulars are given for the London and South-Western electrified suburban system. The length of route electrified is 49 miles and the length of single track is 152 miles. The attached diagram shows the number of passengers carried during seven 12-monthly periods, from which it will be seen that the L. & S.W. electrification has proved satisfactory no only in restoring a diminishing traffic but has been used to its utmost capacity and proved a most valuable additional facility for the Government in meeting the restrictions placed on road motor traffic.

Tables are given in the address showing the position of electric traction on British railways in 1918, and similar figures for eight railways in the United States. During 1918 the electricity used for traction on these railways was 478,000,000 kw.-hours with an annual one-hour load factor of 46 per cent. Almost exactly half of this electricity was bought at an annual one-hour load factor of 49 per cent., while that generated by the railways had a load factor of 42 per cent. For lighting and power 164,000,000 kw.-hours were generated and bought at an annual one-hour load factor of 44 per cent. In every instance the load factor is better than on British railways, being above rather than below 40 per cent. Sixty-eight American railways possess 760 workshops, two-fifths of which generate their own electricity for power, and a total of 366,500 H.P. is connected to the supply. On the 14 British railways, which possess all the electric traction and by far the greater part of the use of electricity for other purposes, the total kilowatt-hours used during 1918 for traction were 400,000,000 and the kilowatts of maximum demand averaged over an hour were 123,000. Consequently the annual one-hour load factor was 37 per cent. Ninety per cent. of the electricity was generated by the railways at an annual one-hour load factor of 41 per cent. The remaining 10 per cent. of the electricity was bought, and from the figures of maximum demand given, which are generally difficult to estimate, the load factor is 19 per cent. The important point is that for suburban services, many of them continuous for 20 hours or more, the greatest annual load factor which has been obtained in this country when railways generate their own electric power is about 40 per cent. It is probable that the electricity bought had about the same load factor. The total use of electricity by the 14 railways for traction, lighting, and power in 1918 amounted to 517,000,000 kw.-hours, and the annual one-hour load factor was 34 per cent. When the war started, British railways were actually committed to the carrying out of additional electric traction, and with it a certain amount of power and lighting which was stopped by the war. Had this work been carried out the estimated kilowatt-hours of electricity generated would have been 357,000,000 at an estimated load factor of 43 per cent. But for the war the total electricity generated and bought by the 14 railways during 1918, including these commitments, would have been 875,000,000 kw.-hours at an annual one-hour load factor of 37 per cent. The 14 railways, therefore, used for all purposes in 1918 12¼ per cent. of the quantity generated by supply authorities, and would have used 20 per cent. taking account of such part of it as would have been bought, supposing their actual commitments had not been stopped by the war. Apart from the importance of the present railway load as compared with the whole load of the supply authorities, a proportion which is quite certain to increase as soon as railway policy is defined, a number of figures including load factors have been quoted because there has been a tendency in some quarters to exaggerate the value of the railway load factor which it will be seen both in actual fact and in estimate is in this country below 40 per cent. for the densest type of suburban service. The highest railway traction annual one-hour load factor in this country for one of the most dense electric services in the world—the London tube service—reaches 48 per cent. and is the same for traction as for lighting and power. But this value is altogether exceptional.



The Effect of Electrification on L. & S.W.R. Suburban Traffic.

Diversity of many loads, of fairly good but different load factors, from one or more interconnected power stations where the individual units can be of greater output than would be possible in a power station devoted almost entirely to traction, will do more to cheapen electricity than the separate generating station for each railway But essential as cheap electricity is for railway electric traction, what is of greater importance is security of supply, and the policy of the railway companies in building their own power stations and in wishing to keep those that they have built is chiefly for security of supply. For railways taking a supply from other power stations than their own the geographical position of the latter relative to the railway is a matter of importance from the point of view of cost, and it has been shown that the economy of using a station equipped with large units may be quite counteracted by the cost of the transmission lines. Whether the railways are worked as a whole or as separate concerns, if main-line electrification is to be carried out it is necessary that an electric locomotive should work anywhere, and it is certainly desirable that one system should be adopted for the whole country for main line as apart from suburban traction. So far as our present knowledge goes the railways of the whole country would be more economically electrified by direct current than by alternating current. Although there are instances to the contrary in Great Britain, it may be stated as a general rule for suburban service that it is not worth while to electrify for a service to be run by mulitple-unit rolling stock unless a pair of tracks can be set apart wholly for the service, and in general it is fair to assume that whatever system or voltage is in use for suburban services, this will not interfere at all or only to a limited extent with main-line electrification. The fullest consideration will have to be given as to whether a pressure of, say, 1,500 volts is high enough for main-line electrification or if double this pressure will be needed for overhead equipment. Two pressures have to be used for main-line electrification, locomotives must be able to use both. Speed control by shunting the field goes far to remove perhaps the only disadvantage of the series motor. In favourable cases field control may reduce rheostatic losses during acceleration by as much as 50 per cent., and the additional running speeds obtainable are essential for main-line working. The economy over the wearing away of wheel tyres and brake shoes by turning the series electric motor into a shunt-wound generator and returning a part of the energy otherwise lost in braking to the line by regenerative electric braking, is so obvious that it must always appeal to the engineer in spite of its difficulties. If it is required, then more contactors are needed, and should it be necessary to run a locomotive at two-direct-current pressures one double the other, to employ shunt field regulation and to have regenerative braking, the 12 original contactors may be multiplied by four at least to give the necessary changes in the connections. The cost and maintenance of so large a number of contactors becomes a serious item, and until considerable experience has been obtained in their manufacture and maintenance they are the most likely source of failure.

Fourteen British railways in 1918 required 118,000,000 kw.-hours for lighting and power; 29 per cent. of this was purchased and the annual one-hour load factor of this was 18 per cent. The annual one-hour load factor of the electricity generated by the railways for lighting and power was 32 per cent., varying from a minimum of 10 per cent. to a maximum of 48 per cent., and for the whole use generated and bought 26 per cent. It is interesting to note that in America the load factor for lighting and power is of the order of 45 per cent. At the present time much attention is being paid to the mechanical handling of goods. The whole railway methods of handling and hauling goods traffic have been built up gradually to suit the trader's requirements, and under the present methods of working railway engineers have designed many schemes of conveyors and transporters which have been carefully considered, but few if any of them have been commercially acceptable. Until the entire habits of the traders are changed it does not seem possible to deal with general merchandise wholly by mechanical means, much as it would be to the advantage of the railways to do so. If it were possible, the engineering problem with electrical machinery is quite straightforward. In a busy goods station careful checkings have shown that not more than 3 per cent. of the total weight of general merchandise handled in any one day is moved by the cranes.

When instead of general merchandise of all sorts of shapes, sizes and weights special goods of nearly uniform size and weight have to be dealt with in large quantities, the whole can be loaded, transferred and unloaded mechanically, and electric machinery is by far the most suitable where the work cannot be done by gravity. For dealing rapidly with large quantities of material of about the same size and weight, it is possible to design a conveyor to meet almost any requirement, supplemented with apparatus for loading on to the conveyor and for receiving the conveyed material.

In addition to a large electric lighting load and a certain amount of heating and cooking, electricity is also used by railways for opening and closing Scherzer bridges, for working all classes of machinery, and in most departments of their locomotive carriage and wagon works for driving machine tools, while the use of the electric vehicle from a 5-ton lorry to a platform trolley is increasing. As regards train lighting apparatus, it is an automatic central station, and railwaymen have been so intent on getting the whole plant reliable that not enough attention has been paid to economy in power. Experiments with different dynamos show for the variable-speed type at high speeds a saving over the non-variable speed type of some 40 per cent. in the power taken from the locomotive for lighting.

Aircraft Telephony.*

By Capt. B. S. COHEN, R.A.F.

(Concluded from p. 549)

The Admiralty are alive to the possibilities of the throat telephone as a ships telephone, and experiments have been in hand for some time on H.M.S. "Vernon" and on battleships. I understand the results, so far as they have gone, have been satisfactory and that the general adoption of this instrument is in contemplation.

The inter-communication telephone sets have been designed to allow the head receivers to be used either for wireless telegraphy and telephony, and a receiver of 2,000 ohms resistance designed for wireless telephony was adopted. This receiver is used mounted with the microphone as a hand combination or a pair are mounted in a flying-cap for use independently. The efficiency of the aircraft telephone depends to a very great extent on the design of the head gear, and many patters were designed and rejected before a generally suitable form was obtained. Fig. 4 illustrates a complete headgear set, including flying cap, receiver and microphone in necklet, &c. The receiver can be used either loose in the cap-ear pockets and pressed up to the ear by the straps or enclosed in spongy rubber ear-cups, which take some of the direct pressure off the edges of the ear and also absorb perspiration. The disadvantage of the rubber ear-cup is bulkiness, rendering the wind pressure on the ear pockets rather noticeable.

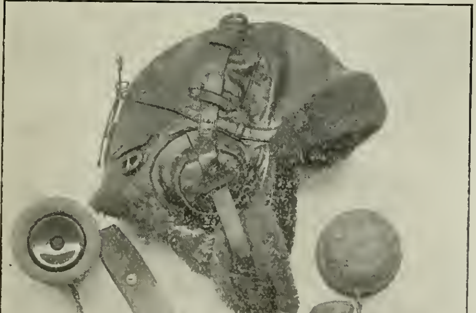


Fig. 4.—An Aircraft Telephone Head Set.

When the hand combination set is used, it is merely necessary to cut a hole in the side of an ordinary pocketless flying cap over the ear and the receiver is placed over this hole, which is normally covered by a flap.

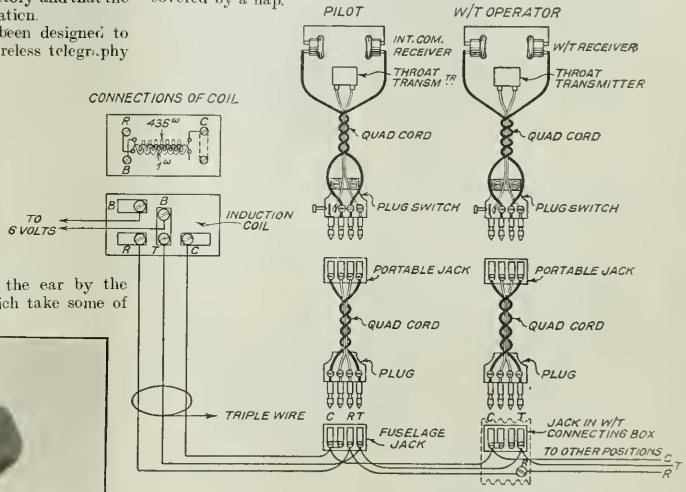


Fig. 5.—Diagram of Connections of Aircraft Inter-Communication Telephones

As regards switchgear, plugs and jacks of the familiar four-prong and hole telephone pattern have been adopted. In a special set designed for use with wireless telephony the plugs and jacks are rendered irreversible by replacing one plug-prong by a prong of larger diameter and drilling out the corresponding hole in the ebonite socket. All jacks and plugs are rendered weather-proof by use of rubber covers, and the cords have a waterproof lapping. A switching-box for connecting up various services is used, which can be arranged to connect up either inter-communication, wireless telegraphy, wireless telephony or direction-finding wireless gear to the same head receivers. The connections of a set of this kind are shown in Fig. 5. The pair of receivers at each station are all in parallel for intercommunication (the individual receivers of a pair are in series) across the 400 ohms secondary winding of induction coil, and all microphones are brought on to the common 1-ohm primary through a 6-volt accumulator battery. The telephone installation on a large long-distance bomber, such as the V-type Handley-Page under war conditions, is quite elaborate. (*See* Fig. 6.) A visual calling up signal is required when using hand combination sets. One form used consists of a push in which the button is replaced by a pea lamp. These little lamps are very strong and capable of withstanding a great deal of hard usage and vibration It may be of interest to note that even aircraft telephones are not immune from cross talk, and in order to prevent interferences with direction finding and other forms of wireless and also disturbance from the engine magneto, it is found desirable to cover the line wiring with copper braiding and bond to earth, *i.e.*, aeroplane fuselage stays, &c., at 18-in. intervals. On a V-type Handley Page there are four engines with a total of 16 magnetos, so that magnete disturbance becomes a factor to be dealt with. An interesting extension of the use of intercommunication telephones on naval aircraft may be mentioned. The machines which fly from the deck of the large aeroplane carrier H.M.S. "Furious" have a jack in the tail connected to the intercommunication phones, and this is connected by a plug to the ship's telephones, and the navigating officer can thus communicate with the air pilot until he actually takes off when the plug is pulled free by the motion of the plane.

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*Abstract of a Paper read before the London Centre of the Institution of Post Office Electrical Engineers.

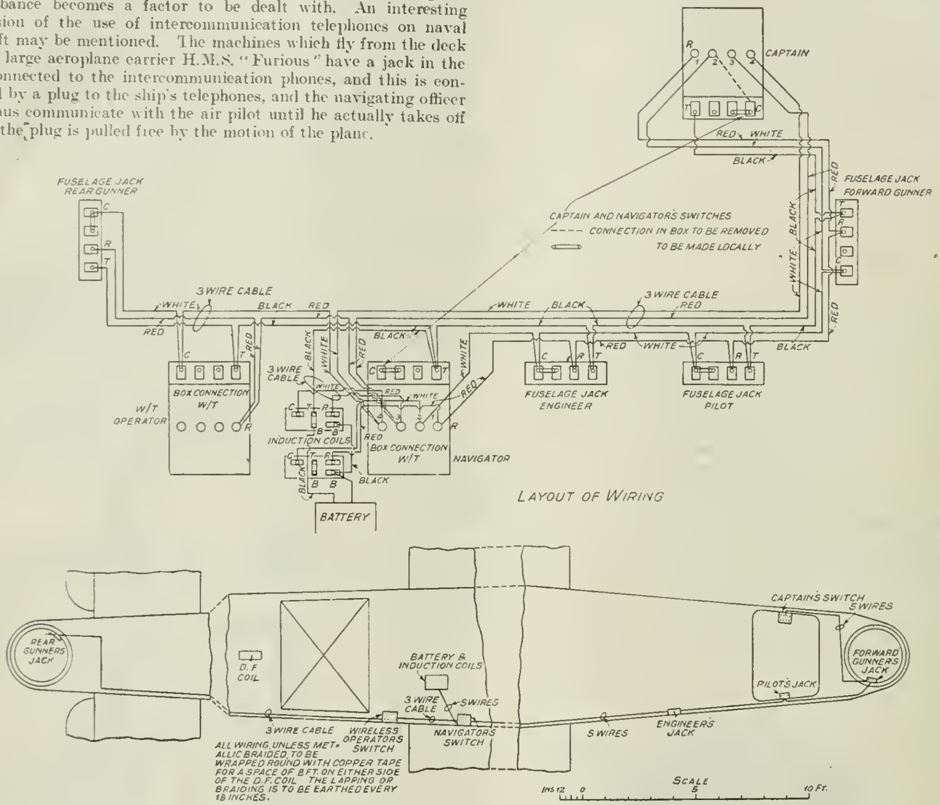


Fig. 6.—Diagram of Inter-Communication Telephone System on "V" Type Handley-Page.

The special problems to be met at high altitudes are numerous. At a height of 15,000 ft. upwards there is a noticeable decrease in the volume of air-borne sounds, and it is also necessary for the occupants of the machine to take oxygen. In some cases a mask is worn into which the oxygen is fed, or alternatively the oxygen can be taken in frequent whiffs through a mouthpiece. The throat microphone is independent of atmospheric density and operates quite as well at high as at low altitudes. If the necklet pattern is in use it is, however, found advisable to wear this very loose. The behaviour of accumulators at the low temperatures met with at high altitudes has been investigated and it is found that the capacity of a cell is reduced to 57 per cent. of its normal capacity at a temperature of 13 C., and this is about the normal temperature at an altitude of 23,000 ft. The difficulty is met by placing the accumulators in lagged wooden boxes, and the duration of time at which the machines remain at high altitudes is then insufficient to freeze the accumulators.

In connection with the development of wireless telephony it was found necessary to equip two-seater machines so that wireless and intercommunication telephony could be continuously connected up without the necessity of switching the head receiver from one service to the other, and difficulty was found in devising a suitable circuit which did not reduce the wireless range. A circuit was devised which fulfilled these conditions by simple means. Fig. 7 illustrates this. The double head receivers at the two positions have the inter-communication induction coil secondary bridged between the central points of the individual pairs. Wireless telephony is in consequence unaffected by the presence of the coil. The introduction of this system necessitated the use of quad wiring and of irreversible plugs and jacks. The advantages, however, outweighed these disadvantages, and this arrangement was adopted as standard in connection with wireless telephony working.

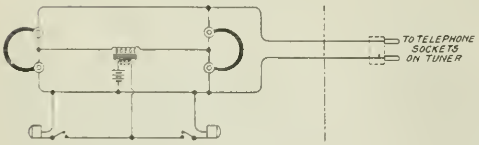
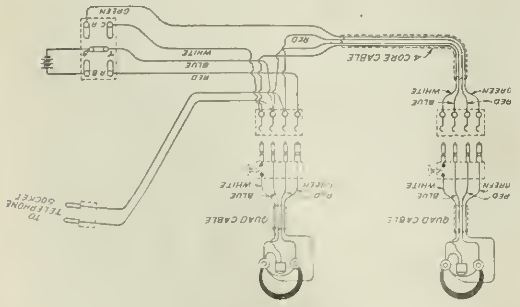


Diagram showing Circuit.



Wiring Diagram.

Fig. 7.—Diagram of Combined Wireless and Telephone Set.

A Direct Method of Calculating Shunt Field Coils Having Two Gauges of Wire.

By R. G. JAKEMAN, B.Sc.

To obtain a given number of ampere-turns from a given shunt field coil at a given voltage, a certain fixed sectional area of wire is necessary if all the wire used is of the same gauge. It often happens, however, that the area of wire required is not included in the S.W.G. table, and then the two nearest standard gauges above and below have to be used, each coil being wound with wire partly of the larger gauge and partly of the smaller gauge. It is necessary, therefore, to find how much of each gauge has to be used to obtain the desired result. The present method used by designers is the "trial and error" method. Certain values of the winding depths of the two gauges are assumed, the winding is calculated out from beginning to end, and then, if the ampere-turns do not come out right, other values of the winding depths are taken and the calculation gone through again. Experienced designers can sometimes arrive at the correct result on the first trial, and seldom have to make more than two attempts; but beginners have ofter to try four or five times, which makes their work very tedious.

The area of the wire in sq. mm. necessary if a single gauge is used can be found at once from the well-known formula,

$$s_0=\frac{0{\cdot}0216\times AT\times l_0}{V},$$

where AT is the total number of ampere-turns and l_0 is the mean length of a turn in metres.

Let us take as a first approximation that the number of turns per spool is the same whether a single gauge is used of the required section or two standard gauges in proportions to be determined later. Now the number of turns of the single gauge is

$$T_0=0{\cdot}95\,\frac{y}{d_0'}\cdot\frac{x_0}{d_0'},$$

where y is the axial length of the spool, x_0 is the total winding depth, d'_0 is the covered diameter of the wire, 0·95 is an allowance for errors in workmanship, &c. We can also write $d'_0=k_0d_0$, where d_0 is the bare diameter of the wire and k_0 is a coefficient depending on the thickness of covering. Further, $k_0^2d_0^2=k_0^2s_0\,.\,4/\pi$. Hence $T_0=0{\cdot}745yx_0/k_0^2s_0$.

From our hypothesis, $T_0=T_1+T_2$, where T_1 and T_2 are the number of turns of the standard gauges, and therefore

$$\frac{x_0}{k_0^2s_0}=\frac{x_1}{k_1^2s_1}+\frac{x_2}{k_2^2s_2},$$

where x_1 and x_2 are the winding depths of the two standard gauges and $x_0=x_1+x_2$.

This resolves into

$$\frac{x_2}{x_1}=\frac{k_1^2s_1-k_0^2s_0}{k_0^2s_0-k_2^2s_2}\cdot\frac{k_2^2s_2}{k_1^2s_1}.$$

For adjacent gauges having the same thickness of covering it is a very close approximation to write $k_0=k_1=k_2$, and hence we have

$$\frac{x_2}{x_1}=\frac{s_1-s_0}{s_0-s_2}\cdot\frac{s_2}{s_1}. \quad \ldots\ldots\ldots \quad (1)$$

Now, by inserting s_0, calculated as shown above, in this equation, we obtain at once the proportion of the winding depths of the two gauges which are necessary to make the resulting coil have the *same number of turns* as a coil wound with a single gauge of the correct section. Unfortunately, however, the *ampere-turns* will not be correct, because the resistance of the composite coil will not be the same as that of the single-gauge coil.

The difference in resistance is greater the smaller the diameter of the coil, because there is a greater difference in the mean lengths of the two gauges. The curves show the ratio of the resistance of the composite coil to that of the single-gauge coil plotted against the fraction of the total winding depth occupied by the larger gauge. Curve *a* shows the case when the larger gauge is wound first, and curve *b* when the smaller is wound first. Both curves have been drawn for a coil 25 mm. inside diameter and a winding depth of 50 mm., which is outside the range of practical machine design. Even in this extreme case, however, it will be seen that the error in the ampere-turns is never greater than 7 per cent., and it would, therefore, appear that by introducing a constant into equation (1), sufficient accuracy can be obtained for practical work. When the larger gauge is wound first the ampere-turns are low, and when the smaller is wound first they are high, so that different constants will be required for the two cases. A further simplification arises from the fact that the ratio s_1/s_2 only varies throughout the standard wire table between 1·14 and 1·44 from 2/0 S.W.G. to 45 S.W.G., and may be taken as a constant to obtain the final formulæ.

Writing for the sake of convenience $x_0/x_1=1+x_2/x_1$, the following formulæ give very accurate results for all sizes of coils, whether round or rectangular.

1. If the larger gauge is wound first,

$$\frac{x_0}{x_1}=1+0{\cdot}45\,\frac{s_1-s_0}{s_0-s_2},$$

where x_0 is the total winding depth and x_1 is the winding depth of the larger gauge.

2. If the smaller gauge is wound first,

$$\frac{x_0}{x_1}=1+1{\cdot}0\,\frac{s_1-s_0}{s_0-s_2}.$$

The application of these formulæ is very simple, and can best be shown by means of an example. Let the total winding depth x_0 be 40 mm., the mean length of a turn, l_0, 0·596 metre, the total number of ampere-turns 11,000 and the voltage 400. Then s_0 can be calculated as shown above, and we have $s_0=0{\cdot}354$ sq. mm. The nearest gauges are 22 and 23 S.W.G., which have areas of 0·397 and 0·292 sq. mm. respectively.

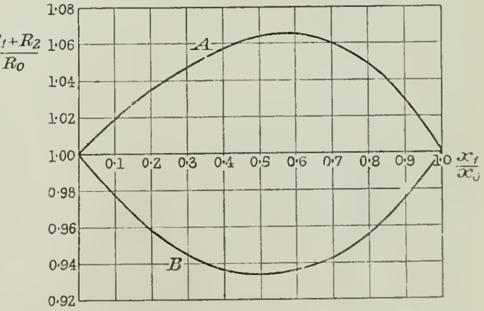


FIG. 1.—RATIO OF RESISTANCES OF COMPOSITE COIL AND SINGLE GAUGE COIL FOR DIFFERENT PROPORTIONS OF THE TWO GAUGES.

Therefore $s_1-s_0=0{\cdot}397-0{\cdot}354=0{\cdot}043,$

and $s_0-s_2=0{\cdot}354-0{\cdot}292=0{\cdot}062.$

Hence $\frac{s_1-s_0}{s_0-s_2}=0{\cdot}695,$

and $\frac{x_0}{x_1}=1{\cdot}312$ if the 22 S.W.G. is wound first.

Therefore $x_1=\frac{40}{1{\cdot}312}=30{\cdot}5$ mm. of 22 S.W.G.,

and $x_2=40-30{\cdot}5=9{\cdot}5$ mm of 23 S.W.G.

If the 23 S.W.G. is wound first.

$$\frac{x_0}{x_1} = 1\cdot7,$$

so that $x_1 = \frac{40}{1\cdot7} = 23\cdot5$ mm. of 22 S.W.G.,

and $x_2 = 40 - 23\cdot5 = 16\cdot5$ mm. of 23 S.W.G.

A convenient method of writing down the calculation is as follows :—

$$\begin{array}{lllll} & 0\cdot397 & 0\cdot043 & & \\ 0\cdot354 & & & [0\cdot695 \quad 0\cdot312] & 1\cdot312 \\ & 0\cdot292 & 0\cdot062 & & \end{array}$$

The portion between the brackets need not be written down, because, when the differences of the areas have been obtained, all that is necessary is a division and a multiplication on the slide-rule and the mental addition of 1.

The following table shows the average errors obtained on applying the formulæ to various sizes of coil. It is most usual to wind the larger gauge first, and that condition has been assumed in the examples given, but the second formula gives equally accurate results. In order to demonstrate over what a wide range the formulæ hold good, there are included in the table examples of a very small and a very large coil, both outside the usual practical range.

It would appear from these figures that the ampere-turns obtained have a tendency to be high for the large coils and low for the small ones ; but too much importance must not be attached to this. In all the figures there is the error caused by the gauges not quite fitting in the space allotted to them, and also the slide-rule error. Finally, after the coil has been wound, the resistance cannot be guaranteed within a few per cent., and the required ampere-turns depend on the permeability of the magnetic circuit. It will be seen, therefore, that all the errors shown in the table are negligible. If, as sometimes occurs, the larger gauge has a thicker covering than the smaller, the ampere-turns are slightly lower than when the two gauges have the same covering, so that in this case the depth of the larger gauge should be taken slightly greater than the calculated value.

Inside dimensions of coil in mm.	x_0 mm.	x_1 mm.	Gauges.	Error. Per cent
25 diameter …………	15	5·0	39 & 40	−1
25 ,, …………	15	10·0	39 & 40	−1
25 ,, …………	50	15·0	36 & 37	−3
25 ,, …………	50	35·6	36 & 37	4
30 × 50…………………	20	18·5	38 & 39	+1
30 × 50…………………	20	12·0	38 & 39	−1
30 × 50…………………	20	6·3	38 & 39	−1
150 diameter …………	40	16·5	22 & 23	−1
150 ,, …………	40	26·0	22 & 23	0
280 × 400………………	34	25·0	7 & 8	+1
280 × 400………………	34	15·0	7 & 8	+2
1,000 diameter………	15	5·0	13 & 14	+2
1,000 ,, …………	15	10·0	13 & 14	+1·5
1,000 ,, …………	50	27·0	13 & 14	+1
1,000 ,, …………	50	43·0	13 & 14	+1

The Electrification of the South African Railways.

(Concluded from page 521.)

On the Monument and Sea Point line the service at present is comparatively slow, owing to the single track and paucity of passing places. With the adoption of electric traction, it is considered possible to provide an 8½ minute service and to reduce the time of the complete journey from 19½ minutes to 16 minutes. It is suggested that the service on week days should be an 8½ minute service for four hours a day, and an 17 minute service for 13 hours. This would increase the annual train mileage from 104,000 to 188,000, leading to an estimated increase in the gross receipts of 50 per cent. The new car shed proposed for Simonstown could also be used for accommodating the rolling stock for this branch, and the necessary energy could be obtained from the Cape Town sub-station. The capital expenditure necessary for the electrification of this line is estimated at £69,740, while the working expenses would be £13,420 per annum, compared with £11,300 for the present service. On the other hand, the estimated increase in revenue would be £7,800, representing 8·1 per cent. return on the capital outlay. On the Monument Docks line, which is only 1¾ miles in length, the present service has two trains in each direction for the greater part of the day. It is proposed that this should be increased to 25 per cent., and the same rolling stock used as on the Simonstown branch, each train to consist of two coaches only. The estimated net capital expenditure for the conversion of this line would be £4,190 and the working expenses £1,780, as against £3,060 as at present. The total profit due to electric working would, therefore, be £1,280, representing a return of 30·5 per cent. on the capital outlay.

The Cape Town Belleville route forms part of the main line to Touws River, and the capital outlay and working expenses are included in the estimates for that section. The service, however, is of the same character as the Simonstown branch, though much less in value. It is proposed to accelerate the time taken from 37½ minutes to 30 minutes, so that the annual train mileage will be increased from 180,000, as at present, to 275,000 with the electric service. The main line to Touws River, which it is proposed should be electrified, includes the shunting yards in the neighbourhood of Cape Town and the suburban service to Belleville mentioned above, as well as the local passenger service between Cape Town and Worcester. The traffic on these lines will be both passenger and goods, though it is not proposed that the large number of sidings which exist on this section should be electrified for the present. In estimating the cost of electrification, an increase of 50 per cent. in the goods ton mileage has been allowed for. If this increased traffic is worked by steam, trains of 1,000 tons can be dealt with except on one section, where the gradients are severe ; but it will be necessary to construct three additional passing places at an estimated cost of £5,000 each. With electric working it will be possible to haul trains of 1,100 tons over the whole section, and there would be no necessity for additional passing places. The number of trains passing over the section would be reduced to 3,760 per annum, compared with 5,990, which would be necessary with the improved steam working. The immediate result of electrification would be a very substantial acceleration in both passenger and goods service, especially in the latter. The reduction in travelling time for a single trip is nearly 5½ hours in the case of goods trains. The result would be a saving in the capital outlay of new wagons estimated at £62,500. For working this section the purchase of 16 double unit goods engines, six single unit goods engines for banking, and nine express passenger engines is recommended, while motor multiple unit motor coaches would be used on the suburban service to Belleville. Sixteen special shunting engines would be required for use in the Cape Town yards, as it is considered the employment of these engines would lead to very substantial economies. The net capital outlay on rolling stock for this section would amount to £48,950, with an additional £10,000 for altering the running sheds at Cape Town and Touws River to fit them for the accommodation of electric locomotives. The line equipment is estimated to cost £452,464 and sub-stations £361,000. The total net outlay on this section is estimated at £1,036,414 ; the estimated working expenses with steam amount to £347,420, and with electrical operation £238,030, showing a saving of £117,090. To this must be added the estimated increase in revenue of £8,000 derived from the Cape Town-Belleville service. The total profit is therefore £125,090, representing a return of 12·1 per cent. on the net capital outlay.

As regards the shunting service in Table Bay Docks, the presence of a large number of cranes of different types prevents the use of live overhead wires over many of the tracks. It is therefore suggested that the overhead line equipment should be confined to those tracks where the work done is considerable, and small storage battery locomotives provided for the other tracks. The batteries on these locomotives would be kept charged by connecting them in series with the driving motors, so that whenever a locomotive is used for shunting on a siding where overhead equipment is provided electrical energy can be taken for charging up the battery. No time would therefore be lost in re-charging or changing battery, and the locomotive would, therefore, at all times be available for service. It is estimated that 11 special locomotives would be required for this purpose, which would release the eight existing steam locomotives and render unnecessary the purchase of six additional steam locomotives to deal with the increased traffic. The estimated capital expenditure on the overhead line equipment of this section is £38,000 ; the net capital outlay on rolling stock is £69,820, and the total net capital outlay, including contingencies and engineering expenses, is £123,520. The working expenses with steam amount to £25,420, and with electric traction £13,480; the profit is therefore £11,940, representing a return of 9·7 per cent. on the net capital outlay.

On the main line between Durban and Glencoe, which is about 249 miles long, the traffic consists principally of goods trains conveying coal from the Natal coalfields. The line in many places contains exceptionally steep gradients, and rises to a maximum altitude of 5,000 ft. The total gross tonnage at present despatched from Glencoe to Durban is about 13,000 tons per day; but owing to the gradients the average load per train differs for each section, thus necessitating frequent breaking up and re-marshalling of trains during the journey. In considering the question of electrification, an increase of 50 per cent. in both goods and passenger traffic has been taken into account, so that the total gross tonnage under consideration is therefore about 20,000 tons per day. Under the present system of working this would mean about 39 goods trains in each direction, some of which would have to be assisted by banking engines, and this is clearly beyond the working capacity of a single line, so that with steam working very extensive alterations would have to be undertaken. No such alterations will be necessary if electric working is introduced, as it would be possible to employ very much heavier trains, and therefore to reduce their number from 78 to 42 per day. Loads of 1,200 tons could be made up at Glencoe and could be hauled through the whole distance with the same locomotive with assistance from banking locomotives on the heavier gradients. The annual train mileage can therefore be reduced from 4,683,400 with steam to 3,013,400 with electric working. At the same time, the average speed could be increased and the total time for the double journey reduced from 56 to 26 hours. A general increase of 50 per cent. in the passenger traffic is also provided for. At present the passenger trains average eight coaches, each weighing 306 tons, excluding the locomotive. With electric working the number of trains would not be increased, but four coaches would be added to deal with the increased traffic. If steam working, however, is continued, it will be necessary to increase the number of trains by about 35 per cent. With the locomotives it is proposed to use it will be possible to reduce the time of travelling from Durban to Glencoe from about 14½ hours to about 11½ hours. All locomotives used on this section would be interchangeable with the exception of the special shunting engines, and the total number required would therefore be 137, as against 218 steam engines as at present. The cost of line equipment on this section would amount to £779,700 and of sub-stations to £660,000. The expenditure on electric locomotives would be £1,302,000. The estimated cost of the track alteration is £751,137. The net capital outlay is £952,713. Similar considerations show that the expenditure and profits obtainable from electrification on the branch line from Glencoe to Vryheid East are as follows:—

£147,000 for line equipment and £98,000 for sub-stations. The total net capital outlay is £287,850. The details of working expenses with steam and electric working show a balance in favour of electrification of £36,060, which represents a return of 12·5 per cent. on the net capital outlay.

In Division 7 the sections to be considered are those between Randfontein and Springs, with the branch to Benoni and between Germiston and Witbank. The traffic to be dealt with is of two kinds, the local or suburban passenger service between Randfontein, Springs and Benoni, and the goods traffic over the whole section, together with one or two through passenger trains. The suburban service on this section is of quite a different character to that in and round Cape Town, as there is no main terminal station and the density of the traffic is much lower. The arguments in favour of the adoption of multiple unit stock for this service are not, therefore, so great as in the case of the other sections; but at the same time, its employment and its adaptability to alteration and development of the traffic would produce better financial results in the near future than the substitution of electric for steam locomotives, and it is therefore recommended that the multiple unit system be adopted. The service proposed provides for an increase of 66 per cent. in the train mileage on an ordinary week-day, and it is estimated that the 25 per cent. increase in receipts may be expected as a consequence of the increase in speed and the improved travelling facilities provided. The financial result of electrification from this service may be estimated to be about £74,000, the same type of rolling stock being used as on the Cape Town suburban branches. The west bound goods traffic on this section consists almost entirely of loaded coal wagons, which are made up at Witbank and are hauled to Germiston, where they are re-marshalled for various destinations. By electrification of this section the train mileage for goods trains could be reduced from 1,277,400 with steam working to 1,060,610 for electrical working, while the journey time from Kendal to Germiston could be reduced from four hours to 2¾ hours with three stops. On this section it should be noted that the goods traffic is practically non-existent during the middle of the day, the main load being between 5 p.m. and 6 a.m. This is a disadvantage if power is to be taken from a special generating station erected for giving a supply to the railway alone. If, however, some or all of the power required could be taken from an outside source the maximum demand on which occurs during the daytime this special arrangement of traffic should enable energy to be purchased at a lower rate than would otherwise be possible. The principal items in the capital outlay on the electrification of this section are as follows: Line equipment, £488,300; sub-stations, £293,000; rolling stock, £109,820, including locomotives and multiple-unit train equipments. The total net capital outlay, including small items, engineering expenses and contingencies, is £1,083,240. The comparative estimates of working expenses show a total saving of £42,560 in favour of electric working. In making this comparison it should be observed that whereas the same goods traffic is dealt with by steam as by electric locomotives, the suburban passenger traffic provided for in the estimate of steam costs is that which is being worked at present, while the corresponding traffic worked by multiple unit electric trains is 66 per cent. greater in train mileage and 48 per cent. greater in coach mileage. The financial result of electrification shows a total profit, including the sum of £74,000 arising out of the increase in revenue derived from the suburban service, of £116,560, which represents a return of 10·8 per cent. on the net capital outlay.

In Division 8 the section to be electrified is the main line from Witbank to Komatipoort, forming part of the main connecting line between the Transvaal and Lourenço Marques. The traffic on this section consists principally of coal from the collieries in the Witbank area which is being conveyed to Delagoa Bay for bunkering and export. The length is 233 miles. The general character of the line is similar to that of the Natal main line, Komatipoort being about 600 ft. above sea level, the line rising fairly steadily to 1,144 ft. at Waterfall Onder. Between these two points, which are not more than 2 or 3 miles apart, there is a rise of 700 ft. The line winds about along the steep slopes on the hill sides and turning back on itself, so that the distance by rail is 8½ miles, the ruling gradient being 1 in 50 compensated. From Waterfall Boven the line rises again to Belfast about 6,460 ft. above sea level, and then descends to Witbank, the altitude of which is 5,320 ft., with a ruling gradient between Witbank and Belfast against the loaded traffic of 1 in 55·5. This makes it necessary at present to divide the total traffic between these points into a comparatively large number of light loads, which involves a good deal of delay. For example, the time for any set of wagons to cover the distance of 91 miles from Witbank to Waterval Boven may be as much as 11 hours and 5 minutes.

The gross tonnage of loaded goods traffic under present conditions is approximately 5,800 tons per day for all sections. In considering the effect of electrification this tonnage has been increased to 8,700. The conversion to electrical working would enable the traffic arrangements to be greatly simplified, as this total load could be made up into nine trains of about 1,000 tons each, and each train could be hauled through to Komatipoort by one locomotive, which would return light to Witbank. This arrangement would have the effect of considerably reducing the annual train mileage, while the total saving on the journey would also be considerable. The reduction in time for the double journey is estimated at about 24 hours. Theoretically, it would be possible to work 24 goods trains a day in each direction for this section, so that the capacity of the line could be raised to 24,000 tons—*i.e.*, more than double. In addition to this goods traffic, passenger traffic consists of a tri-weekly mail train in each direction, running between Pretoria and Lourenço Marques together with one train daily from Witbank to Waterval Boven and back. After electrification the mail train would be run six days a week instead of three, the local train being continued as at present. Eighteen double-unit goods locomotives would be sufficient to deal with the goods traffic, and the same type of goods locomotive could be used for the passenger traffic, as, owing to the number of trains being small, there is no substantial advantage in using locomotives of the express passenger type. The total number of electric locomotives would therefore be 18 double and four single units, and 14 steam locomotives would be released. To accommodate this equipment a new engine shed should be provided at Witbank at an estimated cost of £26,000, while a sum of £5,000 should be allocated for altering the running shed at Komatipoort. The estimates of capital expenditure for the electrification of this section are as follows: The cost of line equipment is £590,810, of sub-stations £441,000, and there is a small credit of £89,300 on account of rolling stock. The total net capital outlay, including contingencies, engineering expenses and small items, is £1,155,010. The details of working expenses with steam and electric working show a balance of £65,100 in favour of electrification, which represents a return of 5·6 per cent. on the net capital.

The General Principles of the Development and Storage of Water for Electrical Purposes.*

By J. W. MEARES.

(*Concluded from page* 534.)

Medium-head Lay-outs.

Medium heads will generally be developed either from actual waterfalls or rapids in rivers, or from rivers near the base of mountains where the volume is great and the slope comparatively small. Higher upstream it is generally possible to utilise a high head at less cost, even though a large volume may be available. Where many rapids occur in a short length of bed it may be possible to pipe the water direct from the stream to the power house with a forebay interposed to prevent detritus getting into the pipes. Where there is an actual waterfall it is seldom necessary to carry the water far to the forebay. Sometimes the pressure pipes can be led directly into the reservoir or into a forebay constructed immediately above the fall; a short canal at most is required, and as it must be of large carrying capacity there is a great saving in such a natural fall.

Where the river has a considerable bed slope, or rapids, it may be necessary to carry the water for miles in a canal in order to accumulate a few hundred feet of fall. Occasionally a medium-head plant may be worked directly from a reservoir behind a high dam, but in such cases there will obviously be very large variations of head to contend with. Generally such a reservoir is built primarily for irrigation purposes, so that beyond a certain minimum the flow is strictly regulated according to season. This detracts from the commercial value of any such scheme.

Low-head Lay-outs.

Slow-running rivers and canals, with a small bed slope and no falls, cannot ordinarily be used for power purposes, as it is not possible to develop even a low fall without the risk of flooding the surrounding country above the dam; while the rise and fall of both head and tail waters, not necessarily to the same extent, further complicate the problem. Even where a small fall exists or can be made, these factors complicate the design.

In the case of irrigation canals, falls of from 3 ft. to 10 ft. are not uncommon, and can be developed by taking a feeder channel as a by-pass to the power house, continuing as the tail race back to the canal below the fall. Sometimes a subsidiary canal (generally in the form of a tail race) will enable two neighbouring falls to be combined so far as the turbines are concerned. Larger heads, but still of the low type, may occasionally be developed, where irrigation requirements permit, by discharging part of a high-level canal through turbines to a low-level canal. All irrigation canal projects suffer from the disadvantage that an occasional closure is necessary—whether for purposes of repair, or because the water is not required, or because it is more urgently required elsewhere.

In the case of rivers, low falls may be developed on the lines already described for medium falls. Great variations in the level of the head and tail waters are often a feature of low-head river developments and floods are a serious menace.

Headworks and Clear Water.

There is always present the liability of bringing down mud and debris from the source of supply to the turbine wheels. This liability increases with the head, as torrents take the place of larger rivers, and its effect on the wheel buckets also increases with the head and the spouting velocity of the jet or nozzle. Even the finest grit under a head of 1,500 ft. or 2,000 ft. is most destructive, and loss of efficiency soon results from worn nozzles.

Where headworks have a considerable dam there is no danger from stones or heavy matter except that their deposition will reduce the capacity of the lake; in hill torrents this in itself is so serious a matter that high dams would seldom be justified. If, however, such a dam is necessary it will sometimes pay to put another and smaller one further upstream, simply as a means of arresting the silt for a few years. The capital charges would generally be less than the cost of periodical cleaning out.

On high and medium heads.—Generally speaking, in the case of high- and medium-head plants, a low diversion dam is all that is necessary, sufficient to ensure the possibility of getting the water into the channel or pipe under normal conditions, and also to protect the stream at this point from scouring out the channel and endangering the supply in times of flood. For protecting the banks above and below the headworks boulder crates, made up of large boulders enclosed in a framework of heavy-gauge galvanised wire, are invaluable. Sometimes a permanent dam is not necessary, the natural lie of the ground alone ensuring the supply. Timber dams are sometimes used in America for levelling the bed.

In the absence of a dam arrangements must be made at the headworks for catching all debris. There will be a succession of screens or trash-racks through which the water passes to a small tank, in which any heavy matter coming through will deposit. This will need constant cleaning out and should be in duplicate. Nothing but fairly fine silt should pass beyond it. If there is no open channel this tank should be large enough to remove even such silt as will deposit readily, or there should be an adjoining settling tank for this purpose. Where there is an open channel there will be the liability of further debris collecting, and a forebay is necessary at the point where the pipes take off. All tanks should be designed for rapid clearance at several exits. The size of settling tanks would be such as to reduce the normal velocity of flow to a few inches per second. Where there is a reservoir at the pipe head it is still necessary to prevent the accumulation of mud. A large volume will become so solid that its clearance is difficult, and a silt trap immediately before it will be an aid. Where water is in excess of actual requirements one may allow a proportion to run off continuously at the headworks chamber, through partly open sluices, which will pass out all solid matter rolling along the bottom.

On low heads.—With low heads the water is generally clear; low velocity postulates a small bed slope and deposition will occur in the river itself. In any case the quantity to be dealt with is so great that artificial settling cannot be arranged for. Strainers are necessary to prevent floating matter entering the pipes and a forebay as well as for regulation. A long canal is seldom necessary. In most cases of very low heads the power station is built across the river, and the water flows directly through the strainers into the turbines. In America much trouble is caused by ice, both from floating blocks and from ground ice, which forms suddenly from super-cooled water where its velocity is checked at the gates. This is dealt with by steam pipes and sometimes even by explosives, and many cause complete stoppage.

Canals and Open Channels.

Where a very large canal is required in connection with a hydro-electric development, the design is carried out on lines of irrigation canals. On medium and high heads the channels are of a smaller order. They may vary in length from a few hundred yards up to many miles, and may be single, duplicate or multiple.

In the case of long channels a break might only be discovered after many hours; even if due only to an earth fall, diverting the supply without breaking down the channel, it would take time to get this cleared and this would involve complete breakdown. Water-level indicators, electrically controlled, are therefore often used in these cases.

On high heads.—For very high heads a comparatively small discharge is required, and this will sometimes be collected from more than one source and by more than one route. Earthwork channels can seldom be constructed, and the choice generally lies between galvanised iron, masonry or concrete, and timber. The first and last can usually be carried on a structure without cutting away the ground. As landslips are always liable to follow the cutting of a roadway on a mountain side this is a great consideration. If masonry or concrete is used catch-water drains of substantial size, leading to the nearest culvert, are essential. Smaller torrents may have to be crossed on bridges, and each of these should be used to afford a discharge outlet for the water in case of accidents and for scouring.

Fairly low velocities, not exceeding 3½ ft. per second in unpitched earth channels and 6 ft. per second in other kinds, are generally necessary for the preservation of the channel. The cross-section may be square, semi-circular or trapezoidal, the latter being generally the best as giving the smaller hydraulic mean radius. In practice the slope is generally decided on first—from 1 in 500 for small channels, to 1 in 1,500 or so for large ones—and the dimensions are calculated to suit. It is very necessary, however, to remember that any data found by a formula dealing with a straight length of channel will need alteration where there are bends or irregularities.

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* Abstract of a Paper in the "Journal" of the Institution of Electrical Engineers.

Where masonry or concrete channels are used most of the above considerations apply with equal force. Here it is necessary first to cut a roadway for the foundation, so that the liability to landslips and rock falls is greatly increased. Where the ground is at all doubtful cut-and-cover is necessary. It is essential to make culverts under, or preferably over, the channel for the very smallest lines of natural drainage. Often it will be advisable to lay small drains down such places, with cross-collecting drains to prevent a wash-out. In extreme cases tunnelling may have to be resorted to, for the avoidance of bad ground.

On medium heads.—While small works on medium heads may be served by the same methods as high heads, canals in earth are generally necessary. The cost of an artificial channel would be prohibitive over a certain size. The largest timber flume the author has seen was at Tacoma, U.S.A., and was 8 ft. square and about 10 miles long, with a fall of 7 ft. per mile. No other material could be used for a channel of this size, and timber has its drawbacks. Unless the water is running full all the time warping is certain to occur, while boring insects and rot have to be faced. The large flume of the Thelum hydro-electric works has suffered severely in this way.

Forebay Reservoirs.

Whether the forebay is mainly for regulation, or whether it also holds a considerable reserve supply, it is an important link in the chain. It must be so designed that, while acting as an efficient surge tank, and as a regulator to deal with loads temporarily exceeding the capacity of the channel, it does not allow any foreign matter to get into the supply pipes. Coarse and fine srainers should be provided. The forebay, or forebay reservoir, should be sectionalised or duplicated to admit of cleaning out. Where the channel discharges into it there should first be a small chamber to take eddies and induce still water; this will also catch some of the residual silt.

The strainer that finally ensures no foreign matter getting into the pipe requires careful thought. The obvious plan is to put it immediately behind the bell mouths of the pipe, and to close it in at the top. But some part of it may eventually rust away and get into a nozzle. Repairs would be difficult without emptying the forebay and shutting down the plant, and in practice the arrangement is not satisfactory. The alternative design, which should be adopted, is to put the strainers in the main forebay, at the entrance to a separate walled-off chamber feeding the pipe and this chamber should be covered over.

An emergency by-pass from the channel, also provided with a screen, should be made to disc arge direct into the bell-mouth chamber. If repairs are required to the reservoir this will prove invaluable.

Pressure Pipes.

There is much diversity of opinion as to the best arrangement of pipes for feeding a number of turbines. Apart from the question of cost there can be no doubt that the ideal arrangement is self-contained units of pipe, turbine, generator and step-up transformer, just as in modern steam practice. Where very large units are involved no other arrangement is likely to be used, and on low heads no other arrangement is generally possible.

On high heads.—With very high heads comparatively small pipes of great strength are required; the locality is likely to be far from rail-head, so that carriage to site is an expensive matter. It pays as a rule to keep down the weight of individual loads, and to use a single pipe for each turbine, but it is often advisable to interconnect the various pipes at the forebay. Each pipe should be capable of being instantly closed at the forebay in the event of a bad blow-out, either by an automatic valve or by electrical control from the power house. Each pipe must also have an isolating valve at the forebay or a gate in the forebay. Air pipes and filling valve may also be required.

In order to reduce the thickness of the lower sections of pipe it is customary to use two or more diameters, the smaller at the bottom; this also economises in freight where they can be nested. Where individual pipes serve each wheel it is advisable to interconnect them at the power house, so that in the event of a joint blowing on one pipe while another generating unit is out of service they can be cross served.

Long lines of pipe, such as are required on high heads, require substantial anchoring not only at the top and bottom but at intermediate points. These also provide safe positions for expansion joints, which can be dispensed with only where the temperature variations are small or the line has many angles in it and not always then. Air valves are not often required, but will be where there is an unavoidable rise in the pipe line. Occasionally air cushions are provided in very long lines to take up shocks.

The reduction of effective diameter due either to ordinary furring from lime, &c., or fine mud deposited when the water is standing, may seriously increase the loss of head. Although cleaners of the revolving turbine type can remove a good deal of this deposit the initial diameter should be always greater than is indicated by the velocity decided on.

On medium heads.—There are no special points in which the pipe system on medium heads differs from that already dealt with. The pipes are of larger size and their carriage becomes more serious unless they are built up at site, but on the other hand the locality is generally more accessible. Air valves and cushions are seldom required.

On low heads.—With very low heads and submerged turbines the draft tube is the only pipe required, while with somewhat higher heads there will be both pressure pipe and draft tube. With large units of plant the size of the pipes becomes very great and the internal hydraulic pressure becomes a secondary consideration. Cases are on record where an automatic gate, serving a very large pipe, was closed at the forebay and air pressure caused a complete collapse. No interconnection is usually practicable or necessary with low heads.

Tail Races.

On low-head plants the essentials of the tail race are that it shall be of ample size to give a very low velocity of discharge, and that it shall be free from eddies. A very small loss of head may be a very large percentage of the total—every inch represents 3 per cent. on a 3 ft. head—and the draft tube and tail race are just as important as the headworks. Backing up the tail water from excessive flow may be unavoidable, but bad design may increase it unnecessarily.

With medium and high heads the water has done its work when it leaves the discharge orifice, but it has considerable capacity for mischief left in it. The tail-race pit must ensure that there are no waves tending to stop the free exit of the water, and it also must cushion the discharge so that the structure is not destroyed. On heads of 2,000 ft. or so the destructive effect of the spent jet is surprising, and masonry is quite unable to withstand it. Baulks of timber or cast-iron blocks, which can easily be renewed, are sometimes fixed in the pit.

Conclusion.

A word must be said in conclusion with regard to cost. From the generator onwards there is no great difference in capital cost between steam and hydro-electric stations, and the cost of the power-house buildings will be comparable. The boilers, steam pipes, engines or steam turbines, condensing plant and accessories are replaced by the comparatively simple turbine wheels and their supply pipes in the most favourable cases; but in less simple plants there is also the whole cost of the hydraulic development, channels, forebays, reservoirs and dams, to set off against the steam plant.

The working expenses—staff, management, lubricants and stores maintenance and repairs—do not differ in principle in the two instances; practically the annual cost of fuel in the one case must be set off against the extra annual capital charges in the other. The total cost of fuel is proportional, roughly, to the number of units generated, and expressed in pence per unit it remains sensibly constant in any undertaking. On the other hand, the total annual costs of a hydro-electric station are practically fixed, so that the cost per unit varies inversely as the number of units generated. In both cases the capital cost and consequent annual capital charges vary largely with the load factor. An important difference between steam and hydraulic working lies in the fact that every unit generated by the former method costs a definite sum in cash for fuel, so that actual loss would result in selling at that figure; whereas with water power there is no such expenditure and any sales which will fill up hollows in the load curve without affecting the peak must be profitable at whatever rate they bring in. The common idea that water power costs nothing is true only in this limited instance. In any such comparison capital cost, cost of fuel, and load factor are the three essentials which determine whether a project can best be served by fuel or by water power.

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An Attempt at Constructive Criticism.

Mr. Roger T. Smith, in his Presidential Address to the Institution of Electrical Engineers, points out that at the present time, when we are recovering from a disastrous war, and when the problems of peace and of reconstruction weigh more and more heavily upon us, what is needed most from all is good citizenship. By this he means that we should take more interest in the affairs of the nation. For any policy which is to give effect to the general desire for better conditions of living and greater prosperity cannot hope to achieve success unless it has behind it the full support of the community at large. Those responsible for framing such a policy should, therefore, discover the opinions of those for whose good it is to be carried out, and these opinions can be best discovered by constructive criticism emanating from those most concerned in the proposals under consideration. The tendency of all bureaucratic bodies, and of those large committees which are now so often set up to consider definite questions of policy, is to take the easiest line, and if possible to arrive at some compromise. They will not be forced to alter their behaviour unless they are convinced by the weight of public opinion that a certain course of action must be followed. At the present time there is criticism in plenty, but it is destructive in character, pointing out that what is being done is wrong rather than showing what exactly ought to be done to be right.

This disastrous type of criticism is equally applied to the electrical engineering profession as it is to the consideration of wider national problems. For while there are not lacking those who point out the disabilities under which we are at present suffering (even though they are not in agreement as to what those disabilities are), those who can suggest a policy which will lead to an improvement are few and far between. We desire to join their ranks.

Now, in itself criticism is a healthy sign, for any form of human activity which escapes criticism is generally so nearly moribund as to be hardly worth worrying about. That is certainly not the case with the Institution of Electrical Engineers. It receives criticism in plenty, and amidst that criticism there are one or two points which, in our opinion, stand out clearly. There is a school—not very audible at the present time, but still influential—which considers that the Institution should confine itself wholly to the consideration of Papers on professional subjects. This was at best a narrow ideal, and was made even narrower by the fact that any Paper which touched more than quite remotely on the commercial side of electrical engineering was likely to receive short shrift at the hands of the authorities. This has now quite rightly been changed. After all, the commercial side of electrical engineering is the one in which by far the largest majority of the members of the Institution are interested, and more attention might well be paid to it than is even now the case. In addition there is what may be called the political side, and this also should not be neglected.

It is complained that there is a lack of interest in the meetings. Various reasons for this have been suggested, but it is a fact that the attendance is deficient not so much in numbers as in quality. Of the large audience which listened to Mr. Roger T. Smith's Presidential Address the other evening, a high proportion were students, whose presence is, we fear, as much likely to be due to curiosity as to a desire for knowledge. Most of the remainder of the audience were veterans. Where were the representatives of that great middle class from which the aristocracy of the profession must in future be drawn? If this is the type of audience when a Presidential Address is the business of the evening, how much more unsatisfactory is it likely to be when a Paper, which can only be of interest to a small proportion of the total members, is down for discussion? To overcome this we suggest for consideration that the subjects dealt with at the Institution meetings should be more definitely controversial in character. Many of the Papers are simply what a contemporary calls "an elaboration of fundamentals," an operation as cold as the phrase itself; and on such Papers little discussion is possible. Many Papers read before technical societies rightly reflect the progress which is taking place but Papers which do this alone are best consigned to the "Journal," and at meetings only subjects which induce discussion should be dealt with. We see no reason, though authors may object, why the Papers presented should not be accompanied by a short summary, written purposely in a controversial form, with the definite idea of providing a discussion. For it is possible to start an argument on almost anything if it is put forward in a proper way. At any rate it might be tried.

Meetings are, however, only one side of the Institution's activities, and we cannot help feeling that at the moment they are not the most important side. What the electrical industry most wants is a body which can justly represent its views and will be recognised by those in authority as so doing. Is the Institution so recognised? We hardly think it is, though there has been a great advance during the last year or two in this respect. We are faced with unrest of all kinds, of which the ever-growing demands of labour are but a symptom, and it is obvious that in dealing with this unrest an organised body stands in an advantageous position, as a well-disciplined army does to a rabble. It is, therefore, necessary that all the best of talent, of which there is enough and to spare in the ranks of the industry, should be placed at the disposal of the Institution, that those responsible for governing that body should be made to understand that it is the desire of electrical engineers generally to see their views placed before the authorities at the right moment, and that those authorities should be made to realise that the Institution is an organised body with weight behind it. There should, indeed, be no matter of policy affecting the electrical industry, however remotely, about which the Institution is not consulted as a right. Moreover, the views of the electrical profession and industry should generally, through the Institution, be represented to, we may even say forced on, the Government, so that our interests are at least as well cared for as those of, say, the medical and legal professions. The individual electrical engineer must cease to be a small detached unit, but must become a definite part of that super-industrial power station represented by the Institution. If this policy is adopted, and properly carried out, we shall cease to hear that oft-repeated peevish question, What good is the Institution to me?

Review.

The Strowger Automatic Telephone Exchange. By R. Mordin. (London: E. & F. N. Spon.) Pp. xii.+186. 21s. net.

This is the best account so far published of the Strowger automatic telephone system as manufactured by the Automatic Telephone Manufacturing Company, of Liverpool. The book is well printed, the illustrations are clear, and the circuit diagrams are excellent. For the purpose of the telephone engineer the book will be extremely useful, perhaps more so than for the student.

In our view the author deals with the circuit descriptions admirably, illustrating these by very clear skeleton diagrams. The author's method of treating the principles of the system is not so good as that usually adopted—namely, to explain the simple connector, weaving in the functions and details of the selector and line switch later. The author treats these items in the order in which they carry the call—namely, the line switch first. This makes it very difficult for the student to follow the operation of the line switch and master switch, although the description as given in the book is quite good. The difficulty is further accentuated by the fact that Fig. 11, illustrating the master switch, has been reproduced upside down.

In dealing with the comparative advantages of the automatic over the manual system the author gives prominence to "absolute privacy." We think this is a mistake. It is clear, of course, that there is *more* privacy in the automatic than in the manual system, because fewer people are concerned in its operation. Nevertheless, in telephone engineering matters absolute secrecy does not exist. The telephone workmen *can*, on occasion, come in circuit as part of their normal duties, and overhear conversations. It should be mentioned, however, that all telephone administrations consider this as incidental to telephone working.

The author rightly claims for the automatic system an immense advantage from the fact that there is practically no limit to the size of the exchange, corresponding to the 10,000 line limit of the manual system. Also that automatic exchanges can be placed in buildings that would be too awkward in shape for the housing of a manual plant.

The reference to the low maintenance charges may lead to some misapprehension. It is not clear that the more complex automatic equipment can ever be maintained under equal conditions of organisation for a lower cost than that involved in maintaining manual exchanges. The claim for a longer life in automatic plant and consequently reduced depreciation charges are quite justified, because automatic equipment as at present designed does not include a full subscriber's multiple, which in a manual exchange is not renewable when deteriorated by wear and tear. Also the greater adaptability of automatic plant leads to a longer effective life.

Some of the expressions in the book are American terms, which in our view it is a pity to perpetuate. In particular, the right and left panels of the line switch units are described as *shelves*. Under no ordinary use of the term "shelf" could the student realise what this term means as applied to a line switch unit. We believe that such ambiguities are about to be remedied as a result of the influence of the British Engineering Standards Committee.

The author appears to favour "slipped banks," but it is a matter for debate whether the advantages of slipped banks in avoiding excessive wear in the switches would not be more than counterbalanced by the use of "straight banks," which would give the advantage of a definite first choice for purposes of relieving traffic congestion.

It should not be overlooked that the title "The Strowger Automatic Telephone Exchange," as described in this volume does not cover the whole field, as Messrs. Siemens Bros. & Company are also manufacturers of a Strowger system having special features of its own, with which the student should, of course, be acquainted. B. O. Anson.

How the Progress Department Assists.

IV.—The Shop Foremen and Charge Hands.

By W. J. HISCOX.

To say that the Progress Department assists the foremen and charge hands is to put the case mildly, for under the progress system the duties of these individuals become revolutionised. Yet, in the average factory, there is, in this direction, more distrust, misunderstanding and antagonism to the Progress Department than is manifested in any other section of the factory.

Perhaps it is this very revolutionising of duties which is at the root of the trouble, for the average foreman is suspicious of any move which savours of unasked-for assistance. He prefers to "gang his own gait," to stagger beneath an ever-increasing load of responsibilities, to be continually upon "the carpet" to answer charges of innumerable sins of omission and commission, rather than accept assistance or relief from any source which to his mind interferes with his authority.

Fortunately for him, however, scientific management has decreed that he must have assistance, that his several responsibilities shall be equitably apportioned, and that a certain amount of leisure time shall accrue to him. This leisure time does not mean idle time, but the time when, free from the drudgery of vexatious details, he can concentrate his mind upon more important things, to consider to-morrow instead of to-day, and thus increase his value to the firm in general and his own department in particular.

For the foreman must have time to think, and he cannot think whilst his mind is full of innumerable little troubles, the solving of which could be safely left to others. He is an important personage, but whilst on the one hand he has an exaggerated idea of that importance, on the other hand, and in the greater sense, he does not realise how important he really is. As monarch of all he surveys, he stands upon his dignity, even though his department is conducted in an inefficient and haphazard manner; but as the chief of a progressive and highly efficient department his dignity is somewhat ruffled, because, forsooth, he received the assistance he did not desire.

He should be grateful for the assistance rendered, and, when once he realises exactly what it means, no doubt his gratitude will rise proportionately. The Progress Department, in particular, will earn this gratitude, and the object of this article is to show precisely how and why that department does assist him.

In the first place, it is the instructional department of the factory in the matter of delivery and output, and as such directly benefits the foreman, inasmuch as it ensures all instructions being issued from the same source. It is also the mouthpiece of the management, and any information or instruction conveyed to the foreman through the medium of the Progress Department may be regarded as strictly authentic.

It has at its disposal records of all matters appertaining to production, and it can determine the degree of urgency of every order in the factory. It discloses to the foreman the firm's commitments, tells him what is expected of his department, and then assists him in discharging his obligations. The centre of the factory organisation, the Progress Department, conducts its business in a systematic manner, and the orders are issued to the foreman in the correct sequence, and in such a way as not only to ensure the most urgent work receiving priority, but also with due regard both to the requirements and the capabilities of the department at any given time.

This reduces considerably the anxieties of the foreman, for, obviously, if he knows at the outset the relative importance of every order from a delivery standpoint, he is able to plan ahead, and thus save worry and confusion at a later stage. He is also enabled to periodically overhaul and inspect his plant, and to readjust this in accordance with the changed circumstances attending production.

Having voiced the wishes of the management to the foreman, the Progress Department prepares to assist the foreman further by ensuring that the requisite material is available when required. This in itself is a task of some magnitude, and requires careful consideration and efficient handling. In the past the foreman has had either to look after the work himself, or simply mark-time until it arrived in his department, the result in each case being unsatisfactory and unprofitable both to the firm and to the foreman.

The foreman who spends the major portion of his time outside his department obviously cannot control that department in an efficient manner. To supervise a department properly the supervisor's presence is necessary, for laxity is bound to develop if the head of the department is absent for protracted intervals. The organisation of the department suffers, and its efficiency as a progressive and a productive department deteriorates. The foreman may rightly point to the fact that only by his personal effort could a certain job be completed to time; but certain it is that that particular effort was only rendered effective at the expense of something else.

If, on the other hand, the foreman simply "marks time," and calmly awaits the arrival of the necessary material, then he is speedily faced with the prospect of paying waiting time, with idle machines and idle men, due to the fact that there is an insufficiency of material to keep his shop fully employed. This, of course, means a decreasing output, which in these days of keen competition cannot be tolerated. Even should there be a sufficiency of alternative work, which would at least enable the full employment of every man and every machine in the department, the fact still remains that the efficiency of the department suffers if it cannot execute orders in accordance with customers' requirements.

The advent of the Progress Department releases the foreman from any obligation to get material into his department, and at the same time relieves him from the haunting fear that his output will diminish. Assured that he will have an adequate supply of material at his disposal at any time, and that of the right sort, he can concentrate upon the problem of producing what is required of him.

In many factories nowadays a centralised tool room is responsible for the production of tools, jigs, fixings, &c., which in the past had to be designed and executed by the various departments requiring them. This in some respects is a boon to the foreman; but unless these tools are ready when required, delay in the productive department must necessarily follow. The tool room caters for the needs of every department in the factory, and cannot be expected to attach the same importance to the early completion of a certain tool as would the foreman of the department requiring that tool. Consequently, it is the Progress Department, knowing the relative importance of every tool from a delivery standpoint, which undertakes the responsibility of instructing the tool room on this matter, to the mutual satisfaction of all concerned.

The departmental component stores are a source of continual annoyance to the foreman, and under his supervision (which is usually of the negative variety) they are rarely efficiently managed. The control of these stores by the Progress Department cannot fail to be productive of good results, which add greatly to the efficiency of the department and the comfort of the foreman. The shop clerical staff, too, can be treated in a like manner, for in this respect superfluous clerical labour is dispensed with, and a departmental progress staff established.

In innumerable ways, therefore, the Progress Department can be of assistance to the foreman, and not only to the head of the department, but to each individual assistant foreman and charge hand. Just as it is not good policy for the head of the department constantly to leave that department, so also should the charge hands be encouraged to remain in their own sections. The same agency that ensures work coming into the department will ensure this work travelling from section to section through the department, and, what is just as important, it will arrange for the work when completed to leave the department. A section charge hand rarely has a surplus of space at his disposal, and what space is given to him must be utilised for work in progress, and not for completed parts.

The assistance rendered by the Progress Department to those departments dealt with in the previous articles of this series directly benefits the shop foreman. The fact that the Progress Department is able to facilitate delivery of material from outside sources is greatly to his advantage, whilst the regulation of supplies from the general store also ensures fair treatment of every productive department in this respect. The systematic handling of costs, too, has its effect upon the shops, and the foreman has the satisfaction of knowing that he will not be continually called upon to explain the reason for this and that: important points for the cost clerk, but terribly exasperating to an already over-worked and harassed foreman. The Progress Department is, without a doubt, a friend to the foreman and it can be of real assistance to him should he so desire.

The Electromagnetic Theory of Relativity.

Some accounts of the joint meeting of the Royal Society and the Royal Meteorological Society to consider the results obtained during the recent solar eclipse, contained a reference to the fact that Sir OLIVER LODGE left before the meeting was over. We are asked by Sir Oliver to point out that the only reason for this was that he had a long standing engagement and a train to catch. He further deprecates the notion that last February he ventured on anything so serious as a prediction concerning the probable results of the expedition, and asks us to point out that he was rash enough to express a hope for a result equal to half Einstein's value. But the double-valued result, he continues, can be assimilated and specified in various ways, one of which is the ponderability of light coupled with a definite effect of motion on the Newtonian constant of gravitation, an effect which the behaviour of Mercury and other planets has already rendered probable; while another is the vaguer suggestion that one of the two ethereal constants responsible for the velocity of light is affected by a gravitational field, so as to cause a kind of refraction. In any case he would issue a caution against a strengthening of great and complicated generalisations concerning space and time on the strength of the splendid result; and he trusts that it may be accounted for, with reasonable simplicity, in terms of the ether of space. Meanwhile he heartily congratulates Prof. Einstein, and also the skilled and painstaking observers who have so admirably verified his striking and original prediction.

We have received from Prof. MILES WALKER a letter which was sent him by EINSTEIN in July, 1914. This letter, of which we give a translation below, relates to the experiments to determine whether there exists any action between masses analogous to the mutual induction between electrical circuits. The experiments were described by Prof. Miles Walker and Mr. W. W. Stanier in an article on "An Inquiry into the Possible Existence of Mutual Induction between Masses," which appeared in the "Philosophical Magazine" for December, 1916.

TRANSLATION OF A LETTER FROM DR. EINSTEIN TO PROF. MILES WALKER.

I hear from Dr. Fokker that you are making experiments upon the induction effect of gravitation, and that you are therefore interested in knowing that result is likely to occur in accordance with my "Theory of Gravitation." Unfortunately, the effect to be expected is so small that one must give up all hope of a direct result. The case is as follows :— If M is accelerated with the acceleration A, then there results upon a mass m at distance r an induced force R of the like direction and of the amount.

$$R = \frac{1 . 88 . 10^{-27}}{4\pi} . \frac{Mm}{r} . A.$$

I regret very much that I can give you no better hopes, and I remain with all respect,—Yours truly,

July 14, 1914. A. EINSTEIN, Dahlem-Berlin.

The Nobel Prizes. The Swedish Academy of Science has awarded the 1918 Nobel Prize for Physics to Prof. M. Planck, of Berlin University, and the 1919 prize to Prof. Stark, of Griefswald University (Pomerania). The Nobel prize for 1918 for chemistry was awarded to Prof. F. Haber, of Berlin University, but it was decided to hold over the 1919 prize for chemistry until next year.

Calculations Relating to High Pressure and High Temperature Steam with Interheating for Power Generation.*

By W. M. SELVEY.

Arising out of my experience of this Centre I am struck with the wealth of enthusiasm, knowledge and good-will which is shown by our younger members and which makes me long to find some way of turning this sterling gold into channels that will enure for the benefit of the Institution, the profession and the whole community. It is most necessary that it should be guided. The question is: How? My own personal experience is that we have need for more ideals to hold together these younger members. No organisation can live without authority, but in this case the authority must be moral authority conceded by the members voluntarily, because they believe that the holders of this authority will use it for the advancement of agreed ideals. It used to be the cry of the younger members: "What does the Institution do for us?" This cry is now out of date, and in any case was based on a misunderstanding of how a body becomes powerful. I am going to venture with great diffidence to make a few remarks on what the older members and younger members can do for each other; what both can do for the Institution, and what the Institution can do for them. In my opinion the older members can do much for the younger members by giving them help and advice, not merely on how to get on, but how to make the best use of the opportunities they now have. It is so very much easier for the experienced members to see the opportunities than for the younger ones to recognise them. The junior members can help the senior members by never relaxing their enthusiastic attentions to their duties. The outlook of each junior member is very largely and legitimately that of desiring to better his position, but he must also equally think of how to fit himself for the position when it comes. The younger members should study what they are able to admire in the older members and to meditate on what qualities make for success. They will be rather surprised in many cases how many of these turn more on high personal character than on abstruse technical knowledge, and if they are honest with themselves they will also be rather surprised at the amount of self discipline and even self sacrifice they will need to exercise to develop these same qualities in themselves. And now a short word as to how both can help the Institution. I lay it down fearlessly that the most important thing of the whole matter is that all members must attend the meetings regularly. The very type of member who says the meeting is no use to him or not worth attending will find the whole Institution a new thing to him if he himself comes regularly and faithfully. Whatever he fails to find, he will find a growing fellowship among the members. Lastly, a word as to what the Institution can do for us all. I venture to suggest that the Institution as a corporate body is and always will be the origin of education in its highest sense. Much is now done in this direction, and more can be done if the members will formulate suggestions which can be put before the Local Committees and transmitted by them to the Council. It is hardly necessary to emphasise that the Council is the only body which can co-ordinate and put into practice the outcome of any such suggestions. On the subject of education I am tempted to say much. I think attention should be now drawn to the continued training of engineers for long years after they have left their college or the works where they have served their apprenticeship. The Institution provides many highly technical Papers written by experts and masters of their subjects, much of the material of which is quite beyond all but a few of the juniors members and perhaps many of the senior members. In the course of such Papers we find assumptions made—quite justifiable—and important information known only to a few, skipped over almost without notice in order to shorten down the paper to consideration of the main matter. It is perhaps often just these points which would most interest and instruct many of us. While they would be out of place in the main Paper it would be a great advantage if notes on such points with reference to other important Papers, text-books and the like, were contained in an appendix at the end of the Paper. Many of these points would be suitable as a basis of examination papers for the Associate Membership Examination. The Council might with a view to adding to the interest of the younger members and building up the Institution of the future through them, arrange for suitable points to be selected and even go the length of arranging correspondence between the junior members and the authors of Papers on points on which further information was required. The natural modesty and diffidence of the best type of younger member will always hinder him either from joining in at the discussion of the meetings or asking questions of the authors of the Papers, and yet this type of member is often the most earnest searcher after truth. Older members must always remember that all the accumulated information and experience which we have has to be retransmitted to the coming generation. I should here like to protest against the cheap sneers that are often indulged in by older members with regard to what is called "theory" and their continual cry that "experience" or "practice" is what is necessary. Hypothesis is the very opposite to theory. It is the attacking of ignorance with an untried sword and armour, highly necessary but very difficult. True theory, on the other hand, is simply highly condensed experience and, as such, should be honoured and kept apart from hypothesis. The real use of experience is to train the younger members to understand what theory really amounts to in actual material facts so that they may be enabled to make a good fight with the ignorance which is yet to be conquered. The man who can conquer this ignorance is the real practical man of the future, and not he who has been described by some "academic" person as "the man who faithfully repeats the mistakes of his predecessors."

Not only do I think the younger members want this help in grasping the foremost questions of the day, but I think the older members require much help in order to be kept in touch with the ever-widening circles of knowledge, all of which are being developed under the ægis of the Institution. I can conceive in the future that no session will be considered complete which does not include at least two lectures per year before each Territorial Centre, one from a distinguished professor, typified to-day say, by Sir Joseph Thomson, who will give the members some résumé of the progress made in pure Science such as affects the interests of the members, and further to this, another lecture given by the experimental type of research engineer who will give some account, say, of the work done at the National Physical Laboratory and of the various activities of the Research Committee.

The subject of interheating is of interest at the present time because it is a means of getting a higher thermodynamic efficiency without resorting to higher temperatures and pressures. The same general figures of temperatures corresponding to high pressures have been taken as in Mr. Shaw's schedules.* All the steam pressures are expressed in absolute measure, the highest taken being 500 lb. The highest temperature taken is 688°F. As regards vacuum, all modern power stations in future will fall within the limits of 28 in. and 29·1 in. Data are given in the Paper relating to diagram efficiencies obtainable with steam initially at 500 lb. per square in. absolute, total temperature 688°F., where the steam after expanding and doing work to certain selected pressures is again reheated to the original temperature and then further expanded down to vacuum pressures.

Results which are also given show that while expanding to the same set of pressures the steam is not reheated to its original temperature but only to its original superheat, and that the best pressure for a single interheat is somewhere above 200 lb., and that the possible gain in efficiency is of the order of $1\frac{1}{4}$ per cent. The effect of twice interheating the steam is to give a fairly wide range of choice for two interheats for which the efficiency remains sensibly constant, the most favourable of these conditions shown being an expansion first to 215 lb., reheating, and then an expansion to 70 lb., and further reheating with a final expansion from 70 lb. to the vacuum pressure, given a possible gain in efficiency over plain expansion of about $4\frac{1}{2}$ per cent. The value of interheating is greater in proportion as the initial pressure is lower. For instance, the expansion from 500 lb. with an interheat to the original temperature at 150 lb. shows a gain for plain expansion from 500 lb. of only 2·4 per cent, while steam originally at 150 lb. interheated at 50 lb. to the original temperature of 688°F. shows a gain over plain expansion from 150 lb. of 7·2 per cent. This draws attention to the value of pressure which at 500 lb. shows a gain of 11 per cent., whereas at 70 lb. pressure there is a deficit of 15 per cent. With the superheat kept at the constant figure of 219·3°F. there is a gain at 500 lb. over 215 lb. of as much as 13 per cent.

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*Abstract of an address delivered to the North Midland Centre of the Institution of Electrical Engineers.

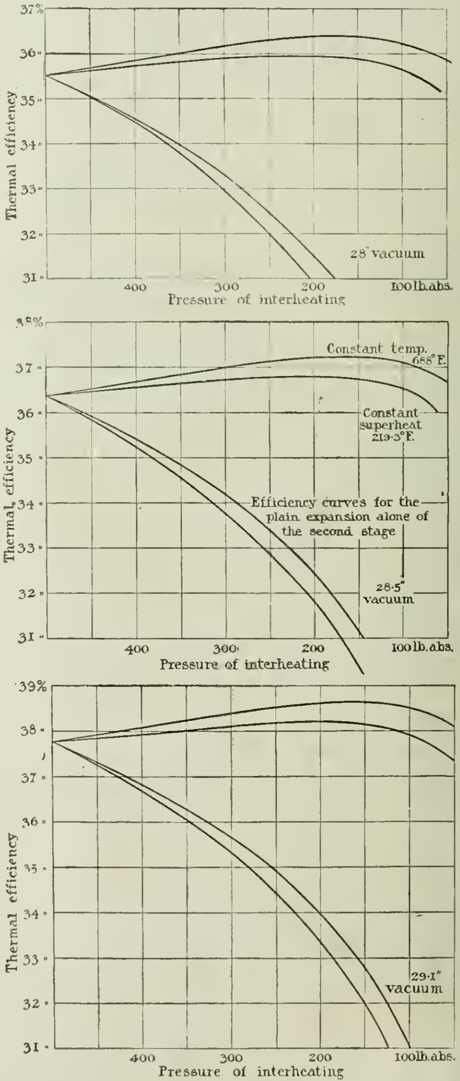
*The Electrician, Vol. LXXXI., p. 330.

It is found that as so much heat has to be put into the feed water at a less temperature than the top temperature there is considerable loss of possible efficiency by the use of water as a working fluid. Without superheat, however, this loss, though considerable, is not very striking, but additional superheat makes the difference in efficiency between using a perfect fluid and using water very considerable. For instance at 500 lb. pressure without interheating and at a total temperature of 688°F., the use of the perfect fluid gives some 44 per cent. higher efficiency than that of the plain use of steam. From the point of view of the materials used on the engine which is to utilise this steam all provisions have to be made corresponding to the temperature of 688°F., the question of pressure very little entering into the practical provisions as drawn out by Mr. Shaw's Paper. In fact the use of high pressure has already very much reduced this difference which is far greater when the comparison is made with low-pressure steam. It will be gathered that in order to approach the possible Carnot efficiencies it is necessary as much as possible to take in all the heat at the top temperature, and for improvements in the use of water as a working fluid we can see from the temperature-entropy diagram that were it possible to keep our engine red-hot so that the temperature of the steam should not drop during expansion for a considerable time, then the engine which could do this would be working more nearly on the Carnot cycle because it would be taking in a further modicum of heat at the top temperature. In the Carnot cycle this heating during expansion or, as it is generally called, isothermal expansion, is carried on to a certain pressure and then stopped. This pressure is such that on further adiabatic expansion the working fluid falls in temperature to the basis or lower temperature. Supposing for a minute that such a system were physically possible, then we can easily judge the gain in efficiency due to what I have termed "ideal interheating." The maximum increase in efficiency to be expected from such "ideal interheating" would be about 11 per cent. A moment's reflection will suggest, however, that such a scheme of continuous interheating would be very difficult to carry out in practice, and in any case instead of the horizontal continuous interheating line we should have a saw-toothed curve representing interheating at every expansion in the case of the turbine engine. The natural course of inquiry, therefore, turns as to what can be attained by doing something towards interheating in the simplest possible way. In turning to this inquiry it must be remembered that the higher the pressure of the interheat the more easy it would be to convey steam from and to the engine. There are two schemes on which one can elect to do interheating, the first and more correct is to the initial temperature and the second of less correct is to the same initial superheat. It is almost obvious that one would not retreat to higher than the original temperature. Somewhere between these two schemes therefore any practical scheme must lie.

Considering single interheating at stage pressures of 365 lb. and 280 lb. it will be found that the added area due to interheating is small, and therefore we could not expect much practical gain at these pressures.

For a single interheat for stage pressure of 215 and 100 lb., it will be found that the added area is a substantial portion of the "ideal interheating" area. Somewhere between these two pressures will be found the maximum gain which will be made with one interheating. In Figs. 1, 2 and 3 have been combined the whole of these results in curves which show the effect of one interheat at any pressure below the initial pressure. It is necessary to draw three different curves for each vacuum. In addition to the efficiency curves for the combined expansion with one interheat, the efficiency curves for the second expansion alone have also been drawn. These curves, therefore, give not only the value of interheating but a direct comparison of the efficiencies between different pressures. The way in which the efficiency rises with pressure as compared with interheat strongly illustrates what has already been mentioned as to the value of pressure. In considering Fig. 1 we notice that the single saw-tooth gives us a curve which is very far from representing heat fully taken in at the top temperature, and it is therefore interesting to extend the inquiry into the region of more than one interheat, and here one would have to abandon the idea altogether of taking the steam back to the boiler but not entirely that of bringing the heat to the engine.

If we draw out the super-heat region of the temperature-entropy diagram to a larger scale and give the superheat portion of the curve from the saturation line up to the constant top temperature of 688°F. for all the pressures employed, it is easy to see the advantage of drawing the "Carnot zone," which is a narrow horizontal band covering the range of the "Carnot temperatures" for the range to a vacuum of from 28 to 29·1 in. It is obvious that in dropping down any vertical line of adiabatic expansion for any stage of expansion we cannot hope to gain much in efficiency after we have gone down to the Carnot zone. The curve of the whole range of efficiency obtained from two interheats would be exceedingly flat, and this shows us that it would not be necessary to define any particular set of exact pressures. Also, once given the high initial pressure of 500 lb., the actual efficiencies do not show much encouragement. We have only gained about 4·4 per cent. over plain expansion, and therefore only 2 per cent. over a gain of a single interheat; this is to say, that the second interheat does not show quite so great an increase as the first interheat, and this rather discourages us from proceeding any further into the region of three or more interheats, as we have already have the figure of 11 per cent. for ideal interheating. The gain due to one interheat is very much greater at moderate pressures than at the highest pressures. This rather signifies that the scheme may be of some value to old



Figs. 1, 2 and 3.—Effects on Efficiency of Pressure at which one Interheating is made in Expanding from 500 lb. (abs.) to Vacuum.

stations which have perfectly good plant only suitable for moderate steam pressure.

Inquirers into the future will have probably turned their thoughts in two directions. One will be the use of a working fluid which has a greater ratio of latent heat to specific heat than in the case of steam. Another direction in which the working fluid could be modified is that its evaporation line should be at a high temperature for a given pressure, provided always that condensation can easily be obtained at a moderately low temperature. In this direction again mercury perhaps offers advantages. The other direction which inquirers will take is probably that of a double-fluid engine. This is a scheme of interheating but with change of fluid whereby the rejected heat of the first fluid is at such a temperature as to be able to evaporate the second fluid. The idea is of course very old and has been explored by using reciprocating engines with steam together with sulphur-dioxide as a second fluid. Other vapours at low boiling points have been suggested. Quite recently, too, all engineers have been much interested in the account given of the Still engine which proposes a double working fluid, first air and then steam. As regards the air part of the cycle, of course, quite good efficiencies are already obtained in the plain gas engine, and gas engine designers have often considered the question and have generally come to the conclusion that the gain in power by adding the steam cycle did not justify the extra complication of the engine, especially as they have been able to find many ready users for the exhaust heat in process work.

With regard to the efficiencies now obtainable with plain gas engines, the efficiency obtainable from the actual working fluid compared with that obtainable from an ideal working fluid is in the ratio of 0·71 to 0·88, that is about 80·6 per cent. This is a much greater difference than perhaps is usually appreciated by steam engineers. If we compare the case of ideal interheating at 500 lb. with the ideal Carnot efficiencies based on the temperature range we see that the corresponding ratio is of the order of 78 per cent., which is remarkably similar. Even in the case of plain expansion this ratio is about 70 per cent. Another curious coincidence can be traced in the fact that the explosion pressures are of the order of 450-470 lb. Another coincidence is that, taking into account the value of superheat and its effect on turbine efficiency, a modern turbine of largest size will have an efficiency ratio at the coupling of 85 per cent., which again is remarkably close to the mechanical efficiency of a large gas engine. We may conclude therefore that in the near future the steam turbine may equal if not surpass the gas engine in efficiency, the competition being still more severe in overall efficiency since the efficiency of large boilers in the most modern practice is now showing a margin of nearly 10 per cent. over the corresponding gas producer efficiency. The battle, if any, which may range between these two methods of producing power in the future may turn on the direct total utilisation of their rejected heat, which is still unfortunately under any system of the order of 60 to 70 per cent. It is along these lines one looks for progress rather than in further improvement of the efficiency and there are already signs that a vigorous interest is being taken by engineering economists in questions arising out of the utilisation of the rejected heat of both forms of working fluid.

Electric Traction in India.

The Legislative Council of India have adopted a resolution in favour of the electrification of the suburban railways within 25 miles of Calcutta. At present the train service to the suburbs is had and the accommodation for travelling poor.

Sir Geo. Barnes said the Government realised the importance of the subject and had no hesitation in accepting the motion. The electrification of railways in the neighbourhood of the great cities was important because by that means they would increase the capacity of their railways to deal with the suburban traffic and make it more possible for the people who had business within the cities to live outside. A few years ago the electrification of the Calcutta area of the Calcutta Suburban area of the Eastern Bengal Railway was examined at the instance of Government by a firm of electrical engineers from England. The scheme was favourably reported on, but like many other works of high importance it had had to remain in abeyance during the war. The East Indian Railway Company had also under consideration the electrification of their suburban services and there was a proposal to provide a joint power house to serve both the systems or it might be found more economical that all the electricity needed should be provided by some central power house set up by private enterprise. He did not know the views of the Bengal-Nagpur Railway (the third system serving Calcatta) on the subject of the electrification of the suburban lines. He would call together the representatives of the three big railway systems when he was next in Calcutta and ask one or two representatives of the Bengal Chamber of Commerce and of the Bengal National Chamber of Commerce to meet them. The whole question would then be discussed, and he hoped the result would be that some progress would be made. The needs of Bombay were, however, even more urgent for the housing problem there was extremely difficult.

Correspondence.

THE DISABILITIES OF POWER STATION STAFFS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In the Editorial Notes of this week's Electrician you touch on the question of the salaries of power station staffs, and suggest the formation of a trade union to advance the interests of these technical workers. Now, "the work is hard and the remuneration pitiable" for technical men in all but the senior positions in engineering works and factories, as well as in power stations. In most electrical works you will find the real "brain work" done by men who are paid less than workmen, by men who have appearances to keep up, who have to wear clean collars; but who cannot even wear overalls when their duties require them to handle or test dirty material and tools.

But there is a better remedy for this than trades unionism. It lies in the hands of the senior members of the profession, who are themselves directors or managers of engineering concerns. The profession is represented by the Institution of Electrical Engineers; why should not this body arrange a standard of suitable salaries for the younger members, to be adopted by those senior members who are in control of the remuneration of their technical workers? As every electrical firm of any importance has some of its chiefs in the Institution of Electrical Engineers, the result would be a satisfactory scale of remuneration throughout the profession. In addition, it would bring about a *rapprochement* between employer and employed; the technical worker would realise that his chief was safeguarding his interests, and not merely picking his assistant's brain in order to line his own pocket, to which latter supposition the present rates of remuneration certainly "lend verisimilitude."—I am, &c.,

London, W.14, Nov. 15. T. H. Solomon.

THE EDINBURGH CONTRACT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to your comments in your issue dated November 7th, it appears to the writers that you do the Edinburgh Corporation a gross injustice in branding them as the scapegoats in the "Edinburgh Contract." We can hardly conceive any public spirited body following any other course, and, had they done so, public opinion would have had every justification for suspecting them of the grossest corruption. The only part of your article with which we agree is that in which you state:—

> "The whole question, therefore, really depends on the necessity on which we have insisted before, that it is most essential for the whole of the British community, employers and employed alike, to increase their production, to improve their organisation and to adopt the most modern methods of manufacture in order that the price of their commodities may be brought as low as possible."

Anyone who has had the opportunity to observe the manner in which the two respective workmen—British and Swiss—discharge their duties does not need to find a scapegoat. When the British workmen realise that the shop is no place to discuss the previous week's football far into the middle of the week, and prospective football for the remainder of the week, we have no doubt that the British firms will be in a position to quote prices as keen as the Swiss firms. British masters have, however, been exceedingly lax in providing any counter attraction to football, and few workers in any of our large works have more than the most hazy conception of the general purpose and products of the establishments. Considering the controlling interest which a British firm has recently acquired in the Swiss firm, we fear the end to foreign place contracts is not yet over. After all, we think a few such examples as "Edinburgh" will do much to stimulate both the manufacturers and the workers in their efforts to produce their own plant at a cost which will compete with any foreign tender.—We are, &c., Ratepayers.

[If our correspondents had read our Editorial Note more carefully they would have realised that we did not "brand the Edinburgh Corporation as scapegoats." We only remarked that they were the *obvious* (not necessarily the *actual*) culprits.—Ed. *E.*]

Mr. E. J. P. Benn on the "New World."

At the monthy luncheon of the Batti-Wallahs Society held at the Holborn Restaurant on Monday, November 17th, Mr. E. J. P. Benn gave an address on the "New World."

He said we were living in what was known as the period of reconstruction, and in dealing with that subject two questions arose. One was whether we meant to reconstruct the world as it was in 1914 or whether we were endeavouring to create a new world, and the other was did we propose to reconstruct ourselves or only other people? Most of the work done so far seemed to be of a negative character, which was sometimes more useful than positive work. They had destroyed and exploded theories. Outside Whitehall there was hardly a creature who had not come to the conclusion that the theory of Government trade or Government control of trade was futile and unworkable. The theory of Socialism as it was understood a few years ago had also been exploded, and they had done something in the last year or two to rob Socialism of its more dangerous aspects. They were beginning to understand that the common weal could be promoted without robbing the individual of his weal. Collectivism and individualism were not opposing doctrines. The former merely enabled the individual to start from a higher plane. There was a danger in these days of individuals relying upon organisations to do what they should do themselves. Societies and trade unions were only useful in so far as they enabled individuals to make greater use of their individualism. The problem overshadowing all their minds was the great problem of employers and employed. He thought they were going to be assisted to a solution of that difficulty through the third party—industrial managers. One usually spoke of Capital and Labour, and overlooked the third party. The new science called industrial administration had been neglected, particularly in this country. But they would hear more of it in the future, and he thought they would reach by rapid strides the point where it would be realised that through management in industrial administration the opposing forces of Capital and Labour would be brought together. They must set their faces resolutely against the damnable doctrine that the interests of employers and employed were diametrically opposed. There was little hope for the industrial problem unless they started from the other end, believing those interests were identical and striving to bring them together. The whole tendency of modern thought seemed to be to regard profits as some form of crime, but one might as well attempt to run a motor car without a magneto as an industry without a profit. Underlying all this bother about wages, hours and conditions of labour, the division of profits and so on was a revolt on the part of human nature against the curse of Adam—a demand of the human being to get rid of work. They had gone a long way towards getting rid of work in the last century. No one, even if he worked 24 hours a day and seven days a week, could of his own effort produce one tithe of the clothes, food, furniture, houses and other things he used in the course of a day. The problem was how to abolish work at a greater rate than that at which the demand for work increased. As work had been got rid of by scientific development, the needs of civilisation had multiplied, so that a great deal more work was required. The Batti-Wallahs represented an industry which could do more to solve the problem than any political agency, trade union or school of social thought. As the great science of electricity developed so work would be abolished. They had got a long way from human slavery, and would by degrees approach the point where there was no manual work and drudgery to be done. But nothing had been produced by man on this planet without the incentive of personal gain. No wealth was ever produced by any Government or Trade Union, and there was no more chance on this planet for platonic industry than there was for platonic love.

Technical Inspection Association.

An interesting Paper was read at the Society of Arts on the 7th inst. before the above Association by Prof. Baly, C.B.E., F.R.S., on the subject of "The Spectroscope in the Science of To-day." Prof. Baly dwelt upon the importance of the spectroscope in all research work, giving instances of its extended use by three independent groups of scientific men, namely astronomers, chemists and physicists, but the line of demarcation between these respective groups was so defined that very little information as to the work done by any one group was known to either of the others. He urged the importance of the extended use of the spectroscope in all branches of scientific investigation, and he believed the time was approaching when it would be in daily use by the commercial exponents of applied science, as much as by thoese working in the realms of pure science.

Electricity (Supply) Bill.

The Committee stage of this Bill was concluded on Friday last by Standing Board of the House of Commons.

Mr. Swann moved the rejection of Clause 36, which applies Sec. 4 of the Conspiracy and Protection of Property Act, 1875, to electric supply works. He said there was no reason for the clause.

Mr. Shortt protested that there was not the slightest intention of interfering with the right to strike legitimately; but the public could not be at the mercy of lightning strikes in a service like electricity.

The amendment was defeated by 18 votes to 3, and the clause passed.

Clause 40 provides that a special order, before coming into force should remain on the table of both Houses 30 days, and then be operative unless a petition from either House was presented against it. For this Viscount Duncannon proposed to substitute "no special order shall be valid or effective until it has been approved by resolution of both Houses of Parliament."

Mr. Shortt promised to adopt the principle on the report stage in clauses where they would be in more proper order, and the amendment was withdrawn.

On the clause applying the Act to Scotland with various modifications, Mr. John Taylor proposed that "in appointing Advisory Committees under Sec. 4 of this Act the Electricity Commissioners shall appoint a Committee for Scotland."

The amendment was accepted.

Amendments were rapidly disposed of, and all clauses up to 43 were added to the Bill. To Clause 44 (which places all powers under the Bill with the Ministry of Transport) there was an amendment standing in the names of half-a-dozen members for the rejection of the clause. It was argued that the Board of Trade was the body to have charge of such duties, and not a new body like the Ministry of Transport.

The clause was rejected by 20 votes to 4.

On the 13th inst. the Committee considered the remaining amendments and the Bill was ordered to be reported to the House as amended.

Mr. Bridgeman accepted a new clause by Lord Duncannon giving greater facility in winding up to companies acquired by the Electricity Boards, and also one by Mr. Waddington sanctioning the payment from Electricity Board funds of subscriptions to electrical associations and conferences attendance at which would be for the common benefit.

Mr. Neal also proposed a new clause giving the Electricity Commissioners power to sanction the annulment of contracts by undertakers.

But Mr. Bridgeman pointed out that it would enable undertakers, in every case in which they found they had made a bargain which was not profitable, to come to the Commisioners for sanction to cancel contracts thus made. He promised to consider any definite hardships, and see if it was necessary to insert any provision in the Bill. The proposed clause was then withdrawn, and the Bill as amended was ordered to be reported to the House.

British Industries Fair (Birmingham).

Exhibitors and visitors to the Birmingham section of the British Industries Fair (1920) will be pleased to hear that the Committee of Management have succeeded in overcoming their initial difficulty, and have now secured buildings which will provide them with 150,000 square ft. of space for the housing of their exhibits. The trouble in this centre has always been the lack of a building of suitable dimensions, and this has been more fully emphasised as the number of exhibitors has grown, and the problem of accommodating all of them has led to constant expansion in the proposed utilisation of kiosks in open spaces and other means of offering the accommodation. The rapid and successful booking of space has therefore compelled the Committee to make a drastic alteration in their original arrangements, and they are to be congratulated on successfully negotiating for the loan of the extremely suitable buildings which were erected during the war at the Castle Bromwich Aerodrome.

The Air Ministry has consented to the buildings being used for the purpose, and this means that there need be no further irritating limitation of space—that exhibitors showing their products in two or more groups will be able to have the same under their eye as it were without travelling to other locations—and finally that the buyers who have more than one interest will not be called upon to move from one district to another. The site has many natural advantages: the buildings could not be better suited for the purpose, the Station (Castle Bromwich) is practically in the grounds on which they stand, and there are railway sidings for the occupants' special use. We understand the subsidiary arrangements are as under:—The Town Hall—one of Birmingham's historic buildings—will be used as a reception bureau for all buyers visiting the Fair, and here they will be able to obtain all the needed information as to hotel accommodation, transport services, &c. A special service of trains will be run on the Midland Railway from New-street station, and at regular intervals during the whole period of the Fair motorbuses will leave the Town Hall for the Aerodrome, and vice versa.

The object of the Committee has been to make the organisation of the Fair as complete as possible and the new arrangement will enable them to perfect their plans. Some 500 firms have already taken space and within a short time all those firms who have been hesitating will undoubtedly be roped in; hence every firm who is desirous of widening its trade connections should make immediate application for space. Letters should be addressed to the General Manager of the British Industries Fair (Birmingham), Chamber of Commerce, Birmingham.

Federation of British Industries.

At the annual meeting last week Mr. W. Peter Rylands was elected president in succession to Sir Vincent Caillard. The new vice-presidents are Mr. G. C. Isaacs, Mr. Th. Lockhart, and Sir Wm. Pearce, M.P., and in addition the seven retiring vice-presidents were re-elected.

In the course of his address, the retiring president (Sir V. Caillard) referred to the present unrest, and asked why should not the results arrived at after a strike be reached before ? He believed himself that so far as employers were concerned they did not, as a general rule, take their employed sufficiently into their confidence and let them know what was passing in their minds. The National Alliance of Employers and Employed had made greater strides during the past year than during any year of its existence. It had now 30 area (or district) committees in constant activity throughout the country, who, in carrying out the policy of conciliation, had actually been called in on several occasions to prevent and settle strikes. The Alliance was also undertaking a great educational campaign to bring home both to employers and employed the necessity for full co-operation, mutual confidence and increased production. An important development had been the institution (as the result of the Industrial Conference in February) of a National Confederation of Employers' Organisations dealing with labour questions. The Federation had been in communication with the National Confederation with the view of effecting co-ordination between the two bodies, and a satisfactory basis of co-ordination had been reached. The world labour unrest was an international question, and he referred to the preparations that were being made for international action in regard to labour problems.

The relations between our expenditure and income must be radically altered. The next essential was to devise some system of taxation which would yield the necessary funds without discouraging that productivity which the present depleted state of the world's stocks of manufactured articles rendered absolutely indispensable. In his opinion a general capital levy would be disastrous to industry, and the taxation of war fortunes, which at first would seem right, would in practice be impossible to carry out.

Sir Vincent Caillard concluded by congratulating the members on the continually growing weight, power, activity and usefulness of the Federation. Their membership had grown to 189 associations and 943 individual firms, so that directly and indirectly they represented 18,000 firms of a combined capital of some £5,000,000,000.

Transport and Electricity Supply.

In moving the adoption of the annual report Sir Vincent said that, though the Transport Bill had become law, it could not be regarded as satisfactory from the traders' point of view ; but it was, none the less, a great improvement on the Bill originally introduced. The Federation's Technical Committee regarded the Electricity Bill as dangerous to industrial efficiency, and likely to increase, instead of reduce, the cost of power ; but amendments had been secured to it, and others were being pressed, which should do a great deal to mitigate the danger. After a reference to the finance of the Education Act of 1918, he stated that, in regard to the introduction of university-trained men into industry, a scheme had been evolved whereby the Federation would act as a clearing house to which the respective Appointments Boards of the universities might send details of men, who were suitable for industrial appointments, and to which manufacturers could apply to be put in touch with them. A strong committee of the Federation was at present engaged in formulating proposals in respect of excess profits duty, which would be pressed with the full force of the Federation upon the Government. In the matter of oversea trade, an estimate of the value of trade, which the Federation had been enabled to offer to members, was difficult to make, but during the last six months it could hardly be less than £20,000,000 sterling, some of which they knew had been diverted from foreign countries.

Patents and Designs Bill.

This Bill was read a second time in the House of Lords last week. In moving the second reading the Lord Chancellor said its provisions had been framed after the most careful consideration by a special expert committee, consisting of some of the principal legal and expert authorities on patent law, presided over by the late Lord Parker, and it had been examined and approved of by the Advisory Commercial Council of the Board of Trade. The Bill was put forward in the interest of reconstruction and of trade generally, and its main objects were to prevent the abuse of the patent monopoly to encourage and reward inventors, and to secure the earliest possible use of inventions.

Lord Parmoor thought the Bill faulty in many directions. He urged that no remedy against abuse of the monoply right would be sufficient unless it rendered null any contract containing outside conditions which aimed at the domination of particular trades or industries. Was there any provision that a patentee who had suffered, and could show that he had suffered, from the conditions existing during the war, would have a further opportunity of now obtaining some remuneration ? He doubted whether, even in Committee, it could be satisfactorily discussed in their lordships' House. It was too complicated, too detailed, and it required a somewhat large knowledge of preceding law, because there was so much legislation by reference.

Lord Emmott said there were useful provisions in it, and he would be glad to see useful inventions made more use of in this country. But he could not find much in the Bill that really encouraged the inventor.

Electrical Trades' Benevolent Institution.

For the first time since 1914 the festival dinner of the Electrical Trades' Benevolent Institution was held at the Imperial Restaurant Regent-street, on Wednesday, November 12th, Mr. H. J. Cash being in the chair. Owing to the Motor Exhibition, and the consequent difficulty of obtaining accommodation in London, the attendance was disappointingly small, numbering only about 60. Those present included Messrs. C. H. Wordingham, Hugo Hirst, C. E. Spagnoletti, F. H. Nalder and W. R. Rawlings.

Mr. H. J. Cash, in proposing the toast of the "Benevolent Institution," wondered why it was necessary to have a dinner when funds were appealed for. He supposed that a function of this kind formed a centre for the members to meet each other, and was also a means for producing subscriptions. They had had their dinner ; now was the time to produce their money. He did not, however, want to appear to be like the parson who blames the small congregation for not attending church more regularly. The people who must be blamed on this occasion were not those who were present, but those who had stayed away. It was distressing to notice that the contributions made to this Institution were small, and might even be described as petty, compared with the importance of the electrical industry. It was necessary to remember that in every industry there must always be those who were unsuccessful, and it was up to the successful ones to provide funds for their assistance. The funds at the disposal of the Institution at present were not sufficient for that purpose, and he hoped that those who were there that evening would help to get at the absentees, with a view to improving this condition of things. If all those appealed to had subscribed only one guinea the subscription list would be very much greater than it was. Even then the sum obtained would be very far below what could be expected from the electrical industry. He would suggest that follow-up letters should be sent out, and that it should not be thought when a man did not reply that he had necessarily refused. It was important that those who might benefit should subscribe the small sum of 10s. per annum, and thus secure membership.

Mr. Hugo Hirst, in supporting the toast, said that he had always treated the Benevolent Institution seriously, and would gladly do what he could in furthering the appeal that had been made by Mr. Cash. As he had said on another occasion, the struggle for our lives was now over, and the struggle for our living had begun. During the war electrical engineers had distinguished themselves in a way which showed they were second to none. These men were now back in civil life, and were doing their work with a love of their profession and a great sense of duty. These qualities mean that they often exposed themselves to risk, and it should be remembered that much of our prosperity was due to the risks they took in carrying out their work. It was regrettable that a great industry had not done more to support its members. He thought that one way of getting more funds was to approach the various institutions, and also the contractors, not necessarily engaged in electrical work, who were making money out of the electrical industry.

Mr. C. H. Wordingham, also supporting the toast, said that one reason why funds of this kind received petty support was because their necessity was not sufficiently brought home. He suggested that typical cases where relief had been given should be published, to show what work was being done. He also suggested as a matter for consideration the amalgamation of this fund with the I.E.E. Benevolent Fund. From his own point of view, though he was personally in favour of amalgamation, he thought that perhaps it would be best for the funds to remain separate, as more money would be obtained that way.

At the conclusion of the dinner it was announced that the collection which had been made amounted to £888 19s. During the course of the evening Mr. G. E. Taylor put a sovereign up to auction. As, however, all those present were too diffident about taking on the duties of auctioneer, it was agreed to raffle it, tickets being sold at 5s. each. In this way £13 10s. was collected, and Mr. Hextall, the honorary solicitor of the Institution, was the winner. Mr. Hextall then put the sovereign up to auction, and it was first bought by Mr. Hunter for £15, next by Mr. Hirst for £20, next by Mr. Hawes for £6, and was finally bought in by Mr. Taylor for £5. This species of trading in the current coinage of the realm therefore realised £59 10s. for the funds of the Institution.

Trade Marks Bill.

This Bill has been read a second time.

Lord Emmott said that certain Chambers of Commerce urgently desired the omission of the words "without search" in the provision enabling the registrar to refuse an application for the registration of a trade mark in Part B of the Register if it appeared to him without search that the application was inconsistent with the provisions of sec. 11 or sec. 19 of the principal Act. Commercial people who had considered the question said they would prefer paying a higher fee to dispensing with the search. The strongest objection was also raised by large groups of commercial men to the amendment proposed of sec. 62 of the principal Act, which would omit examination of the goods passing under an association trade mark. The chief point of an association trade mark ought to be a guarantee of quality.

The Lord Chancellor did not think it was intended to dispense with examination. It was insisted in the schedule that the Board of Trade should satisfy itself of competence of the association to judge of quality.

Legal Intelligence.

Carriage of Goods on Tramways.

At Wednesbury County Court last week Mr. C. K. Edwards sued the Birmingham and Midland Tramways Joint Committee for £29 15s. damages for loss of a parcel of goods in transit from Birmingham. The company disclaimed responsibility for the loss of or damage to goods exceeding £5 in value (which was a condition of the contract), and the Judge held that this was one of the terms of the contract. As this sum had been paid into court he gave judgment for the defendants with costs.

British Thomson-Houston Company v. Corona Lamp Works.

On Monday, before Mr. Justice Russell, this case was mentioned by Mr. Kerly, K.C. (for defendants), who asked that the action should not be tried at this sittings. He said the pleadings were closed in 1917, but notice that the trial had been set down was only given to defendants in July last, and their experts had since been engaged on a forty-day case in that division. The present case, which related to electric lamps, entailed delicate experiments, involving (amongst other things) the life of the lamp, and they had to run over a long time. There was also a difficulty in getting the material.

Mr. COLEFAX, K.C. (for plaintiffs) opposed the application. Plaintiffs were ready to proceed. He failed to see how any experiments could be relevant to any issue at present raised in the case. He would agree to a postponement to Dec. 2.

His LORDSHIP said the case had better go over until next sitting, in order to give the experts an opportunity to complete their experiments and evidence.

C. A. Ohlson v. Cowpen Coal Company.

At Newcastle Assizes last week, Mr. Justice Lawrence heard this action, brought by plaintiff for the recovery of damages for the loss of his son, George Andrew Ohlson (16). In December last plaintiff's son was going to work at Delaval Colliery, and passed along a colliery line owned by defendants, which was a commonly used short cut. Standards along the line carried electric power cables, and at a lower level telephone wires. The telephone wires were under repair, and one length was hanging down in wide curves. The boy caught hold of a strand and sustained a shock which killed him. It was suggested that that constituted a hidden danger for which defendants were liable, especially as they had taken no steps to prevent people using the line.

Evidence was called by defendants to show the wire must have been tampered with, because there was no current on the telephone wires, and current could only come into them by their being thrown over the power wires above. It was also contended that the boy was a trespasser on the colliery line, and, even if habitual user could be construed into a licence there was no evidence of a breach of duty by defendants.

The jury found that the boy was a licensee, but that the wire did not constitute a concealed danger, nor was there any negligence on the part of defendants.

Judgment was accordingly entered for the defendants.

Telegraph Companies' Dispute.

The dispute between the Direct United States Cable Company, Ltd., and the Western Union Telegraph Company concerning the lease of the former Company's transatlantic cable for 99 years at a yearly rental, was before Mr. Justice Peterson on the 13th inst. and was adjourned until next term for evidence from America.

Mr. Mark Romer, K.C., Mr. Patrick Hastings, K.C., and Mr. Whinney appeared for plaintiff company; and Mr. Maugham, K.C., Mr. Douglas Hogg, K.C., and Mr. Tyldesley Jones for defendants.

Mr. ROMER stated that the object of the action was to obtain relief under the Defence of the Realm Act. The plaintiff company owned one of the transatlantic cables connecting this country with the United States, and in March, 1912, it granted a lease of that cable to defendant company (an American Corporation) for 99 years at a rent exceeding £58,000 a year. The lease contained a covenant by the lessors to repair and renew the line and maintain through communication. To ensure this being done penal clauses were inserted and power was reserved to the lessees in the event of continuous interruption for 18 calendar months to give notice determining the lease. Interruptions had taken place and notice to determine the lease had been given. The case for plaintiff company was that it was prevented from effecting repairs and restoring communication by reason of the control exercised by the Admiralty during the war over the only available cable-repairing ship.

Mr. MAUGHAM contended that even if plaintiff company was able to establish that it had used its best endeavours to repair the cable, and that either owing to the war or repeated storms or any other reason it was unable to do so the mere physical fact that there had been that continuous interruption gave defendant company the right to determine the lease. It was alleged that between March 1, 1912, and Oct. 31, 1919 —some 2,800 days—through communication had been possible only on 1,378 days, a percentage of 49·2. The breaks were primarily due to the age of the cable, which was laid in 1874.

The hearing was adjourned to enable defendant company to bring witnesses and records from America to prove the interruptions.

Commercial Topics.

Import and Export Licences.

The Export Licence Department has been amalgamated with the Department of Import Restrictions at 22, Carlisle-place, S.W. 1. The combined Department will be under the charge of the Assistant Secretary, Industries and Manufactures Department, Board of Trade. Applications for licences in respect of commodities (except dye-stuffs and coal) and all inquiries relating thereto should be addressed to the Director of the Imports and Exports Licensing Section, Board of Trade, 22, Carlisle-place, S.W. 1.

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Trade With Turkey and Bulgaria.

It is announced that the special list D. of articles prohibited from export to Turkey, Bulgaria and Black Sea ports, covering many specified kinds of war materials, was abolished on Nov. 14. List E was also abolished, and the articles specified in it—namely, vehicles and articles used for land transport, telegraphs and telephones, and materials needed in connection with them, may now be freely exported to Bulgaria without licence. Of the large number of articles included in list D all are now freed for export except armoured motor cars, implements and apparatus designed exclusively for the manufacture of munitions of war, &c. These excepted articles are under a stricter formal prohibition from export than before.

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Provisional Order Applications.

Though several local authorities and companies have expressed their desire to apply for provisional electric lighting orders in the 1920 Session of Parliament, the Board of Trade have intimated that they are not prepared to consider such applications. No doubt this decision is due to the rapid progress recently made with the Electric Supply Bill, which it is anticipated will be passed by both Houses of Parliament before the end of the current Session. As soon as the Bill becomes law it is proposed to appoint the Electricity Commissioners and to set up at once necessary administrative arrangements for carrying out the provisions of the Act. In this event the procedure to obtain electric supply powers will be simplified and cheapened, and it will not be necessary to submit orders to Parliament for confirmation.

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Consolidation of Electric Manufacturing Interests.

The announcement that the English Electric Company have bought the Siemens works at Stafford marks a further important stage in the development of the policy of the English Electric Company, which, as formed early in the year, represents the consolidation of the interests of Messrs. Dick, Kerr, the Coventry Ordnance Works, Willans & Robinson and the Phœnix Dynamo Company. The comprehensive scheme of the amalgamation aims at not only the ability to undertake contracts of any magnitude or description in world-wide competition, but scientific sectionalising of the various manufactures of the group, with a view to the maximum efficiency in production at the several works in Preston, Coventry, Bradford, Scotsoun, Rugby and Stafford. A working agreement which has been entered into between the English Electric Company and Siemens Brothers & Company provides for the preferential exchange of the special products of each, and thus both companies will benefit, as both now command the supply of a greater variety of manufacture than hitherto.

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British Trade in Germany.

In a proclamation by General Sir William R. Robertson, Commander-in-Chief of the British Army of the Rhine, regulations are made respecting trading in the British occupied zone in Germany. The proclamation, which applies to all persons in the British occupied zone, except those belonging to the Allied armies, states that whilst the import and export of goods are, as heretofore, free, yet such goods and the persons dealing in them on arrival in the British occupied territory are subject to the existing German laws regarding the protection of commerce, etc. Allied subjects have the right to bring actions against other Allied, neutral or German subjects before the existing German courts. All persons whether principals, representatives, or agents, trading in the British occupied area must be in possession of a trading certificate, where such is required by German law. The British authorities reserve the final decision as to granting or refusing such certificates.

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International Exhibition at Barcelona.

An interesting International Business Oragnisation Exhibition will be held in the Palacio de Bellas Artes, Barcelona, from the 2nd to 12th April, 1920. The King of Spain is Honorary President, and the British Chamber of Commerce for Spain has also been offered an Honorary Presidency. The exhibition, which it is proposed to hold annually, will be divided into four groups, as follows:—(1) Steel and wooden office furniture, interior decoration of offices, office fittings, etc.; (2) typewriters duplicators' calculators, dictaphones, telephones, mechanical clocks; (3) account books, auxiliary books, commercial, industrial and banking publications and advertisements, etc; (4) industrial and commercial advertisements, luminous signs, etc. Exhibitors will be accepted up to the 30th January, 1920. British firms, who are contemplating entering this market should find this an excellent opportunity for introducing their goods in Barcelona, the most important industrial and commercial centre in the Peninsula. Further details can be obtained from the Secretary of the British Chamber of Commerce, Rambla de los Estudios, 8-30, or from the temporary offices of the Exhibition, Calle Aribau, 21, pral., Barcelona.

Electricity Supply.

NUNEATON Council has adopted an increased scale of charges for large electric power consumers.

A sanction to a loan of £3,000 has been applied for by ST. ANNES' Council for electricity services.

ATHY (Co. Kildare) Council has appointed Mr. S. McEntee, M.P., as consulting electrical engineer.

PONTYPRIDD Electricity Committee has decided to proceed with the electric lighting scheme for Cilfynydd.

The Powell Duffryn Company is sinking a new colliery at Deri, about two miles from BARGOED, South Wales. The whole of the machinery will be worked by electricity.

DUNDEE Electricity Committee has decided to purchase a dictaphone installation at £98 15s., and a Gammeter multigraph printing machine at £213, for the City Electrical Engineer's office.

It is proposed to establish an electric supply station for PEWSEY and district (Wilts) and engineers are invited to submit proposals. Particulars from Mr. Arthur J. Phillips, Victoria House, Pewsey.

Owing to the bad gas lighting, the CARDIFF Board of Guardians have asked the Building Committee to consider the question of lighting the City Lodge electrically, which is said to be the only institution of its kind in Wales that is not lit by electricity.

The Blackburn Board of Guardians have been advised to adopt electric lighting at their institution. Gas lighting cost £942 for the year ended Sept. 30 last, exclusive of mantles, and it is estimated that a saving of 25 per cent. can be effected by the change.

CANTERBURY City Council has applied to the Ministry of Health for a loan of £20,000 for the provision of a 1,000 kw. turbine set, transformers, &c.; and Messrs. May & Hawes have been instructed to prepare the necessary specifications and obtain tenders.

OLDHAM Council are asked to approve of certain provisional contracts for work required in a large scheme of electrical extensions and to apply for sanction to borrow £150,000 to cover the cost of providing additional electrical plant in accordance with estimates prepared by Mr. Robert Blackmore, consulting engineer.

The Mayor of NELSON (Ald. J. Rickard), in a speech last week, foreshadowed developments at the local electricity works, and said it was proposed to re-model the method of generation, and to increase six-fold the capacity of the station, which would supply electric current to Nelson, Colne, Brierfield and Barrowford.

Ald. Dagnall and Ald. Walker have been elected chairman and vice-chairman of the MANCHESTER Electricity Committee. The demand for electricity is increasing at a rapid rate. In the course of last month there were 750 applications for electric current, but only 350 could be met. The Committee, which reports a scarcity of skilled workers and difficulty in getting plant, is advertising for two 25,000-kw. turbo-alternators, four boilers and other plant for the new Barton station.

The BIRKDALE District Electric Supply Company has increased charges for current as follows: Private lighting, 8d. per unit; heating, power, &c., 2½d. per unit; business premises lighting, on maximum demand system, 8d., 6d. and 4d. per unit, plus 15 per cent.; heating, power, &c., 2½d. per unit; special prices, 5½d. per unit; meter rents, 2s. 6d. per quarter.

Owing to the recent breakdown of a turbine set the BRADFORD electricity department has had to make an appeal to consumers to exercise economy in the use of electricity, and particularly for heating and cooking purposes. They are requested not to use electric radiators and cooking apparatus between 3.30 and 5.30 p.m. between Friday and Monday, inclusive.

BURLEY Council has referred to the Gas Committee a proposal by an Eccles engineer to establish hydro-electric works for supplying electricity in the district. The engineer states that he can provide electricity at ⅝d. per unit, in addition to saving 5,000 tons of coal yearly. If he did accomplish this by harnessing the available water power now running to waste in the locality his fee would be 35 guineas; otherwise he would not claim a fee.

At a meeting of electricity consumers in GUILDFORD a resolution has been passed asking the Town Council to take into consideration the question of acquiring the undertaking of the Guildford Electricity Supply Company. It appears that there has been a breakdown on one of the generating sets, and owing to the difficulty of getting new plant, restrictions upon the supply have had to be imposed. The use of current for power is forbidden between the hours of 2 p.m. and midnight until further notice.

In moving the adoption of the annual accounts of the electric supply and tramway department for the past year Ald. Sir Chas. Sturmer stated at last week's meeting of DARLINGTON Town Council that that was a net profit of £3,538 9s. 5d. on the electricity department, and a loss of £126 16s. 6½d. on the tramways. In regard to the cost of electricity per unit, Sheffield and Stalybridge were the only two towns lower than Darlington, which also tied with Bolton for first place for the least coal cost for each unit generated. The three towns in question had a far larger output, and Darlington's position was a tribute to the efficiency of its undertaking.

The accounts of the ABERDEEN electricity department for the year ended July 31, 1919, show revenue £109,219 (compared with £103,316 in the previous year), working expenses £65,305 (£58,502) and special expenditure £887 (£1,328). Interest required £14,128 (£13,839) and sinking fund £21,025 (£19,625), leaving a surplus of £7,872 (£10,022), which has been placed to reserve. Units generated were 19,815,610 (20,276,880) and sold 16,368,054 (17,408,147). Motors connected aggregate 18,684 H.P. (increase 1,829 H.P.), and the number of heating and cooking utensils hired out is 1,721 (increase 123). Total costs per unit sold were 0·909d. (0·767d.). The maximum load was 7,744 kw. (7,459 kw.) and load factor 24·13 (26·64) per cent.

Mr. H. K. Beale has been appointed chairman of the BIRMINGHAM Electric Supply Committee in place of Mr. J. B. Burman, who was not elected at the recent municipal election.

Owing to the consumption of electricity having lately come so near the full capacity of the plant, the electric supply department has agreed to connect new consumers only on the understanding that power shall not be used except at periods when the normal load is at its lowest—during the night and in the early morning. Some agreements permit the installation of motors and other apparatus on condition that the Corporation might at any time cut off supplies. The department has found it necessary to notify consumers with conditional agreements to cease using current between 3.30 p.m. and 5.30 p.m., but in some cases this prohibition applies only to a portion of consumer's plant which has been recently installed. In these cases, however, manufacturers can maintain their production by starting earlier in the morning or working into the evening. Mr. E. J. Jennings, the secretary of the department, states that the order is essential if a safety margin is to be maintained. The new generating plant will probably not be available before the end of 1920.

The accounts of MAIDSTONE electricity supply department for the year ended March 31 show revenue £31,341 (compared with £26,630 in previous year), and gross profit £7,539 (8,030), and after providing for capital charges the net result was a deficit of £176 (compared with a profit of £745). Total maximum load was 1,643 kw. (as in previous year) and load factor 33.6 (32.8) per cent.

Mr. E. E. Hoadley (engineer and manager) reports that the bald statement that revenue failed to meet outgoings by £176 conveys an erroneous idea of the state of affairs, the deficit being due to restrictions imposed by the war, loss of business caused by the armistice, the expenditure of nearly £1,500 from revenue on work of a capital nature, etc. The industrial power demand account for 77 per cent. of the energy sold. Total costs per unit sold were 1.364d. (1.079d.) exclusive, and 1.84d. (1.531d.) inclusive of capital charges. In regard to the Electricity Supply Bill, Mr. Hoadley states that "provided the Maidstone Electricity Supply Committee has the courage to adopt a wide and far-seeing policy Maidstone should very shortly become a place of considerable importance electrically, for it is intended that Maidstone shall be a generating centre for years to come, and neighbouring towns will be supplied in bulk from there."

In our issue of 22 August we give some particulars of the Glasgow Corporation Peace Day illumination scheme including, we learn that for the FLOOD-LIGHTING of the beautiful municipal buildings. Seventy-six B.T.H. floodlight projectors, each containing a 1,000 watt half-watt type lamp, were employed. The batteries of projector units were placed on the roofs of buildings opposite, and were so arranged that the whole façade of the City Hall was uniformly and very brilliantly illuminated. Ten of the 76 lamps were used for lighting the central tower. This installation is believed to be the first of its kind in this country. The floodlight projectors are to be retained by the Corporation, and will be used in future for a variety of municipal purposes, such as night construction work, fire salvage, street patrols, etc. One fact emerges clearly from the Glasgow scheme, and that is the tremendous spectacular value of flood lighting, especially in the case of large public buildings and memorials. Why should not places of historical interest or great beauty such as the Whitehall Cenotaph, Westminster Abbey, and other public buildings and monuments—be illuminated at night, so that their significance should not be obscured at a time when most people are in the mood, and have the necessary leisure, for artistic indulgence? Readers interested in the question of flood-lighting should communicate with the British Thomson-Houston Company, Ltd., 77, Upper Thames-street, E.C.4.

Electric Traction.

Tramway authorities in LANCASHIRE are already being asked by their employees not to run a service of cars on Christmas Day.

DUNDEE Tramways Committee has accepted a tender for the erection of new tramcar sheds at the Mayfield depot.

Ald. Bowes and Ald. Chapman have been elected chairman and vice-chairman respectively of the MANCHESTER Tramways Committee.

The Sheriff (Mr. A. Digby Willoughby) succeeds Colonel James Walker as Chairman of the HULL Tramways Committee, with Mr. Richardson as deputy chairman.

MIDDLESEX County Council will seek Parliamentary power to allow the Council to own and run omnibus services, and to construct a new tramway from Bridge-terrace to Cricklewood.

Owing to the recent award of the Court of Arbitration PORTSMOUTH Tramways Committee propose to increase the fares, which have not been raised during the war, by 50 per cent.

The freedom of the borough, enclosed in a silver casket has been presented to Ald. T. Baker, chairman of the PLYMOUTH Tramways Committee, and Mrs. Baker was presented with a silver rose bowl.

ST. ANNES-ON-SEA Urban Council is making arrangements for the purchase of the local lines of the Blackpool, St. Annes and Lytham Tramways Company, and Mr. J. B. Hamilton, of Leeds, has been retained to report upon the system.

In a report by Mr. J. Ferguson, of Glasgow, it is stated that a large section of the rails and some of the cross-overs of the Ayr tramways require immediate renewal. The cars, although in need of considerable repair, are in fairly good condition, but several of the metal poles are in a dangerous condition.

Swansea Corporation decided on Monday to abandon the proposal to make certain extensions of the municipal tramways. The Joint Tramways Committee reports that to construct tramways at present would cost £45,000 a mile, including street widening, and therefore it has been decided to obtain powers to supply those and other routes with omnibuses.

The Advisory Committee on London Traffic, of which Mr. Kennedy Jones, M.P., is chairman, has, with the approval of the Minister of Transport, appointed a technical sub-committee of 18 experts to consider and recommend immediate steps which can be taken to remove the congestion existing in London traffic. Sir Alexander Gibb will be chairman of the sub-committee.

At the end of 6½ months' working of the Plymouth tramways there was a profit of £8,054 after meeting all expenses and carrying out permanent way repairs. The number of passengers carried was more than 2½ millions in excess of those carried in the corresponding period of last year. Mr. C. R. Everson has retired from the position of tramways manager, and the new manager has assumed his duties.

In a short article in the "Evening News" of the 13th inst. on the question of adopting ELECTRIC TRACTION on STANDARD RAILWAYS, Major-General Sir H. Thornton, general Manager of the G. E. Railway Company, states that as far as his company is concerned, they must electrify in order to increase their suburban carrying capacity sufficiently to meet the public requirements. Under the present steam system they cannot run any more trains in and out of Liverpool-street Station during the rush hours than are being operated now.

In the House of Commons last week the Minister of Transport was asked whether he was aware of the delay to workers at the various London Tramway Termini each evening, and whether he was taking measures to prevent the inconvenience and overcrowding. In reply Sir R. Williams said the Minister had no power to control municipally owned trams, but all measures for relieving congestion and overcrowding, whether of trains, buses, or trams were engaging the attention of the Advisory Committee of London traffic.

The London County Council has passed an estimate of expenditure on capital account of £3,000 in respect of alterations to the coal bunkers and the completion of the coal shoots at the Greenwich power station.

On Tuesday the Highways Committee reported to the Council that H.M. Office of Works had stated that they were opposed to the proposal to construct a tramway in Hyde Park from Victoria Station to the Marble Arch, but before coming to a definite decision they desire to have the advantage of the views of the Minister of Transport, but they could not authorise the posting of notices in Hyde Park announcing the Council's intention to seek Parliamentary powers. Paddington and Westminster Borough Councils are also opposed to the new tramway scheme of the L.C.C.

Bournemouth Tramways Committee, which has been considering the relative merits of tramways and motor omnibuses has decided not to entertain a suggestion to adopt omnibuses. The tramway manager (Mr. J. Bulfin) has reported that an omnibus could be obtained for about £2,000, and a tramcar would cost about £3,000. The life of an omnibus was about five years, and that of a tramcar 15. The accommodation of an omnibus was for 38 persons, or, if crowded, 48; that of a tramcar was 64, or, if crowded, 80. The cost or running per mile was 2s. 2d. for an omnibus against 1s. 1d. for a tramcar.

Ald. E. Russell Taylor was re-elected chairman and Ald. F. Smith deputy-chairman of the Liverpool Tramways and Electric Power and Lighting Committee last week. In returning thanks for his re-election Ald. Taylor said he looked forward to the coming year with some anxiety. The revision of the tramway stages would occupy their attention, and they would also have to consider at an early date the question of tramways versus omnibuses, and the re-instatement and repair of the track. Workmen's fares, the carrying of school children and the question of contracts would also come up for discussion. The continued progress of the Corporation tramways was evidenced by increases in receipts and passengers carried. From the 1st January to the 8th inst. the increases are—in receipts, £182,582 in passengers 11,850,630, and in car mileage 638,024, the respective totals being:—Receipts, £995,987; passengers, 178,932,960; and mileage, 11,109,350.

It is expected that within the next few weeks arbitration proceedings will take place in connection with the transfer and sale of the Oldham, Ashton & Hyde Electric Tramways Company's lines to the local authorities. The Stalybridge, Hyde, Dukinfield and Mossley Joint Tramways and Electricity Board are taking over some portions of the system, and there is a hope that after the transference and the linking up of Hyde with Manchester, the financial position will be improved. The Board's electricity department has in recent years made good progress, and there is now a prospect that the Board will soon be able to set aside a sum for the relief of rates of the four boroughs. The original capital expenditure of the Board's electricity department was £185,000, and to-day it is £362,000, but £140,000 has been redeemed by means of a sinking fund, and during the same period the sum of £22,000 has been spent out of revenue of plant. Extensions are in progress to increase the output of the generating station by 9,000 kw. to 12,000 kw., and already contracts have been entered into for the supply of all the increased production. The board are contemplating the erection of a new generating station at an approximate cost of £250,000. Many mills and workshops are taking electricity from the Board for power and lighting.

Imperial and Foreign Notes.

The Municipal authorities of Kingborough (Tasmania) have guaranteed the State Hydro-Electric Department a revenue of £500 a year if it extends its electric mains to the town.

The New South Wales Government Railways and Tramways Department require tenders by noon Jan. 14 for 70 three-phase induction motors for terminal wheat elevator (specification 518). Specification, &c., from the Electrical Engineer, 61, Hunter-street, Sydney.

The Rivadavia (Argentina) Municipality propose to establish electricity supply works.

The Electric Welding Company of Argentina has also been formed to acquire from Mr. Schenstrom patent rights for a special system of electric welding, &c.

The Marconi Wireless Company has submitted a proposition to the Brazilian Government to construct receiving and transmitting stations at Rio de Janeiro and Belem (Para).

The Government of the Republic of Venezuela recently invited tenders for the erection of a wireless telegraph station at Caracas capable of communicating with similar stations in Europe and the United States.

It is announced that land for a cable station has been acquired in Barbados by the Western Telegraph Company in connection with the proposed submarine cables from Brazil to Barbados and to New York.

In connection with the proposed electrification of the Central Railway of Brazil, it is reported that an Anglo-Italian syndicate has submitted an offer to the Brazilian Government to undertake the work, and a French syndicate has also submitted a competitive proposition.

The Japanese Government railway department has decided to construct a submarine railway tunnel under the Moji-Shimonoseki Straits, connecting the island of Kinshu with the main island of Japan. The cost is estimated at 20,000,000 yen, and the railway will be operated electrically.

Owing to the difficulty of obtaining fuel the Alpin Montan Gesellschaft of Vienna, the principal coal and iron and steel company in German-Austria, proposes to utilise water-power for the generation of electro-power. It is hoped to dispense with the use of coke in the blast furnaces and to replace them with electric reduction furnaces for the smelting of ore. Two of the technical chiefs of the Company (H. Backstrom and A. Zahlbruckner) are visiting Sweden in order to inspect the electricity generating stations and works where iron ore is smelted by electricity. In ordinary times the total production of the company's works was from 600,000 to 650,000 tons of pig-iron per annum, apart from the output of finished articles.

Miscellaneous.

The Mansfield magistrates have sentenced Harry Hayes, chief clerk and collector of Mansfield Corporation Electricity Committee, to six months' imprisonment for embezzling money belonging to his employers.

The members of the Swansea Corporation electricity department staff held their annual dinner last week. Mr. J. W. Burr, borough electrical engineer, presided, and among those present were the newly-elected Mayor, Col. Sinclair, who has been Chairman of the Electricity Committee for many years.

The Postmaster-General has made arrangements with the Swedish Government for a WIRELESS SERVICE, supplementary to the cable service between this country and Sweden. Messages intended for it should be marked "via wireless" and handed in at a post office. The rates are the same as by cable.

The Old-street (London) Police Court magistrate has committed Alfred Woods, electrical engineer, for trial, on a charge of stealing a 5½ H.P. Century electric motor valued at £100, the property of Messrs. McGlennon & Company. Defendant was entrusted with the overhauling of certain electrical motors, and afterwards it was noticed that machines to which the motor mentioned had been fitted were not being driven satisfactorily. The firm called in an electrical expert, who found that a 3½ H.P. motor had been substituted for the one the man was supposed to have overhauled. The defence was that the substitution was an accident.

A number of constructional firms who are devoting special attention to housing schemes are represented at the Public Works Exhibition in the Royal Agricultural Hall, which opened on Thursday. On the closing day (Nov. 27) Dr. Addison, the Minister of Health, will address a housing conference of members and officials of local authorities, which has been arranged by the Institution of Municipal and County Engineers. This Exhibition is being held simultaneously with the Roads and Transport Congress and Exhibition, initiated by the County Councils' Association, which was opened by Sir Eric Geddes, Minister of Transport. The whole of the available space has been filled with a collection of exhibits of exceptional interest to local authorities, engineers and architects. Both exhibitions have been organised by Mr. A. F. May, managing director of the Municipal Agency, Ltd.

In reply to a question in the House of Commons on Tuesday the Assistant Postmaster-General (Mr. Pike Pease) stated that permits for establishing WIRELESS RECEIVING STATIONS for experimental purposes had been issued for some time past, and a limited number of transmitting stations had also been authorised in cases where the installations were required for experiments of a special nature. General regulations had been framed for the issue of permits for experimental transmitting stations. It was necessary to secure that installations shall be so constructed and worked as not to interfere with the working of naval, military and commercial stations.

The British Science and Key Industries Exhibition, at Glasgow, which has been organised by the Glasgow Corporation, was opened on Monday by Sir Charles A. Parsons. It has been arranged in order to demonstrate what has already been done in applying the latest scientific discoveries and research to the production of substances not previously made in this country, and it is claimed that the range of exhibits exceeds in importance similar exhibitions which have been held in London. There are about 160 different firms exhibiting, and we hope to give some particulars of the exhibits in an early issue The exhibitors include Messrs. Siemens Brothers & Co., Ltd. and Messrs. Vickers, Ltd., and there are many interesting electrical and chemical displays, including a noteworthy section relating to wireless telegraphy and telephony.

The Midland Electrical Engineers' Ball, which was held at the Grand Hotel, Birmingham, on the 13th inst., proved to be a much greater success than any which have taken place on previous occasions. No less than 325 guests assembled, and amongst these were many who came from distant parts of the country. Excellent arrangements were made for the comfort and general enjoyment of the guests by the hon. secretary (Mr. G. J. Bish), and the expressions of appreciation which were heard on all sides augur well for the success of future dances.

An opportunity was taken during the supper interval of making, on behalf of the Committee, a presentation to the eldest daughter of the chairman, Mr. R. A. Chattock and Mrs. Chattock, whose birthday happily coincided with the date of the Ball. Mr. Archibald Joyce's Orchestra proved a great attraction, and induced many of the older members of the electrical fraternity to compete with their younger brethren in treading the modern measures that are now so much the vogue. Many applications in excess of the accommodation were received, and the Committee wish to express their regret at the disappointment which was incurred on this account.

An interesting review of existing industrial conditions in Yorkshire Lancashire, &c., is given in "The Industrial North," which was recently published by the "Yorkshire Observer" (at 1s. 6d.). There are several important articles on industrial and economic problems, including "Profit Sharing and Co-partnership," by Lord Leverhulme; "Harmony and Efficiency," by Mr. H. S. Smith; and "Science in Industry," by Sir Alfred Keogh. There is the report of an interview with Sir A. Duckham on the coal question, and also an article by Prof. Kendall on the coalfields of South and West Yorkshire, while the editor of the "Electrical Times" supplies a thoughtful and well-written article on the "Electricity (Supply) Bill and the Manufacturers." There are a number of special trade articles which deal in an authoritative manner with local industries and trades. The publication, which is well illustrated, is a very creditable and useful production.

Tenders Invited and Accepted.

Particulars and forms of tender from the Clerk of the Council, County Hall, Spring Gardens, S.W.1, and tenders by 1 p.m. Dec. 9.

Dublin Electricity Supply Committee require tenders by Nov. 26 for supply of 20,000 yellow flame arc lamp carbons (7·5 mm. × 25½ in.).

Bolton Corporation require tenders by noon Dec. 10 for e.h.t. switchgear for their Back-o'-th'-Bank generating station. Specification, &c. from the Borough Electrical Engineer.

London County Council invite tenders for overhead electrical equipment, l.t. electric cable, and laying stoneware ducts, etc., in connection with the reconstruction of the Lea Green and Eltham tramway.

The directors of the Sligo, Leitrim & Northern Counties Railway, Company invite tenders (by Dec. 1) for Stores, including Electric Telegraph Materials. Tenders to the Secretary, Enniskillin.

The Cheshire Lines Committee require tenders by 10 a.m. Nov. 26 for one year's supply of stores, including telegraph materials, carbons, oils, &c. Specifications from the Stores Superintendent, Warrington.

Tenders are invited for cement plant machinery, electric power plant) motors, etc. Plans may be inspected and particulars obtained from Messrs. Rees & Company, Consulting Engineers, 16, Clifton-gardens, London, W.9.

Tenders are invited for the supply at the Davyhulme Sewage Works, Urmston, of three 30 h.p. three-phase induction motors, &c. Specification from the Secretary of the Rivers Department, Town Hall, Manchester, and tenders by Dec. 1.

H.M. Commissioners of Works invite tenders (by 11 a.m. Nov. 28, for the supply of incandescent electric lamps for 12 months. Forms of tender, etc., from the Controller of Supplies, King Charles-street, S.W.1, and tenders to the Secretary, Storey's-gate, Westminster, S.W.1.

A head of the engineering department of Darlington Technical College is required. (Salary according to qualifications, rising to £450 per year); also a lecturer in physics (£160, rising to £350). Particulars from the Director of Education and applications by Dec. 6.

The Tyne Improvement Commissioners require tenders by Nov. 24 for 6 or 12 months' supply of incandescent lamps, arc lamp carbons, metals, ironmongery, oils, &c. Forms of tender from the Manager and Secretary, Bewick-street, Newcastle-on-Tyne.

The directors of the Great North of Scotland Railway Company require tenders by 10 a.m. Nov. 27 for six or 12 months' supply of various stores and materials, including telegraph material, ironmongery, &c. Forms of tender from the Stores Superintendent, 80, Guild-street Aberdeen.

Walthamstow Urban Council invite tenders for the supply and delivery of c.i. circulating water pipes, e.h.t. and c.t. cables and an engine-room crane. Specifications from the electrical engineer (Mr. G. R. Spurr), and tenders to the Clerk by 5 p.m Nov. 26.

Merton and Morden Urban Council invite tenders for the supply of two 2-ton electrically-driven dust vans and the installation of a motor-generator at their depot. Forms of tenders, &c., from the engineer and surveyor, Mr. G. Jerram, A.M.I.C.E., and tenders to the clerk of the Council (Mr. C. J. Mountifield), Council Offices, Kingston-road, Merton, S.W.19, by noon Nov. 28.

Tynemouth Corporation invite tenders for the supply of some three-core insulated lead-covered cable for 6,600 volts, four pair paper-insulated lead-covered telephone cable and three-core cable carrying conductors for Merz-Price protective gear. Specifications, &c., from the borough electrical engineer, Mr. C. Turnbull, and tenders to the town clerk, Mr. Stanley Wilson, by Dec. 1.

Manchester Electricity Committee invite tenders for the supply, delivery and erection at their Barton Power station of two 25,000 kw. and two 1,000 kw. three-phase turbo-alternators, with condensing plants; four 1,000 lb. water-tube boilers for a working pressure of 375 lb. with steam economisers, air heaters, induced and forced draught plants, chimneys, flues, coal chutes and ash hoppers, pipe work and valves coal and coke handling and conveying plants and waggon tippers. Specifications and forms of tender from the Secretary of the Electricity Department, Mr. F. E. Hughes, and further particulars and information can be obtained from the Chief Engineer and Manager, Mr. S. L. Pearce. Tenders to the Chairman of the Electricity Committee, Town Hall, Manchester, by noon Dec. 24.

Southport Corporation has placed an order with the General Electric Company for a switchboard at £3,538.

Leicester Corporation has accepted the tender of the English Electric Company for the supply of 12 tramcars at £2,087 each.

Sunderland Corporation has accepted the tender of the British Insulated & Helsby Cables, Ltd., for the supply of cables.

Sydney (N.S.W.) Council has accepted the tender of the Standard Waygood Hercules, Ltd., for the supply of switchgear at £138,491.

Bethnal Green (London) Borough Council has placed an order for the supply of three-phase motors with the British Thomson-Houston Company, at £3,580.

Southend Corporation has accepted the tender of Edgar Allen & Company for the supply of points at £325. 10s., and that of the Thermit Welding Company for welding at 30s. per joint.

Appointments Vacant and Filled.

An assistant lecturer in engineering is wanted at the Swindon and North Wilts Technical Institution. Application forms, &c., from the principal (Mr. G. H. Burkhardt, M.Sc.), to whom applications must be ent by Nov. 25.

A chief instructor in physics and electrical engineering is required for the Seddon Memorial College, Auckland, New Zealand. Commencing salary £400 per annum. Particulars from the High Commissioner of New Zealand, 415, Strand, London, W.C.2. Applications by Dec. 6.

An assistant electrical engineer is required for the electric lighting department of the Government of the Federated Malay States. Salary £360–£15–£390, with a duty allowance of £79 and a war bonus of 30 per cent. Applications to Crown Agents for the Colonies, 4, Millbank, S.W. 1.

Additional teachers of engineering subjects, physics, practical mathematics and engineering workshop practice are required at the Technical Institute, Walthamstow. Commencing salaries £250. Forms from the Clerk to the Governors, 1, Selborne-road, Walthamstow, E.17. Applications by noon Nov. 27.

Applications are invited for the position of lecturer in electrical engineering at the University of Cape Town. Commencing salary £350, rising after three years' service by annual increments of £25 to £450, plus war bonus. Applications to the Secretary, High Commissioner for the Union of South Africa, 32, Victoria-street, S.W., by Nov. 30.

A laboratory assistant is required for the electrical engineering department of the L.C.C. Hackney Institute. Wages 18s. a week, rising by annual increments of 1s. a week to 30s., with a minimum of 25s. on attaining the age of 21, together with a temporary economic addition of 20 per cent. and a bonus not exceeding 23s. a week. Application forms from the Education Officer, Victoria Embankment, London, W.C.2, and the forms must be returned by 11 a.m. Dec. 1.

Mr. J. H. Davies, M.A., has been appointed principal of the University College of North Wales, Aberystwyth, in succession to the late Dr. T. F. Roberts.

Dr. J. Proudman, Lecturer in Applied Mathematics and Mathematical Hydrography, has been appointed to the chair of Applied Mathematics at Liverpool University.

Mr. H. Nicholson, B.Sc., who is at present working under the Ministry of Munitions, has been appointed to the vacant lectureship in Faraday House Electrical Engineering College.

In succession to Mr. S. Windle, assistant electrical engineer to Sunderland Corporation, Mr. James Townley, of Barnsley, has been appointed. Mr. Windle takes charge of the Doncaster electricity undertaking at the end of the year.

Dr. R. H. Pickard, D.Sc., Ph.D., F.R.S., has been appointed principal of the Battersea Polytechnic. Dr. Pickard has been principal of the Municipal Technical School, Blackburn, since 1908, and has been for some years consulting chemist to the Corporation of Blackburn and the Blackburn Cotton Employers' Association. He has done much for the advancement of chemical knowledge by the publication of the results of his researches in the "Transactions" of various learned societies.

Business Items.

The Stanton Ironworks Company, Ltd., has issued its stock list of .i. pipes for the month of November.

Messrs. Vickers, Ltd., have acquired St. Ermin's Hotel (Westminster) for use as part of the Company's headquarters.

The name of the Elmore's German & Austro-Hungarian Metal Company has been changed to Elmore's Metal Company, Ltd.

In a leaflet issued by the Cressall Mfg. Company, of Stanhope-street, Birmingham, particulars are given of the mica-wound resistances manufactured by them.

Mr. S. H. Richards, late of the Calcutta Electric Supply Company, has joined the sales staff of Messrs. Ferranti Ltd. (Hollinwood, Lancs.) as sales engineer for the South of England.

Joseph James and William Mason (trading as J. Jones & Company), electrical and mechanical engineers, 18, Canal-street, Nottingham, have dissolved partnership. Debts by Mr. Jones, who continues.

Chas. Herbt. Evans and Fredk. Chas. Goss, electric lighting, &c., contractors, 64, Gloucester-road, Bishopston, Bristol, have dissolved partnership. Debts by Mr. Goss.

The proprietors of patent No. 13.731/1911, for a "Method of supplying electric furnaces with triphase currents," wish to grant licences to manufacture under royalty. Particulars from Messrs. Carpmaels, Ransford & Newton, patent agents, 24, Southampton-buildings, London, W.C.2.

Mr. F. Chambers, the foundry general manager of the Stanton Ironworks Company is retiring, and his place is being taken by Mr. P. H. Wilson. Mr. Chambers is retaining his seat on the board and will continue to act as consulting engineer to the company in connection with their foundry business.

Mr. S. F. Palmer, who was for a number of years experimental engineer to Ferranti, Ltd., has been appointed Australian representative for Messrs. Ferguson, Pailin, Ltd., switchgear specialists, of Manchester and London. Mr. Palmer has sailed on the s.s. "Ormonde" for Sydney, where he will open up a central office.

The Sterling Telephone & Electric Company have issued an artistic souvenir of their progress since 1900, when the business was first established. It consists of a number of photographs of their offices and works, which are sufficiently indicative of the modern way in which their business is being conducted. It is evident that the lighter side is not forgotten for there is a splendid canteen and recreation hall for the use of the employees.

New price lists and leaflefs have been issued by the British Rawhide Belting Company, Ltd., of Hythe-road, Willesden, N.W.10. The price lists relate to "Chicago Rawhide" belting, oak tanned leather as well as Balata belting. The special leaflets describe their well-known rawhide pinions, in which they carry on a large merchant's as well as a direct user's trade. Other specialities are their rawhide packing, mallets and hide-faced hammers.

The General Electric Company, Ltd., of 67, Queen Victoria-street, E.C.4, have recently issued two pamphlets dealing with stardelta starters and auto-transformer starters respectively. In specification 58a illustrated particulars are given of the design, construction and operation of the G.E.C. air-break and oil-immersed types of star-delta starter. The air-break type is used for starting squirrel cage induction motors, which do not have to start against more than about one-third full load torque, and is suitable for motors up to 20 h.p. at 550 volts and 15 h.p. at 250 volts. Every detail of the starter, which is mistake-proof is easily accessible, and the insulation is of mica throughout. The oil-immersed type of starter which is designed for 25 h.p. squirrel-cage motors up to 550 volts and 20 h.p. motors up to 250 volts, is similar in general construction to that of the air-break type; there are two kinds of the former starter, one without automatic features and the other with two overload tips and one no-volt release.

Specification No. 82a gives an illustrated description of the "Witton" auto-transformer starters, which are used for starting up squirrel-cage motors when a starting torque greater than 33 per cent. of the full load torque is required. The function of this type of starter is to reduce the line pressure by means of an auto transformer, thus reducing the starting current in proportion. Every part of the starter, which is mistake proof, is readily accessible, and a diagram of corrections is supplied with each.

Messrs. H. W. Butler & Company, Craven House, Kingsway, W.C. 2, have been appointed sole agents in this country for the products of the Locke Insulator Mfg. Company (Victor, N.Y.), one of the most important manufacturers in the United States of all kinds of porcelain insulators for h.t. and e.h.t. work, and also for all the varied requirements of wireless working. The Locke Company have had many years' experience of actual manufacture, and supplied Locke material to several power companies operating at 110,000 volts, and to the Pacific Light & Power Company, which operates at 150,000 volts. In fact, the company has supplied practically all the power companies operating h.t. lines in the United States and Canada, and many operating in Europe. The Hydro-Electric Power Commission of Ontario, with considerably over 1,000 miles of supply lines, 80 per cent. of which are insulated with Locke porcelain. As regards wireless work, a large part of the American Government stations and Navy are also equipped with Locke insulators.

One of the fascinating incidents in nature study is the attraction of a bright light for moths and other winged insects. A casual observation of this phenomenon often reveals to us what striking hues many of these insects possess. Such a subject as this is obviously suitable for adoption to a design in colour for the cover of an electric lamp price list, and this has been done by Pope's Electric Lamp Company, Ltd., for the latest edition of their price list of Elasta Drawn Wire and Half-watt type lamps. The list is printed in red and blue on white paper and thereby helps to remind us that Pope lamps are entirely British made. Prices and particulars of Elasta drawn wire lamps are given in a conveniently arranged table for wattage of 5 to 100, and the latest reduced prices of Pope half-watt type lamps for wattages from 15 to 1,500, or approximate candle-power from 30 to 3,000. A typical illustration and description of both types of lamp is given, the half-watts being put forward as unequalled for the lighting of shops, warehouses, streets, shipyards, railways, factories, mills, &c. The front cover design is artistically printed in three colours and represents multi-coloured moths attracted to a Pope Elasta drawn wire lamp and shows one saying to another "If you know of a better light, go to it." Contractors and dealers desirous of receiving supplies overprinted with their names and address should communicate with the Pope's Electric Lamp Company, Ltd., Willesden, N.W.10.

Bankruptcies and Liquidations.

An application for the discharge of Cecil Hellyar (trading as A. Parker & Company), electrical engineer and contractor, 130, Upper Richmond-road, East Sheen, Surrey, will be heard on Dec. 8 at the Court House, Garratt-lane, Wandsworth, S.W.

A meeting of creditors of I. Frankenburg & Sons, Ltd. (which is in voluntary liquidation for the purpose of transfer to the Greengate & Irwell Rubber Company, Ltd.), will be held at 71, King-street, Manchester, on Nov. 25. The meeting is a statutory meeting, and creditors need not attend unless they so desire.

At the meeting of the creditors of Mr. Charles Colton last week the Official Receiver, Mr. D. Williams, reported that the debtor, an American citizen, had acted as manager of various electrical concerns both in this country and abroad. During April, 1918, he became interested in the Aabada Trust, Ltd., the idea being to utilise the trust for floating electrical and engineering propositions. Debtor transferred to the trust a large number of shares he held in various companies; he became managing director and was to receive 15 per cent. of the net profits. He purchased from Hudsons' Consolidated 40,000 of its Aabada Trust shares at 2s. 6d. and sold them to friends at 5s. or 6s. each. The Stock Exchange refused a quotation, and the shares could not be sold to the public. His friends took up the attitude that they had been let in by him for a bad deal; he refunded their money, but one gentleman who had promised to keep his shares and make the trust a success subsequently asked debtor to take up his shares. He agreed to do so, and gave in return three promissory notes aggregating £3,100, and payable at 60 and 90 days. He was unable to take up the promissory notes at maturity, and they represented the claim of the petitioning creditor under the bankruptcy. Altogether, debtor had put £20,000 into the trust. He resigned his post of managing director last September, but expected to be appointed general manager. The debtor had also been interested in a dry battery, a wireless demonstration set and an electric piano player. No statement of affairs had been lodged, but the debtor roughly estimated his liabilities at £9,000 and the value of his assets had yet to be ascertained. He attributed his failure to losses in connection with the Aabada Trust, and to a loss of £5,000 by Stock Exchange speculations. Mr. F. S. Salaman, C.A., will act as trustee and administer the estate in bankruptcy, but the Official Receiver promised to delay the application for the order of adjudication to give the debtor an opportunity to submit a proposal to the creditors.

Educational.

GLASGOW UNIVERSITY has been offered £20,000 by Mr. John T. Cargill, for the foundation of a Cargill Chair of Applied Physics.

The fund for establishing degrees in commerce at the UNIVERSITY of LONDON now amounts to about £120,000. In addition, the trustees of Sir Ernest Cassel's fund have made a conditional offer of £150,000.

The Council of the Senate of CAMBRIDGE UNIVERSITY, whilst putting forward a grace for the appointment of a syndicate to consider the allocation and the administration of the benefaction of the British Oil Companies, are of opinion, after consultation with Prof. Sir W. J. Pope, that it is desirable in the interests of the Department of Chemistry, to take steps at once for the establishment of a Professorship of Physical Chemistry, the stipend of which would be furnished out of the benefaction. The stipend suggested is £1,000.

The number of evening students enrolled at the Heriot-Watt College is 2,946, compared with 1,515 last year. While with a few exceptions the enrolments are good in the commercial and general classes, the great increase has taken place in the technical classes. There has also been a large increase in the enrolments of the day College, the total number of diploma students in mechanical, electrical and mining engineering being 204, and in the chemistry department 97, a total of 301 against 94 last year.

Draft statutory rules and orders of the Board of Education with reference to technical schools give the Board power to increase or decrease the rate of garnt prescribed in any case in which they are satisfied that, as a result of changes since 1913-1914, the grant so deermined has become inadequate or excessive. Aid may also be given in respect of TECHNICAL INSTITUTION sourses of advanced instruction in science or in science and art, either alone or in conjunction with subjects of general, commercial, manual or technological instruction, provided that the Board are satisfied that the course is suitable in character to the needs of the students for whom it is intended.

Companies' Reports, &c.

The directors of the Chloride Electrical Storage Company, Ltd., have declared a dividend of 5 per cent. (tax free) on the ordinary shares.

The directors of Messrs. Mirrlees, Bickerton & Day, Ltd., have declared an interim dividend of 1s. per share on the ordinary shares.

The British Ever-Ready Company, Ltd., has declared an interim dividend of 7½ per cent. on the ordinary shares for the half-year ended Sept. 30.

A dividend of 12 per cent. has been declared by Messrs. Richardsons, Westgarth & Company, Ltd., on the preference shares for the two years ended April 30, 1914.

The Shawinigan Water & Power Company is offering for sale a maximum of $86,000, par value, of the issue of 5 per cent. 30-year consolidated mortgage bonds, due 1934.

An interim dividend at the rate of 5 per cent. per annum (less tax) has been declared on the ordinary shares of Ruston & Hornsby, Ltd., for the past half-year.

An extraordinary general meeting of the shareholders of Sir W. G. Armstrong, Whitworth & Company, Ltd., will be held on the 22nd inst. to consider a resolution to increase the capital to £11,012,500 by the creation of 1,500,000 new ordinary shares of £1 each.

The directors of the Electric Construction Company, Ltd., have declared the following interim dividends in respect of the year ending March 31, 1920 :—At rate of 7 per cent. per annum on the preference shares, and at rate of 6 per cent. per annum on the ordinary shares, both less tax, payable on Nov. 29.

The directors of the West India and Panama Telegraph Company, Ltd., announce the payment on the 27th inst. of the following interim dividends for the six months to 30 June in respect of the year 1919 : 6s. per share on the first preference and 6s. per share on the second preference shares.

The directors of Water Softeners, Ltd., recommend a dividend of 2 per cent. (tax free) for the past year, after writing £545 off for bad debts and depreciation, £261 for repairs of plant and premises, £750 to reserve for income-tax. A sum of £86 is carried forward, after deducting the debit balance of £3,721 brought forward.

An extraordinary general meeting of the London Electric Wire Company and Smiths, Ltd., and separate meetings of the holders of the ordinary and preference shares were held on Wednesday, when it was decided to convert the existing five per cent. preference shares into seven and a-half per cent. cumulative preference shares as from 1st January, 1920 ; to subdivide each of the existing ordinary and preference shares of £5 each into five shares of £1 each ; and to increase the capital to £1,250,000 by the creation of 430,000 preference and 50,000 ordinary shares of £1 each. It is proposed to offer 350,000 preference shares for subscription at par.

The directors of Electro Bleach & By-Products, Ltd., have decided to increase the nominal capital from £180,000 (120,000 preference shares of £1 each, and 120,000 ordinary shares of 10s. each) to a total of 480,000 to be divided into 320,000 preference shares of £1 each and 320,000 ordinary shares of 10s. each. It is proposed to issue 80,000 preference and 80,000 ordinary shares. The proceeds of this issue will be applied in paying the balance of the amount advanced by the Government for an extension of the plant, machinery and buildings at Middlewich (£35,890. 17s. 4d.), in purchasing the whole of the plant, machinery and buildings of the Government at Middlewich (£10,000), and in redeeming the whole of the outstanding debentures (£50,500). The balance will be available for extensions and development.

The Directors of the Newcastle-upon-Tyne Electric Supply Company, Ltd., propose to ask the shareholders to sanction an increase of the capital from £3,500,000 to £6,500,000. In a circular the directors state that the capital is needed to meet expenditure on developments now in hand, and that the interests of the company will best be served by the creation and issue of 1,500,000 seven per cent. cumulative preference shares of £1 each. The issue is required to meet existing commitments mainly incurred in 1917 and 1918 in respect of generating plant and mains extensions, which, while much delayed by war conditions, are now nearing completion. It is expected that by the end of June, 1920, two-thirds of these extensions will be completed, and the whole before the end of that year. It is estimated that owing to its economy in coal consumption this plant will, even on the basis of the present year's reduced output and of the present cost of coal, save at least £60,000 in working expenses during 1920, and over £100,000 if the new plant were working for the full year. The estimated saving of £60,000, together with the saving of interest on bank loans, which would be repaid, will represent in 1920 approximately four-fifths of the amount required to meet the dividend on the proposed issue. In addition to the horse-power already connected, further demands amounting to over 86,000 h.p. have been made upon the company and its associated companies. Having regard to these large demands and the greater economy in operation, the directors have every confidence that, after the present difficult period is passed and upon the return of more stable conditions, the business and revenue of the company will largely increase. To make provision for future requirements the directors intend also to ask the shareholders to authorise the increase of the existing five per cent. preference and ordinary share capital by £1,000,000 each. An extraordinary meeting will be held on 24th inst. for passing necessary resolution.

In the course of his speech at the recent annual meeting of the Singapore Electric Tramways, Ltd., the Chairman, Sir Frank A. Swettenham, G.C.M.G., stated that, after meeting all expenses and outgoings, there was a loss for the past year of £9,626. Deducting the credit balance at the end of 1917, the net adverse balance was £5,406. The traffic receipts for last year were £6,450 better than in 1917, and there was an increase of £595 from the sale of energy. The loss was due to the great increase in costs of every description, and power expenses, amounted to £42,300, against £21,800 for 1917. They had not only had to pay very much higher prices for coal, but they had had to produce a very much larger number of steam units, owing to the main Diesel engine being inactive as the result of the accident in 1917. The supply of energy to the municipality instead of being a source of revenue resulted in considerable loss, and although strong representations had been made to the Municipal Commissioners they had declined to pay a higher rate or to raise the price to the Singapore consumers, although in the case of gas, which they controlled, the cost of coal had, in their view, justified them in raising the price of gas on more than one occasion. Instead, therefore, of making a fair profit on the supply, there was a loss of about £7,000 in 1918 from the sale of energy to the municipality. The Commissioners had also failed to carry out their part of the contract, which provided for taking from the Company electric energy for lighting the Tanglin district, although special plant had been put in to give an alternating-current supply. The question of the renewal of the track was being dealt with. It was practically impossible to obtain new rails in this country at even the extravagant prices to which they had risen, and the Company was forced to go to the United States of America to supply its urgent needs. It had been found necessary to raise the fares, but it might be advisable later to reconsider the scheme of fares and introduce a lower fare for a shorter section. The tramway revenue for 1918 exceeded that of the previous year by £6,450, while for the nine months (January to September) of the current year it amounted to £69,458, against £62,971 for the similar period of 1918.

At an extraordinary general meeting of Marconi's Wireless Telegraph Company, Ltd., last week it was decided to increase the capital of the company by the creation of 1,500,000 new ordinary shares of £1 each. The deputy chairman (Mr. Godfrey C. Isaacs), who moved the resolution authorising the increase, said that the company's commitments on business and agreements already entered into in the East were very considerable, requiring in the neighbourhood of one million sterling, and the arrangements entered into in respect of developments in South America would call for another million sterling. There were many more engagements which would entail the provision of smaller sums which in the aggregate represent a much bigger total. The war had brought home to every Government and to the peoples of every country the great necessity of wireless telegraphic services. The war clearly demonstrated to everybody that wireless telegraphy was no longer a toy, but had become a really reliable means of telegraphic communication. Consequently, as soon as the Armistice was declared and the possibility of supply of material and construction of stations came into reasonable prospect of execution, nearly every Government turned its mind seriously to the problem of how best the new art could serve them. France lost no time in making provision for a chain of stations which would enable her to have through communication with all her colonies. A number of stations were being erected by her both in Europe and abroad. The French company, in which they were substantially interested, was engaged in constructing these stations. Italy, Spain, Portugal, Belgium, Holland, Denwark, Sweden and the new Balkan Republics were all considering or negotiating for the erection of long distance independent wireless communication, and stations of the latest type would be erected in each of those countries. In North America a number of high power stations had been erected and a large number of additional stations were about to be built by the new American Radio Corporation. In South America the Marconi Company was building stations, and there was considerable further work in prospect. The time was, perhaps, not far distant when much of their attention must be turned to Russia. After referring to the attitude of the Post Office to the company, and to the great telegraph delays in communications abroad, he said that a six-hours wireless service was being conducted by the Post Office with Holland and Denmark, but either the traffic was such that the time alloted for the service was insufficient or the stations used for the purpose were of an old type and built for other purposes, for there has been no noticeable improvement in the expedition of the telegraph services. As regards the Imperial chain of stations, he believed something was being done in continuing the construction of the English and Egyptian stations, but he could not believe that the installation of an obsolete system would be persisted in.

There was another field of development which would call for very considerable resources, and that was wireless telephony. Considerable progress had been made and was being made daily in that new art, and a great future lay before it. It was already assuming a practical commercial shape, and gave promise of an immediate extension to their business throughout the world. The company was in a very sound financial position ; its reserve account in the last balance-sheet stood as £1,250,000, and they had since received £590,000, the amount of the award, and they had sold the whole of their shareholding in the American Marconi Company, which would add a further substantial sum. The arrangements with the General Electric Company of New York and the American Radio Corporation were of such importance that they felt satisfied that, besides obtaining a reasonable price for their interest in the American company, they had secured as further consideration advantages of far-reaching importance which would cement and strengthen their world-wide organisation.

Having answered some questions, and stating that Lord Moulton would act as arbitrator on the company's claim against the Admiralty, the War Office and the Air Ministry, the resolution was put and carried.

New Companies.

ACCURATE ENGINEERING COMPANY, LTD. (160,417)—Private company. Reg. Nov. 8, capital £2,000 in £1 shares, to take over the business of engineers and tool makers until recently carried on by Dimmock, May and Pickering at Walthamstow, and to carry on the business of mechanical and electrical engineers, &c.

AMPERE ELECTRICAL ENGINEERING & PLATING COMPANY, LTD. (160,498)—Private company. Reg. Nov. 12, capital £2,000 in £1 shares. Objects: To take over the business of electrical engineers and cycle agents carried on by S. E. Culham and A. T. L. Steedham at 21, Victoria-terrace, South Shields, as the "Empire Electrical Engineers." First directors are S. E. Culham and A. T. L. Steedham (both permanent). Reg. office: 21, Victoria-terrace, South Shields.

HENRY BISSEKER, LTD (159,930)—Private company. Reg. Oct. 24, capital £30,000 in £1 shares, to carry on the business of gas and electrical engineers, electric, gas and water fittings manufacturers, &c., carried on by H. Bisseker. Reg. office: 9-15, New Bartholomew-street, Birmingham.

CRAY NSTALLATIONS, LTD. (160,598.)—Private company; reg. Nov. 14, capital £15,000 in £1 shares, to carry on the business of electrical and mechanical engineers and contractors, manufacturers of agricultural implements and other machinery, &c. First directors, E. H. Joynson, C. H. Beadle, J. Young, D. H. W. Alexander. Reg. office, South Factory, Sugar House-lane, Lower High-street, Southampton.

GREENWELL & IRWELL RUBBER COMPANY, LTD. (160,288)—Reg Nov. 4, capital £800,000 in 400,000 ordinary shares and 400,000 7½ per cent. cumulative preference shares, all of £1 each, to acquire the business of I. Frankenburg & Sons and the Irwell & Eastern Rubber Company, and to carry on the business of manufacturers of and dealers in india-rubber and leather goods, electric cables, belting, rubber growers, &c. First directors are J. Tinto, M. Frankenburg, S. Frankenburg, S. T. Rowe, H. Standing, R. Colsell and J. G. Tinto. Reg. office: Greengate Rubber Works, Salford.

LANCASHIRE ORDNANCE ACCESSORIES COMPANY, TD. (160,425)—Reg. Nov. 8, capital £200,000 in £1 shares, to acquire certain lands and buildings at Heaton Norris formerly occupied by the Lancashire Dynamo & Motor Company in the name of the Lancashire Ordnance & Accessories Company, and certain machinery and stock-in-trade therein, and also the rights of working certain patents relating to improvements in roller bearings, to carry on the business of manufacturers of and dealers in patent roller bearings, stampings, motor car and general engineering components, &c., and to enter into agreements with the Lancashire Dynamo & Motor Company, the Chain Roller Bearing Company and with J. R. Garner. First directors are N. Kilvert, H. V. Kilvert, A. Tongue, J. C. Hoyle, W. Hopwood, G. L. Hardcastle and J. R. Garner (managing director). Reg. office: Georges-road, Heaton Norris, near Manchester.

REAVELL-MOSSAY PNEUMATIC TOOL COMPANY, LTD. (160,298)—Private company. Reg. Nov. 4, capital £5,000 in £1 shares. Objects: To carry on the business of manufacturers of and dealers in pneumatic and other tools, machinery and apparatus, mechanical, hydraulic, electrical and consulting engineers, &c., and to enter into certain specified agreements. First directors are P. A. H. Mossay and W. Reavell. Reg. office: 7, Princes-street, Westminster.

Prices of Metals, Chemicals, &c.

Copper— Tuesday, Nov. 18.

		Price.	Inc.	Dec.
Best selected	per ton	£112 0 0	—	—
Electrolytic bars ...	,,	£117 0 0	—	—
H.C. wire basis......	per lb.	1s. 3$\frac{9}{16}$d.	—	—
Sheet	,,	1s. 4$\frac{1}{16}$d.	$\frac{1}{16}$d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 7$\frac{9}{16}$d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 11$\frac{3}{8}$d.	$\frac{1}{8}$d.	—
Sheet, basis	,,	1s. 2$\frac{5}{8}$d.	—	—
Wire, basis	,,	1s. 2½d.	—	—
Iron—				
Cleveland Warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	£32 10 0	—	—
Lead Pig—				
English	,,	35 10 0	£1 0 0	—
Foreign or colonial	,,	34 5 0	£0 12 6	—
*Tin—*Ingot	,,	284 0 0	£4 10 0	—
Wire, basis	per lb.	0 3 6	½d.	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Ton £23.

,, (Roll Brimstone).—Per ton £22 10s.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate. Per lb. 6d.

Shellac.—5 5s. December delivery 505s. to 512s. 6d.

Rubber.—Para fine, 2s. 6½d.: plantation 1st. latex 2s. 4½d. lb

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W. T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From The Electrician, Nov. 18, 1882.]

Edison Lamps on Board Ship.—Two steamers of the Union line are to be fitted with Edison lamps. The motors in these instances will be Brotherhood three-cylinder engines. Lengthened trials are being carried out with these engines as motors for Edison machines.

New Secondary Battery.—A Belgian contemporary announces some improvements on the Faure battery effected by Messrs. Tamine, a civil engineer, and Arnould, chief engineer of mines at Mons, in that country. The improvements consist in forming the plate of metal wire wound in a spiral form, and placed in sulphate of copper. The felt of Faure is replaced by very thin discs of porous earthenware.

Electric Lighting in London.—The Bermondsey Vestry do not seem to be much impressed with the recent conference of the local authorities of South London on the subject of electric lighting. A member, who acted as the Vestry's delegate at the conference, described his impression of the proceedings as "a jumble of figures which came from a man interested in gas shares." The St. Pancras Vestry will apply for a provisional order.

Swan's Lamps in a Factory.—Messrs. Guinness, Son & Company, of Dublin, have had the looms in their new woollen factory lighted up with Swan's incandescent lights, the current being supplied by a Crompton-Burgin machine. The result has been so satisfactory that this firm have entrusted an order to Mr. J. H. Greenhill, of Belfast, who supplied the above plant, for the introduction of Swan lights into their extensive offices in connection with the breweries. We understand Mr. Greenhill has obtained the concession of manufacturing the Crompton-Bürgin machines in Ireland, being the first dynamos made in that country.

Wire Fencing in Thunderstorms.—During the thunderstorm of Wednesday week five sheep were killed on the farm of Cotland, Tinwald Parish, in Scotland. In one field there was a wire fence for a distance of 300 yds. The current had travelled along this, breaking the wooden posts at various distances, and at the end of the fence two sheep were struck and killed. In the adjoining field, separated from the other by a farm road, the fence was a stone wall, with a single wire on the top. This wire was broken, and touched the ground about 40 yds. from the road. A number of sheep were crouching near the broken wire, and three of them were killed.

Danger from Exposed Electric Light Wire.—"A. I. C. E." writes to "The Times" of 13th inst. as follows: "Your paragraph in 'The Times' of Nov. 9 is not an instant too soon. Doubtless in England also we shall have to wait for legislation until, to use your own words, 'some dreadful accident occurs to arouse public indignation.' Meantime, public opinion, if freely expressed, may do something. It is no secret that more than one theatrical manager has in comtenplation, or has already decided, to employ the electric light in the coming Christmas pantomime or extravaganzas as a personal ornament for their hobgoblins or fairies. This can only be done by means of some form of accumulator carried by, or attached to, the individual, and whether the star light is to form an ornament for the head, or to glisten at the end of a wand, the constant danger is patent. There is no need to be an electrician to understand this. A grave responsibility will be incurred by those managers who permit it—a still graver one by those who force it on their employés. The life of even a super at 20s. a week ought not to be placed in jeopardy by that autocratic production of our time, the theatrical manager, even if both are willing to run the risk."

Fire Alarms in New York.—Much comment has been caused by the fact that although there was a special fire-alarm signal-box in the Park Theatre, New York, which was recently destroyed by fire, no alarm was received from it at the central station, and much valuable time was lost until an alarm was given from somewhere else, more than a block away. According to a New York paper, a workman ran to the box in the theatre, broke the glass case, and endeavoured to give the alarm, but he was probably so excited that he failed to push in the button to send the alarm, and now seeks to cast the blame ypon the signal-box of the Fire department. The same authority says that it has been also claimed that the difficulty was caused by the underground wires being out of order.

Electric Light in a Stockport Mill.—Messrs. R. M'Clure & Sons, of Travis Brook Mill, Stockport, partially lighted their weaving shed last winter with the electric light. A 16-light Brush machine, with 16 lamps, each of 2,000 c.p., was used for the purpose, and the result was so successful that they decided to complete the lighting of their shed, and also to extend it to other portions of their mill. For this purpose they have now had erected a 40-light Brush dynamo with 40 Brush lamps, 31 of which are now in the weaving shed and the remaining nine in the engine house and other rooms. The whole of these were set running a few days since and burnt satisfactorily. The installation has been carried out by the Hammond Electric Light & Power Supply Company, Liverpool, under the superintendence of Mr. James Shaw, the district manager, and Mr. Rowley, electrician to the company for the district.

New Cable Ship.—We announced in a recent note that the Postmaster General had contracted with Messrs. D. J. Dunlop & Company, Port Glasgow, to build for the service of the Post Office an iron screw steamer, specially constructed for the laying and repairing of telegraph cables. The vessel will be built from designs by Mr. Joseph H. Ritchie, Fenchurch-street, E.C. The principal particulars of the vessel are: Length 240 ft., breadth 33 ft., depth 20 ft.: to be propelled by a pair of engines having cylinders 30 in. and 58 in. diameter, with a length of stroke 48 in. To meet the requirements of the special work to be performed, the steamer will be fitted with three circular telegraph cable tanks and a double bottom for water ballast, with fittings adjusted to trim the ship as the cable is paid out.

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Notes.

Imperial Wireless.

THE appointment by the Secretary of State for the Colonies, as Chairman of the Imperial Communications Committee, of a Committee to consider what high power wireless stations it is desirable on commercial or strategic grounds the Empire should ultimately possesss, and to prepare estimates of the cost of such stations, to examine the probable amount of traffic which they are likely to carry, and to recommend the order in which such stations should be built, is an important move in the right direction. The Committee itself seems to us well constituted. It consists of the Right Hon. Sir HENRY NORMAN as chairman, with Sir JOHN SNELL, Rear-Admiral F. L. FIELD, Prof. J. E. PETAVEL, Dr. W. H. ECCLES and Messrs. F. J. BROWN, JAMES SWINBURNE and L. B. TURNER as members. The secretary is Brigadier-Gen. S. H. WILSON, and the assistant secretary Lieut.-Col. C. G. CRAWLEY. It will be seen, therefore, that Post Office, naval and scientific interests are directly represented, while the army will be able to put its views forward through the secretariat. The only criticism which we have to make is whether Sir JOHN SNELL, who, as is well known, is chief electricity commissioner-designate, will have sufficient time to spare from his present arduous duties to devote to the large problems of power supply for wireless purposes which must be considered by the Committee.

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THE appointment of this Committee will, we hope, mark the end of a depressing period of storm and stress in wireless history. The idea of an Imperial wireless chain was first suggested in 1909, and, after considerable discussion, the Government entered into a contract with the Marconi Company for the erection of 18 stations in July, 1912. Nothing was done however, to carry out the terms of this contract by the Government, and it was consequently repudiated by the company, though subsequently a revised contract for six stations was entered into. In November, 1913, Mr. SAMUEL, who was then Postmaster-General, caused great surprise by announcing that he was prepared to receive tenders for the second three high-power wireless stations of the Imperial chain. No company was, however, able to satisfy him as to the efficiency of their system; and it is interesting to note that Sir HENRY NORMAN was then a severe critic of the Marconi contract and an advocate of a State-owned Imperial wireless system. Matters were recently carried a step further when the Marconi Company sued the Post Office authorities for breach of contract, claiming a sum of seven million pounds in damages. The case was fully reported in our columns, and it will be remembered they were awarded £590,000 in settlement of their claim. The result has been that, while other countries have been building stations, we have done nothing, if we except two relics of the proposed Imperial chain at Oxford and at Cairo. The present means of intercommunication between this country and the Colonies are highly unsatisfactory from every point of view, and we hope the Committee will be able to provide a speedy solution of existing difficulties.

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Tramway Problems.

ELECTRIC tramway systems throughout the country are at present under a cloud. They are said to be inefficient, costly and out of date, and in many towns when extensions become necessary the adoption of motor 'buses is recommended as an alternative. It is, of course, impossible to criticise this procedure in a general way, because each town presents different problems which must be decided on their merits, and of these merits the tramways manager is obviously the best judge. But that is no reason why electric tramways as a whole should be subjected to a sniping attack which is as misinformed as it is unfair. The proposal of the London County Council greatly to extend their system has formed exactly the excuse tramway critics needed. Now, undoubtedly, tramways have their weak points, and if the criticism had been directed to pointing them out we should have nothing further to say; but to take up a "scrap the lot" attitude, when not so long ago they were calling for further extensions, is a little inconsistent, if not unnatural on the part of those who are always searching for some new stunt. If the London traffic problem were now being considered from the start, it is very much to be doubted whether tramways would be laid down; but this has never been possible. When they were laid down the objections to them which are now evident did not exist, and the promoters of the system were honestly working in the best interests of Londoners generally. At the moment we are too apt only to remember that tramways have their limitations; but, at the same time, the London County Council must not forget that cogent fact. Their latest proposals make us think they have done so. Traffic in London becomes more and more dense, and to run tramways through the narrow crowded streets of the City will, therefore, be most unwise, so that we hope that before it is too late the London County Council will reconsider the matter, and not allow their pride in their tramways system to lead them to what may be a disastrous fall. Anything that can be done to help solve the present London traffic problem will be welcome, but the London County Council has not in this instance hit on the right solution.

Licences for Wireless Telegraphy.

We have referred frequently in these columns to the desirability of allowing the amateur to work experimentally at wireless telegraphy, and now that the Postmaster-General has issued regulations under which the necessary licences may be issued, we are able to judge in what light the official mind regards the matter. In considering the question it may be well first to decide who is an amateur. Generally, by an amateur we mean a person who has studied a subject in a non-professional manner, simply as a hobby. Thus we speak of an "amateur electrician," by which is meant a person who has not followed a recognised course of study, and who has merely picked up certain haphazard knowledge. In the present connection, however, the "amateur" means much more than this, for the term includes not merely the schoolboy, who knows nothing of the physics underlying the subject, and who merely wishes to catch messages from the ether, but it includes equally the college professor and trained physicist who is anxious to carry out serious investigations. The term "amateur" here means that the person to whom it is applied is not engaged professionally in the subject, and thus such amateurs may be classed as technical, on the one hand, and non-technical, on the other. So far as the non-technical amateur is concerned we have always felt that he should be encouraged so long as he is not permitted to be a trouble to other people, for his activities serve to increase public interest in scientific matters. If difficulties are placed in the path of this class of amateur he will probably satisfy his desires without any official sanction. He is generally harmless, and the person who wishes to do harm is certain to carry through his designs notwithstanding all Government regulations to the contrary. Thus, it is better to make the path of the non-technical amateur easy and to charge but a small fee, even less than the 10s. now prescribed.

There is, however, a complication as compared with prewar days, for the thermionic valve has now completely altered the state of affairs. The wireless amateurs must henceforth be divided into those who work merely with the old style detector and those who are sufficiently ambitious to handle valves. The difficulty is that the thermionic valve is such an extremely sensitive device that somewhat severe restrictions must be enforced to render the "valve amateur" innocuous. It would matter but little if the valve could be used only for reception, but the fact that it can be readily arranged to generate oscillations for transmission makes the position much more difficult. Thus it is that the Postmaster-General proposes to restrict aerials to 100 ft. of single wire, or 70 ft. of double wire. Having rightly reached this position, however, we think that more difficulties than are really necessary are placed in the path of the amateur who merely seeks permission to receive. Why should a description of the proposed apparatus and a diagram of the circuits (if thermionic valves are to be used) be required? Is the style of the installation never to be varied when once it has been established? Also, why should it be necessary to give the name of the firm from whom it is proposed to purchase apparatus? Suppose an amateur makes his own, must he receive a permit for this purpose also? In the case of licences for transmission, we quite agree that much greater stringency is necessary. But even here, the main need is that the amateur (doubtless of the technical class) should be a responsible individual with a knowledge of the regulations of the International Convention. It is not really so essential for him to satisfy the Postmaster-General that he has "in view some definite object of scientific value, or general public utility, or that he should be "certified as a competent investigator" for scientific research. It is not every technical amateur who will decide just what investigation he will make before he has the apparatus available. Nor does it seem really essential that he should possess "an operating speed of at least 12 words (Morse) a minute, sending and receiving." In other words, we feel that the regulations are really too official, and that they will cause quite a deal of unnecessary trouble.

The Electrical Education of the Public.

Many years ago some of the more enterprising supply undertakings established showrooms in more or less suitable positions within their areas, with a view to bringing to the public notice the benefits of employing electrical apparatus. The establishment of these showrooms was admittedly an experiment, and the results obtained varied greatly. In some cases a distinct success was gained, while in as many others failure had to be recorded, we think owing to ignorance of what exactly was needed. We remember in our younger days paying anonymous visits to a number of these places, representing ourselves to be a non-technical seeker for information, and subsequently giving a more or less facetious account of our experiences in the columns of this journal. In short, the result of these visits was disappointing considering how the question was agitating supply engineers at the time; but we thought that with the passage of years matters would have changed. We, therefore, regret to learn that Mr. J. W. Beauchamp is still of opinion there is considerable room for improvement in this direction; and an inquiry into the reason for this should not be unprofitable. The vital point about the sale of electrical apparatus seems to be that there is too much mystery about it. That was our own experience. Showroom attendants must realise that the public do not want to hear about watts and amperes, but to be told exactly what the cost of employing electrical equipment will be, and exactly why that particular equipment is best for a particular purpose. Mr. Beauchamp's suggestion that all those engaged in electricity supply undertakings should be appointed unofficial canvassers for the development of the use of electricity by providing them with electrical apparatus in their homes, and arranging with them to report on the cost and other results of its employment, is one that we should like to see widely adopted. At the present time too many of those engaged in electricity supply work are inclined to praise the apparatus which they are supposed to be selling with a faintness which is almost condemnation. That sort of thing will never bring about the development we desire to see, and it would, therefore, seem that our first step along the road to an all-electric house is to educate those whose business it is to educate the general public. A man who does not believe in what he is talking about is best engaged in some other sphere of activity than electrical engineering.

Linking-up in Lancashire.—At a time when the Electricity (Supply) Bill is an important topic it is interesting to note that on Saturday last, the following interconnected systems in Lancashire were all working in parallel: Manchester Corporation, Salford Corporation, Lancashire Electric Power Company, South Lancashire Electric Power Company and Wigan Corporation.

"Engineering."—From and including the issue of Jan. 2, 1920, the price of "Engineering" will be advanced from 9d. to 1s. per copy owing to the increase in the cost of paper, engravings and printing charges generally.

Royal Institution.—The 94th Course of Juvenile Lectures, founded by Faraday at the Royal Institution, will be delivered this Christmas by Prof. W. H. Bragg on "The World of Sound." The lectures will be given on the following days at 3 p.m.: Dec. 30th, Jan. 1st, Jan. 3rd, Jan. 6th, Jan. 8th and Jan. 10th.

Junior Institution of Engineers. The Council has received a petition from Assam, signed by a number of engineers, to sanction the formation of a local section of the Institution in that district. This is the second Colonial section of the Junior Institution of Engineers to be established within a year, and indicates that the reputation of this Society is continually on the increase.

Ex-British Westinghouse Association. The second Annual Re-Union dinner of this Association will take place in the Holborn Restaurant on Friday, Jan. 23, at 7 p.m. Invitations to members are shortly being issued. Enquiries should be addressed to:—The Hon. Secretary, Mr. L. S. Richardson, 14, Sydney-road, Richmond, Surrey.

Testimonial to Sir Oliver Lodge. A representative committee has been formed for the purpose of making a presentation to Sir Oliver and Lady Lodge, to mark appreciation of the services of the former on relinquishing the post of Principal of the Birmingham University. The Chairman of the Committee is Sir Gilbert Barling, Bart., and the hon. treasurer is Mr. H. C. Field, to whom contributions should be sent, at the University, Edmund-street, Birmingham.

Radio Telephony Stations. In a notice to airmen the Air Ministry states that the radio-telephony stations at the aerodromes at Hounslow and Lympne are now working on 900 metre wave length. The registration marks of aircraft should be used as the call signs in making or receiving signals by wireless telegraphy or other methods of communication, except when opening up communications by means of visual signals, when the usual methods will be employed.

The Institution of Electrical Engineers.—*Liverpool Sub-Centre.*—At a recent meeting which was largely attended by members of the Institution of Electrical Engineers in the Liverpool district, it was agreed to form a local sub-centre of the Institution in Liverpool. The officers for the ensuing session will be as follows:—Chairman, Professor E. W. Marchant; vice-Chairman, Mr. H. Dickinson; secretary, Mr. C. Waygood (electrical engineering department, University), from whom all information relating to the local centre can be obtained. A committee of 12 members was appointed to arrange for the meetings of the section.

Overhead Suspension Fittings.—The "Electrical World" describes a form of overhead lighting fitting which seems to present some advantages for industrial lighting. The lighting fitting terminates in a short length of iron tube, with a metal loop at the end, which fits over a hook let into the ceiling. A short length of flexible wire connecting with the lamp passes through this iron tube to a plug socket on the ceiling, such outlets being arranged symmetrically. The advantages of the method is that it allows a short displacement of lighting units from their normal positions, so as to meet the needs of individual operators, and also provides for some flexibility in the event of the positions of desks, machines, &c., being altered. It is quite an easy process to displace the hook from which units are suspended.

Detection of Invisible Objects by Heat Radiation. A recent issue of the "Physical Review" contains a summary of a Paper read by Mr. S. O. Hofman at the Washington meeting of the American Physical Society on the above subject. In trench warfare on the Western Front operations took place mainly in the night time, as any movement during the day quickly attracted hostile fire. An attempt was therefore made to detect men moving in No Man's Land by recording the heat radiated from their bodies. The receiver for this purpose was a thermopile at the focus of a 14-in. parabolic mirror, and connected to a D'Arsonval galvanometer. It was found that with this sensitive apparatus the presence of a man could be detected at a distance of 600 ft., and the device appears to have proved very useful in detecting hostile raiding parties creeping towards the trenches by night. It is also suggested that the method might be made the basis of a short-range form of secret signalling.

Coal Supply to Electricity Works. A deputation of representatives of the Institution of Electrical Engineers, the I.M.E.A., the London Electrical Supply Companies, the Provincial Electricity Supply Committee, the Association of Municipal Electrical Engineers of Greater London and the Diesel Engine Users' Association recently waited upon the Coal Mines Department in order to make representations upon (*a*) the quality of coal supplied to power stations, (*b*) the increase of price per ton at the pit mouth, (*c*) the consequent increase in the cost of electricity and the necessity for increasing the maximum prices to the public, and the restrictions on the sale of current. The views submitted by the deputation were favourably received by Mr. Lee on behalf of the department, and the deputation were satisfied that a substantial improvement in the position would be effected.

Standard System of Limit Gauging.—The British Engineering Standards Association has had under consideration for some time past the question of a standard system of limit gauging for plain cylindrical work applicable to engineering generally. The Sub-Committee on limit gauges, recently reorganised as a result of a trade conference held in April last, has decided to recommend the adoption of the hole basis, and is hoping to settle shortly the important question of the disposition of the tolerances with regard to the nominal dimension. Two methods have been proposed: (1) That the mean dimension of the hole should be its nominal size, the tolerance being both positive and negative; (2) that the minimum dimension of the hole should be the nominal size, the whole tolerance being positive. From inquiries addressed to a number of engineering firms it appears that opinion is divided as to which method should be adopted. It is hoped, however, that the question may be finally discussed in a few weeks by a sub-committee, and any firm desirous of obtaining further information, or of giving its views, is invited to communicate at once with the Secretary of the British Engineering Standards Association, 28, Victoria-street, Westminster, S.W.1.

Société des Ingenieurs Civils de France.—The inaugural meeting of the British Section of this Society was held in the rooms of the Royal Society of Arts on Monday, Nov 24, Mr. C. H. Wordingham, Honorary President of the new section, being in the chair.

In opening the meeting Mr. Wordingham said that organisations had already been created to strengthen the Entente Cordiale between Great Britain and France in the worlds ot art, of commerce, of education and of politics. This section had been formed to show that engineers did not wish to lag behind. In giving a short historical account of the Society, he mentioned that it was formed in 1848, and admitted to membership all engineers except military engineers. In its early days it received a good deal of opposition from Napoleon III., who started a close system of State engineers; but in spite of this the Society flourished, and had to a certain extent retaliated by excluding State engineers from its membership. It was interesting to note that the first Paper read before the Society was one on the Conway Bridge. In 1861, when it was recognised as a Society of public utility, its membership was 500. This figure had increased to 4,500 in 1914.

Mr. T. J. Gueritte, who has been elected President of the section, then delivered his presidential address. He described the policy of the section, which aims at the forming of a link between British and French engineering societies by drawing them into close contact with each other, and keeping them informed of important forthcoming Papers or meetings in either country. It aims also at promoting personal and friendly intercourse between French and British engineers, and in inducing British engineers to take an active interest in the work of the French societies and French engineers who seek admission into British institutions or societies. A scheme is being set up for the exchange of engineering students and young engineers between the two countries, and to secure a recognition in one country of the university degree or diplomas conferred in the other. Papers dealing with engineering questions which affect Franco-British relations will be read at the meetings, of which six have already been arranged for the 1919-1920 session.

Women in Engineering Trades.—An interesting report, covering information received from 1.422 firms, and giving valuable statistics in regard to the employment of women in engineering and other trades, has been issued by the Women's Industrial League. The object of the League, which was founded under the presidency of Lady Rhondda when hostilities ceased, is "To secure equality of treatment and opportunity for employment of women." From Schedule I. of the report we learn that 79.900 women were employed at the end of May 1919, compared with 245.000 during the war, and letters received from the firms concerned show that they were highly satisfied with the work of women, and are willing to retain or reinstate them if allowed to do so. The report shows that the work of the women was satisfactory. A third of the firms who employed women for the first time during the war have been able to retain them on some processes, and a further third would be willing to keep them on but for the opposition to such a policy. Of the firms who had employed women in pre-war days, 67 propose to increase their number in view of the greater experience of women's work that they have gained. The report also gives details of new industries open to women since the war, notably aircraft manufacture, in which they have obtained a high standard of efficiency on many processes The Women's Industrial League, whose offices are at 1, Central-buildings, Westminster, S.W.1, is asking for "equality of treatment," which can, it is claimed, be the only successful solution of the problem, on economic grounds as well as those of justice.

Applied Science, Now and a Century Ago. In his address before the Royal Society of Arts Sir Henry Trueman Wood drew an interesting parallel between the industrial conditions prevailing at the termination of the Napoleonic wars and those facing us to-day. In many respects these problems are similar, though naturally accentuated by the unprecedented scale on which this last war has been conducted. It is interesting to observe that the foundation of the Royal Society of Arts was almost contemporaneous with the beginning of the Seven Years' War (1763), and the recovery of trade following that period has encouraging lessons for us to-day. In the same way, after the Napoleonic war recuperation was remarkably rapid, though the force of the "industrial revolution" seems to have gradually spent itself, and the country did not occupy the same position of pre-eminence in the latter part of last century. Several interesting parallels with the situation a century ago were drawn by Sir Henry. The present year has seen the crossing of the Atlantic by air; in 1819 it was first crossed by a steamer, the "Susannah," though apparently 14 years elapsed before another attempt was made. The present year may also be regarded as a telegraphic centenary, for it was in 1819 that Oersted discovered that a compass needle was affected by a neighbouring current, while in 1816 Ronalds had succeeded in transmitting signals and messages for a distance of 8 miles by a method based on the use of frictional electricity. Industrial chemistry, broadly speaking, also made its debut about 100 years ago. There can be no question that it was in Great Britain that the application of science on a large scale to industry was first initiated. In the coming years it may play an equally important role; great as are our present difficulties we have one weapon which is vastly more powerful than a century ago—the accumulated scientific knowledge and the recognition of its value in industrial enterprise—and this may greatly hasten the period of recovery from the ravages of war.

Obituary.

The death is announced of Mr. T. ARTHUR EVANS, electrician, of Swansea. Deceased, who was 45 years, had taken an active interest in local affairs.

The death has taken place at Littleborough of Mr. THOMAS HUMPHREYS, electrical engineer to Messrs. Fothergill & Harvey, Ltd. Deceased was about 51 years of age, and before the Corporation established its electricity undertaking he put in the first electric light installations in Rochdale at the Market Company's premises and at Messrs. John Bright & Bros.' mill. Later he became manager of the Rochdale Electric Company, a position he held for about 20 years, leaving shortly before the war to take up duty as electrical engineer to Messrs. Fothergill & Harvey.

Personal.

The degree of D.Sc. has been conferred by the University of Leeds upon Admiral Sir Henry B. Jackson, G.C.B., K.C.V.O., F.R.S., and Prof. W. H. Bragg, C.B.E., M.A., D.Sc., F.R.S.

The Senate of the University of London have appointed Sir Cooper Perry to the post of principal officer, which has been in abeyance since Sir Henry Miers' resignation in 1915.

Mr. R. E. Entheven, C.I.E., has concluded his work under the Board of Trade as Controller of Import Restrictions, and he has returned to the India Office.

The Admiralty have received, with great regret, the resignation of Prof. J. C. McLennan, O.B.E., F.R.S., whose services had been lent to the Admiralty by the University of Toronto since 1917, and who, since January last, has been acting as scientific adviser to the Board. Prof. McLennan, who has recently found it necessary to return finally to his duties as professor of physics and director of the physical laboratory in the University of Toronto, has rendered most important services to the Admiralty, particularly in connection with the development of helium gas.

Arrangements for the Week.

FRIDAY, Nov. 28th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Discussion on "Lubrication," to be opened by Dr. T. E. Stanton, F.R.S.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

6.15 p.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper on "A Test of Watertight Bulkheads for Ship Sub-Division," by Mr. A. Hogg.

STOKE-ON-TRENT ASSOCIATION OF ENGINEERS.

7 p.m. At the Council Chamber, Town Hall, Hanley, Stoke-on-Trent. Lecture on "Notes on Theory and Practice of Lubrication," by Mr. J. P. Hamer.

MONDAY, Dec. 1st.

INSTITUTION OF ELECTRICAL ENGINEERS—WESTERN CENTRE.

7 p.m. At the Merchant Venturers' Technical College, Bristol. Address by Mr. W. A. Chamen.

ROYAL SOCIETY OF ARTS.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Synthetic Drugs," by Dr. J. T. Hewitt, F.R.S. (Lecture I.)

TUESDAY, Dec. 2nd.

INDUSTRIAL LEAGUE AND COUNCIL.

2.30 p.m. In the Council Chamber, Guildhall, London, E.C. Lecture on "Government Control and Industry," by the Right Hon. Lord Emmott, G.C.M.G.

7.30 p.m. At the Y.M.C.A., Tottenham Court-road, London, W.C. Lecture on "Co-operative Production," by Mr. T. Owen Jacobsen, J.P.

INSTITUTION OF ELECTRICAL ENGINEERS—NORTH-WESTERN CENTRE.

7 p.m. At the Engineers' Club, Manchester. Informal Discussion on the Present Position of Electric Power Supply.

RÖNTGEN SOCIETY.

8.15 p.m. At the Medical Society of London, 11, Chandos-street, Cavendish-square, London, W. Paper nn "The Action of Induction Coils," by Dr. E. Taylor Jones. Description and Demonstration of New High-speed Interrupter for Induction Coils, by Major Cooper, R.A.M.C.

WEDNESDAY, Dec. 3rd.

INDUSTRIAL LEAGUE AND COUNCIL.

5.30 p.m. At the Institute of Journalists, Tudor-street, London, E.C. Open Discussion on "Scientific Management."

INSTITUTION OF ELECTRICAL ENGINEERS—SOUTH MIDLAND CENTRE.

7 p.m. At the University, Edmund-street, Birmingham. Lecture on "Dielectrics," by Mr. G. L. Addenbrooke.

SOCIETY OF TECHNICAL ENGINEERS—NEWCASTLE BRANCH.

7.30 p.m. At the County Hotel, Newcastle. Discussion on the Third Party Policy.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. At the Royal Institution, Colquitt-street, Liverpool. Paper on "Marine Propelling Shafting, Bearings and Supports," by Mr. J. Watson, M.I.N.A.

FRIDAY, Dec. 5th.

INSTITUTION OF ELECTRICAL ENGINEERS—STUDENTS' SECTION.

7 p.m. At the City and Guilds Technical College, Leonard-street, Finsbury, London, E.C. Paper on "Thermionic Magnifiers," by Mr. H. M. Barlow.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Paper on "Some Notes on Extra High Tension Switchgear," by Mr. E. F. Hetherington.

TECHNICAL INSPECTION ASSOCIATION.

7.30 p.m. At the Society of Arts, John-street, Adelphi, London, W.C. Paper on "Inspection and Testing of Materials," by Messrs. R. D. Summerfield and H. J. Davey.

Mr. J. A. Robertson on the Electricity (Supply) Bill.*

The part played by the electrical industry in the war is being recorded officially by the Ministry of Munitions, and the first portion of the published returns dealing with power supply during the war reveals some striking results. When called on to provide an adequate supply of power for the manufacture of munitions, power stations were labouring under serious disadvantages in 1915, as power stations were depleted. When later on the country became organised for war munitions, large and urgent demands for power were made. Existing plant had to be run to its full capacity, new plant had to be hurriedly installed, and risks taken which would not have been justified under any other than war conditions. Power stations were able nevertheless to meet all demands made by the Ministry, and thereby to assist in the manufacture of munitions, which could not have been turned out had a public supply of power not been available. One result of the increased electrical activity during the war was to stimulate its employment for ordinary industrial purposes, and to place electricity beyond all doubt as the most efficient and reliable cheapest form of power for all industrial and manufacturing purposes. Between August, 1914, and November, 1918, the supply of electricity from public generating stations was doubled, and the plant installed, or put on order during the war, was greater in capacity than all the plant in use in August, 1914. Most of this plant was supplied on the "rationed" principle, and it must be said that on the whole the Ministry of Munitions, who had the responsibility for issuing permits to enable plant to be purchased, carried out their duties with fairness and discretion.

It was not surprising that the increased use of electricity called attention to the possibility of cheap power production, and the question of centralisation under joint control became a problem of vital national importance. The difficulties in carrying out any scheme of unification were political rather than commercial or technical. The Board of Trade, since 1883, had granted provisional orders to companies and local authorities on the assumption that the local authority area already delimited for administrative purposes was also a suitable area for the supply of electricity. The Electric Lighting Act of 1883 undoubtedly favoured municipal control, and placed restrictions on private enterprise which at that stage tended to retard progress. Something may, however, be said for the Board of Trade. Public utilities such as water, gas and tramways had in previous years been entrusted to private companies, and the results were not encouraging. The Board apparently determined that this new public utility then used for lighting purposes only, and likely to be a strong competitor of the gas industry, should be placed under public control.

The Electric Lighting Act of 1888 was rather more favourable to private enterprise, but the power companies who obtained supply rights in perpetuity over large areas between 1898 and 1902 had not, up to 1914, made much progress in the direction of cheap power production, and the fact remains that it required the strain of this great war to bring the importance of cheap electricity supply into the region of national politics.

The first actual step in this direction was taken by the reading of Mr. Williams' Paper before the Institution in the early part of 1916.† This Paper put forward bold comprehensive proposals for national electricity supply under a board of commissioners in London. The scheme included the erection of super-stations, transmission lines and supplies in bulk to local authorities over districts to be set up by the commissioners. At a discussion on the Paper in Manchester in April, 1916,‡ I stated that Mr. Williams' proposals were impracticable under the conditions at that time, when the problem was really one of immediate and abundant supplies of power for all purposes. As an alternative I suggested the linking-up of existing stations as a means of increasing the output from the present plant, and affording reliability of supply. As an outcome of the discussion a committee of engineers was appointed about two weeks later to report on a linking-up scheme for Lancashire and Cheshire. The majority of the committee felt that the report to be of any value, must put forward a full scheme which would provide not only for linking-up, but for the joint ownership and control of generating stations. The second report was considered at a conference representing 35 authorities in December, 1917, and by a majority of two to one (each authority having equal voting power) the local authorities refused to consider the latter portion of the engineers' scheme dealing with the purchase of existing stations, and the erection of new stations. The decision was, I think, unfortunate. Had it been otherwise, Lancashire would have had the opportunity of setting an example to the rest of the country by carrying out proposals which were in all essentials identical with the main proposals in the Electricity Bill now before Parliament. Nevertheless a number of instances of voluntary linking-up have taken place. Perhaps, the most interesting of these is the recent linking-up of Manchester and Salford. A cable has been laid of 10,000 kw. capacity at 33,000 volts between the Moss Side sub-station of Manchester Corporation and the Salford generating station in Frederick-road. The energy is stepped up from 6,600 to 33,000 volts at Moss Side, and stepped down again at Frederick-road to 6,600 volts, where the two systems are operated in parallel. In the meantime provision is made for a supply of 5,000 kw. by Manchester to Salford, but this can be increased to the full capacity of the cable by installing a second set of transformers. It may be mentioned that the Salford system in addition to operating in parallel with Manchester, also operates in parallel with the system of the Lancashire Power Company. The power company's system is connected to two generating stations each generating at 6,600 volts, so that we have a series of five linked up stations extending from Manchester, in the east, to Wigan, in the west.

Following the reports of the Lancashire Committee, the Special Committee on Power Supply appointed by the Board of Trade issued its report in June of last year, and as a result we have the Electricity (Supply) Bill which is now before Parliament. This Bill, which has now emerged from the Committee stage in Parliament, is by far the most important event in the history of electricity supply in this country, and is bound to exercise an enormous influence on future developments. The reports of the proceedings in Committee show that the proposals in the Bill have undergone the most exhaustive and searching scrutiny. Company and municipal interests have been ably represented, and while compromises have naturally had to be effected, the Bill will, I think, be accepted in its present form by the supply industry at large, as being, on the whole, a comprehensive and satisfactory measure for dealing with what is now an extremely complicated problem. The most striking feature of the Bill is the enormous powers which are to be exercised by the five commissioners to be appointed "to promote, regulate and supervise" the supply of electricity. They will, in short, exercise complete control over the whole electricity supply industry. Such powers are quite unprecedented, and their exercise will call for men of undoubted standing and ability who can be trusted to act impartially, and who are free from any interest—political, commercial or otherwise—which might clash with their duties as commissioners. So far the only commissioner appointed is the chairman-designate, and it will be a source of satisfaction to power station engineers that the choice has fallen upon Sir John Snell, an ex-president of the I.E.E., who is not only an engineer of great ability and wide experience, but who possesses, to an exceptional degree, the confidence of all parties—municipal and company—who are interested in electricity supply.

The discussion of the Bill has largely centred round Clauses 5 and 7, and some material alterations have been made to both. Instead of setting up district boards in each of the districts, the commissioners now may exercise any one of three alternatives. They may leave matters as they are, or if they are not satisfied, they may hold an inquiry at which any local authority or other interested party may put forward a scheme for consideration, which the commissioners may accept, or modify or reject. If the scheme is accepted, a joint electricity authority may be formed under the scheme comprising the various undertakers within the district, with or without the addition of large consumers and other interests. This board will have power to take over existing undertakings in whole or in part, and exercise the provisions of the Act which apply to district electricity boards. The third alternative is that if the commissioners are not satisfied with the existing organisation, and if the authorities or those interested cannot or will not themselves put forward a scheme—*i.e.*, if the authorities will not voluntarily co-operate on a scheme which receives the approval of the Electricity Commissioners—the commissioners may then set up a District Board which will carry out a scheme, including the taking over of power stations and the erection of new stations with or without the consent of the supply authorities. The effect of the modification is to make the provisions more elastic, and to give the local authorities and companies themselves a chance to co-operate on a combined scheme.

The terms on which existing stations and transmission lines may be purchased as set forth in Clause 7, have, as expected, given rise to acute controversy, the criticism coming with equal force and measure from municipal and company representatives respectively. The "standard price," in the case of local authority stations, may either be the outstanding capital liabilities in respect of the station, payable in the form of annuities for interest and sinking fund charges, or, as amended, the local authority is entitled, if it desires, to have the price determined by an arbitrator on the basis of capital cost of the station, less depreciation. An increased amount is also to be paid on account of any portion of the station or transmission lines which has been paid for from revenue account. In the case of companies, the "standard price" is to be the certified cost of the generating station and transmission lines, less an amount for depreciation, to be determined by the Electricity Commissioners, and plus an allowance for "loss by severance." The critics of the purchase terms in the case of local authorities contend that owing to the operation of sinking funds and the increase in values, the generating stations of local authorities are worth considerably more than the standard price, under either of the alternatives offered. It will be found that, as a rule, local authority generating stations have redeemed on the average not less than 40, and in many cases as much as 60 per cent. of the original capital expenditure, and as the value of plant has increased from 2 to 2½ times over pre-war prices, the joint boards, or district boards, will make a very good bargain indeed. Another criticism is that the terms make no distinction between the prudent and imprudent local authorities. There is much force in this criticism, but it must be remembered that local authorities are not, strictly speaking, trading for profit. Their proper function as a public authority is to ensure that a cheap and efficient supply of electricity is available for the community they represent. The changes proposed in the Bill simply mean the transfer of their responsibilities and liabilities to the new authority, and they will reap the benefit of cheap purchase of their station by the district board in the reduced rates charged to them for bulk supplies.

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* Abstract of an Address to the North-Western Centre of the Institution of Electrical Engineers.

† The Electrician, Vol. LXXVII., p. 48.

‡ The Electrician, Vol. LXXVII., p. 175.

In the case of companies the conditions are somewhat different. They have invested their shareholders' money in providing electricity supply under Parliamentary sanction with the perfectly natural object of making a profit from the business. Whether the ownership of public utilities by private companies under limited tenures is a right policy or not need not be discussed now. The fact remains that these companies were willing to risk their capital in providing public supplies of electricity at a time when the local authorities themselves were not prepared to do so. They have been operating under Parliamentary guarantees regarding purchase terms, and it would be contrary to all our Parliamentary and national traditions to take their generating stations from them now on terms less favourable than they are entitled to under existing Acts of Parliament. The terms were discussed at considerable length in committee, and it is unfortunate that a compromise satisfactory to the companies could not be arrived at. The matter will probably be raised again in Parliament. The Government are evidently prepared to recognise that the companies are entitled to better terms, because in a later clause—Clause 12—it is provided that if the company's generating station is taken over by a district board, the company may within two years call on the district board to take over their distribution system also, at the original capital cost of the whole undertaking, less the sum already received for the power station. The effect is, of course, that if the companies also lose their generating stations and wish, as many of them will, to dispose of their distribution systems, they will receive the original value of the whole undertaking, including the station, without any deduction for depreciation. The provisions of Clauses 7 and 12 as they stand appear to be designed to drive private companies out of the business of electricity supply, and I trust that Clause 7 may be so amended that the companies will receive the same terms for the station alone as it is proposed under Clause 12 for the whole undertaking.

There is one provision in Clause 7 which is, I think, open to very grave objection. Sub-section 5 stipulates that when a generating station has been taken over by a district board, the board is obliged to supply the authority from whom it is taken with electricity not less in amount than could have been generated at the transferred station, and at a price not greater than that at which it could have been generated, having regard to any reduction of costs which may have been expected to accrue from improvements contemplated on May 8, 1919. This provision simply bristles with difficulties, and will give rise to interminable disputes. Who is to decide what the station could have generated at if certain contemplated improvements had been carried out? This is a task too big even for the commissioners. The chief objection, however, in my opinion, is one of principle. This provision strikes a blow at the main purpose for which this Bill has been drafted. The anomaly at the present time in nearly all industrial districts is the difference in prices and rates charged by the various supply authorities. A consumer situated in one area may be charged a certain rate for electrical energy, say, to a cotton mill. Half a mile away a consumer requiring an exactly similar supply operating under the same circumstances as regards load factor and costs of transmissiom, may be charged rates 50 per cent. more because the energy is furnished by another supply authority. Surely we had a right to expect that these anomalies would be swept away by the new Electricity Bill.

Under Sub-section 5 the anomaly is to be continued in perpetuity. The various supply authorities will be entitled and obliged to receive bulk supplies from the district board at prices based on the previous costs of generation. If the generation costs at one station were high, the prices charged by the district board will be high, although the cost of transmission may actually be less than in other cases where the authorities are entitled to a cheaper supply because they were previously, for some reason or other, able to generate more cheaply than their neighbours. If such a provision has been introduced as a safeguard it is entirely illusory, because the district board is only bound to supply the amount which could have been generated at each station, and, if a further amount is required, there is apparently no limit to the price which may be charged. This subsection in my opinion, is a most serious defect in the Bill. I trust it will yet be deleted, and that the district boards will be obliged to supply energy to the distributing authorities over the whole of the respective electricity districts at uniform rates. Under Clause 16 of the Bill, which authorises district electricity boards, with the sanction of the Electricity Commissioners, to exercise their powers through authorised undertakers or by companies formed for the purpose, the committee have by a large majority limited the district board to exercising their powers through "authorised undertakers" only. The principle of public contraol has therefore been established in cases where schemes are financed with public money.

In Clause 17 the compensation terms will be accepted as generally satisfactory by those interested, and under Clause 15 the Board of Trade can authorise the power to abstract water from rivers or canals, and has now been extended to include authorised undertakers. Powers are also conferred with regard to wayleaves and hiring by all local authorities, and an important proviso has been added that the fittings and appliances provided on consumers' premises, either before or after the passing of the Act, are to be held to form part of the undertaking.

It is gratifying to note in addition to their administrative powers, the Commissioners will have power to make experiments with the object of improving the supply of electricity. There will be no question as to the necessity and urgency of such work. In this respect manufacturers may be very often short-sighted, and as they are now pooling their commercial resources, I suggest that, with proper understanding, and good faith, they might be able to carry out co-operative research work for the benefit of the whole industry. There is still much investgiation required regarding the properties of insulating materials for high pressure cables and generating plant, the corrosion of turbine blading, protective devices for high-tension system, switchgear to deal with pressures up to 50,000 volts, and many similar problems. It is likely that within the next five years a sum of not less than 100 millions will be expended in the construction of new stations and transmission lines, and a small fraction of this amount, say, a quarter of 1 per cent., expended immediately on research work, would prove a thoroughly sound investment. It appears certain that within a very short time the Bill will become law, and the supply authorities will be faced with some interesting and vital problems. When the commissioners come to create electricity districts, it will be found that in not more than one or two industrial areas matters will be allowed to remain as they are. Certain districts, where the power demand is not a pressing problem, may also be left alone in the meantime, but in the remaining districts—Lancashire, Yorkshire, the North and South Midlands, South Wales and London—joint or district boards are certain to be formed. It appears likely that the Lancashire and Cheshire area will be one of the first to be dealt with, probably under three Boards representing South-East Lancashire and a part of Cheshire, North Lancashire, and South-West Lancashire, the latter including the stations in the Wirral peninsula in Cheshire. The supply authorities in these districts will have the opportunity of formulating schemes of their own for submission to the Electricity Commissioners. Under such schemes the boards may be composed of authorised undertakers only, and it appears that in most cases such a board will be preferable to a district board which will have outside representatives, representing labour and large consumers. The question is, Will the local authorities be able to sink local jealousies and co-operate with each other and with companies for the purpose of a joint scheme? The engineers, who are the responsible advisers of their committees or boards, have a tremendous responsibility, and their attitude will largely determine whether a voluntary scheme is adopted or not. It is to be hoped that on this occasion, and having in view the fact that if they fail to agree on a voluntary scheme a district board will be set up, in which they will be compelled to take part, they will take a broad view, uninfluenced by personal or local considerations.

(*To be concluded.*)

Testing Transformers by the Alternating Current Potentiometer.

By DOUGLAS C. GALL.

It is doubtful if any method of instrument transformer testing offers such facilities as the employment of the alternating-current potentiometer. The reason for this lies chiefly in the difficulty of getting an alternating-current voltmeter to read to 0·001 of a volt, and, further, that the measurements with the wattmeter are necessarily roundabout.

For the determination of phase-displacement and ratio of transformation three readings only are necessary, at each load, when making the test, and these readings are, furthermore, self-checking, inasmuch as they are three voltages forming three sides of a triangle thereby checking if their measured magnitudes are in agreement with the angles measured between them.

It is sometimes the custom to compare instrument transformers with a standard transformer. The advantage of this method is that the differences being small, errors in the readings will be a still smaller proportion of the whole value. This method can still be used with the potentiometer, with advantage, as will be described, but it would seem that the independent test is quite accurate enough for all ordinary purposes.

The following is a description of a test made upon a current transformer of nominal ratio 1 to 10, secondary full-load 5 amperes.

The primary side was fed at a reduced voltage from the same source as the potentiometer. In the primary circuit was connected a 0·01 ohm Drysdale-Tinsley non-inductive standard of the well-known type. A similar standard resistance of 0·1 ohm was connected in the secondary side, so arranged that the voltage across these resistances were in opposition, and since they were in the same ratio as the nominal transformer ratio, were nearly equal. The inner side of the resistance was interconnected.

Since these two resistances were non-inductive the pressure drops across them were in phase with the primary and secondary currents, so that the displacements of these two pressures are the primary and secondary current displacement.

Measures were taken of the pressure P_1 across the primary resistance r_1 and P_2 across the secondary resistance r_2, and ΔP the difference between them.

These three are shown vectorially in Fig. 1.

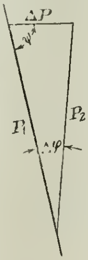

FIG. 1

As said above, $\Delta\varphi$, the angle between P_1 and P_2 is the phase displacement between primary and secondary, and may be read direct on the phase shifter of the potentiometer to 0·2 deg. or closer if provided with a micrometer head, but since it is important to know this angle with considerable accuracy it can be found with much greater exactitude from the simple relation existing between the three sides of the triangle.

$$\Delta\varphi=\sin^{-1}\frac{\Delta P\,.\,\sin\psi}{P_2};$$

or, when $\Delta\varphi$ is small, as is usually the case,

$$\Delta\varphi=57{\cdot}3\;\frac{\Delta P\sin\psi^0}{P_2},$$

from which the error $\delta\varphi$ in $\Delta\varphi$ resulting from an error $\delta\psi$ in ψ will be

$$\delta\varphi=57{\cdot}3\;\frac{\Delta P\,.\,\cos\psi}{P_2}\;.\,\delta\psi.$$

That is, an error in $\Delta\varphi$ calculated from an error in the observed value of ψ is proportional to $\cos\psi$, and therefore less than the error in ψ, and in general much less, since the relation $\Delta P/P_2$ is small. If r_1 and r_2 are well chosen so that ψ equals nearly 90 deg., $\cos\psi\simeq 0$, the error in $\Delta\varphi$ is practically independent of any error in ψ, and will depend only upon the numerical values of ΔP and P_2, which can be relied upon as measured on the alternating-current potentiometer to within 0·1 per cent. and with practice to 0·05 per cent.

The value of $\Delta\varphi$ obtained by calculation should agree with the observed value of displacement between P_1 and P_2: otherwise, there must be some error of observation greater than is permissible.

Table I.—*Observed Values.*

P_1.	P_2.	ΔP.	ψ.	$\Delta\varphi$ observed.	$\Delta\varphi$ calc.	R.
Volts.	Volts.					
0·11935	0·09734	0·02727	30°	8·2	8·052°	12·25
0·13872	0·11901	0·02541	32°	6·8	6·497°	11·65
0·22061	0·20800	0·01842	42°	3·4	3·39°	10·59
0·27998	0·27470	0·01267	59°	2·1	2·263°	10·18
0·50940	0·50808	0·00870	77°	1·0	0·956	10·01
0·54355	0·54757	0·00668	91°	0·5	0·716°	9·917

R, the ratio of transformation, is obviously I_1/I_2, when I_1 is primary and I_2 secondary currents, so that $R=P_1r_2/P_2r_1$.

The values of the 0·01 ohm and 0·1 ohm standards were 0·010004 and 0·09996 respectively.

An additional reading on both primary and secondary is required to determine the efficiency, and the separation of the losses may be carried out by varying the frequency if required.

In the case of the potential transformer, the connections may be made as in Fig. 2.

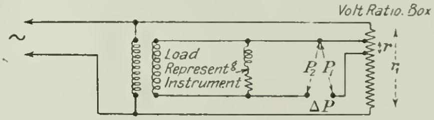

FIG. 2.

A volt ratio box is connected across the primary as shown, and the secondary connected to one side, so that the potentials P_1 and P_2 are in opposition and nearly equal.

The three readings P_1 and P_2 and ΔP are again taken with varying values of $P_{\cdot 1}$, and as before the displacement between primary and secondary

$$\Delta\varphi=57{\cdot}3\;\frac{\Delta P\sin\psi}{P_2},$$

and the ratio of transformation $R=P_1r/P_2r_1$ if the volt ratio box is non-inductive. If this is not the case it can be corrected, but it has been found possible to construct volt ratio boxes with a negligible time constant.

The loading of the secondary may be varied if required, or a fixed load may be put in circuit equivalent to the instrument

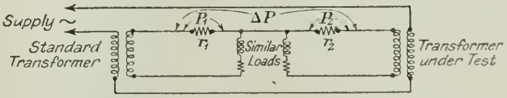

FIG. 3.—COMPARING CURRENT TRANSFORMERS.

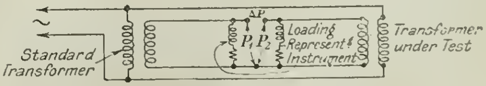

FIG. 4. COMPARING PRESSURE TRANSFORMERS.

it is intended to use. For reproducing instrument constants a variable inductance with inserted resistance is most convenient.

If the comparative method is preferred it may be connected up with a standard current transformer and the difference measured, as in Figs. 3 and 4.

In comparing current transformers three readings taken across non-inductive standards P_1, P_2 and ΔP and phase angles as given on the phase-shifting transformer, ψ being the angle between P_1 and ΔP.

Then comparative ratio of transformation in percentage of standard,

$$R = 100\,\frac{P_1 \cdot r_2}{P_2 r_1}\,{}^0\!/_0 .$$

Displacement from standard $\Delta\varphi$ is given by

$$\Delta\varphi = 57{\cdot}3\,\frac{\Delta P \sin\psi}{P_2}.$$

In Fig. 4, ratio of transformation in percentage of standard.

$$R = 100\,\frac{P_1}{P_2}\,{}^0\!/_0$$

$$\Delta\varphi = 57{\cdot}3\,\frac{\Delta P \sin\psi}{P_2}.$$

The above tests were carried out at the works of Messrs. H. Tinsley & Company, at South Norwood, who kindly provided all facilities necessary for same.

Dr. C. C. Garrard on Engineering Ideals.*

The Institution has passed in recent years through very trying times, but has emerged from them rejuvenated and strengthened and ready for the great work which lies in front of it. But it behoves the territorial centres by their work to justify the confidence which the Institution has reposed in them, and it is to be hoped that the South Midland Centre will take the lead in this movement. Among the matters calling for urgent attention on our part is the resuscitation of the Students' Section and the formation of a sub-centre at Leicester. It is gratifying to be able to record a decline in the feeling of antagonism to the Institution which formerly existed in some quarters. It is of the very greatest importance that all electrical engineers who take a pride in their profession should support the Institution. It too often happens that the labour and application necessary for engineering work falls upon the engineer's shoulders, while the material reward, which is the direct result of his work, goes elsewhere. And it is easy to see why this is so. Absorbed as he necessarily must be in his work, the engineer's whole mind is given to the actual matter in hand, to making the machine work, to designing and constructing the apparatus, and the like. His commercial colleague, however, does not bother his head about such matters, but stands by waiting for the propitious hour to arrive when the profits are forthcoming, which he generally takes, and leaves the engineer stranded. While, however, we have to recognise the facts there is no need to acquiesce in them. Rather should it be the object of all organised bodies of engineers to protest against them, and to endeavour to bring about a more just state of affairs. In other words, one of the prime objects of an institution such as ours is to set up a true criterion of engineering work, and to see to it that the reward of the engineer is in conformity with this rather than with the fortuitous and accidental commercial standards at present in vogue.

Now, while the prime function of the Institution is the guardianship of the standard of electrical engineering accomplishment it must not be forgotten that engineers must live by the exercise of their calling. The Institution must, therefore, act as a support for them in the assertion of the high status of their profession, and we must all rejoice to see that in recent years the Institution has become alive to its responsibility in this respect. Very much more, however, is necessary to be done in this direction. Another aspect from which the value of the Institution can be appreciated is that it develops a broad-minded outlook in the attitude of its members to engineering in general. This is a day of specialisation, and each one of us must especially cultivate some particular corner of the vast field of engineering. There is danger in this of acquiring a narrow-minded point of view. Some members of the Institution never, or rarely, come to its meetings, because the Papers deal with subjects not immediately concerned with their special everyday work. Such an attitude is deplorable. One has only to make a very casual examination of the lives of great engineers to find that they are always very extended and general in their outlook. It is surprising to find what hints and help one can obtain in one's own particular branch of work by a study of engineering applied in other directions.

The question is sometimes asked, "What benefit do I obtain by becoming a member of the Institution?" The question should be rather, "In what manner would my membership enable me to help forward the cause of electrical engineering?" The greatness of a national institution, and ultimately the benefit accruing to the individual members, is measured by the work it does in the national interest. It might be profitable if we could for a few moments to-night consider the work of the Institution from this point of view, and, in particular, to direct attention to three special aspects of this question, as follows: The national importance of bringing to bear the engineers' knowledge and training in the executive control of affairs; the permeation of industry and commerce by the scientific method; the promotion of standardisation both as regards products and performance.

There is no doubt that we are at the present moment face to face with a fundamental change in the relationships between the State and industry. The great industrial problem to-day is the increase of output. Now, if the State approaches its new tasks in its old spirit we have nothing in front of us but stagnation or decline. The tradition of the Civil Service, which has, in the past, carried on the business of Government, has been that of administration, and in the production of mere administrators there is no doubt it has been very successful. For industrial progress, however, something more than mere administration is necessary, and that is creative effort. Herein lies the function of the engineer, who is above all things a creator. Now, it may be argued, that one could still go on under the old scheme with the administrator in charge and the engineer called in from time to time as a hired man, something like the man who comes to tune the piano, to do the creation when it is thought to be necessary. This same idea has been the curse of British industry in the past, and it certainly will not do in the future. Even the workman is demanding that his status shall be raised from that of an employee to a partner. If the engineer is to perform his function properly in the new society which we see arising around us, he must assume responsibility, as it is only this sense of responsibility which will stimulate his brains to do the work that is required of him. As members of the Institution we must insist that the Institution adopts this attitude, and be ready at all times to maintain it.

The basis of the scientific method is accurate measurement. The scientific investigator always proceeds along the path of careful measurement and comparison. In applying scientific methods to commerce and industry we do exactly the same; by means of statistics and accurate costing we obtain figures of absolute and relative efficiency, and the data necessary for correct judgment. It is to be regretted that engineers have not given the subject of costing, as applied to engineering manufacturing, the attention it deserves. It is within my knowledge that not many years ago the Papers Committee rejected a Paper on the subject, not because it was a bad Paper, but because it was not considered a suitable subject for discussion by the Institution. Costing as applied to the electrical supply industry, is, of course, recognised as providing the ultimate test of the working of a supply station, which is judged finally upon the cost per unit generated. When we consider a manufacturing works, on the other hand, no such simple test can be applied. In the past, however, competition has provided an alternative one. The costs eventually have affected the selling price, and that factory which could not sell cheaply had to close down. With the development of industry at the present day this kind of check is failing. Industry is becoming more and more organised, and price competition between the different factories less effective. It is conceivable that a works, forming part of a large combination, could go on for years working in a most inefficient manner because it is protected from the crude but effective test of competition. With the organisation of industry, therefore, and the limitation of competition, both, it may be said, inevitable and beneficial tendencies, the development of scientific costing must go hand in hand.

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* Abstract of an address delivered to the South Midland Centre of the Institution of Electrical Engineers.

A cost competition must in fact, in the future, place the hitherto obtaining price competition in more and more branches of the engineering industry. In order that this may be effective, however, two things are necessary: The details of costs will require to be published and publicly discussed, and the cost keeping at the various factories must be conducted according to a common principle.

As regards the first condition the engineering industry is hardly in a condition at present to agree to it. Nevertheless, there is no doubt that much greater publicity as regards such matters will be usual in the future. Indirectly such publicity would have a very good effect in showing everybody where the main items of cost are incurred. It might do something to help dissipate the erroneous notion, still industriously propagated, that manufacturing is a system whereby the workman is robbed of the greater part of the product of his labour. It is in this way, there can be no doubt, that a good deal of the industrial unrest at present handicapping trade can be removed. Every manufacturer has got to face the demand of labour for a voice in the control and direction of industry. If this demand is answered by a simple negative, I am afraid disaster will result. The only safe road is to work incessantly for a true co-operation between labour, capital and management, and a necessary preliminary step is to place upon the table the true economic facts governing the situation.

The second condition mentioned is necessary, as it would be useless comparing costs in various factories if these are not obtained by the application of a common principle. A considerable amount of work has been done in the United States with the object of securing such uniformity in cost-keeping methods among electrical manufacturers. We have to recognise that the days of pure individualism are over, and that progress in the future will depend more and more upon co-operative effort. The standardisation of accounting and costing would, I am convinced, help forward this ideal in no small measure.

It is now universally recognised that a great extension of the idea and practice of standardisation is necessary if the problems in front of the engineering trade and profession are to be solved. This has been, there can be little doubt, recognised by our late enemies. During the war a body known as the "Deutsche Industrie Norm" was formed in Germany to advise in the matter of uniformity of pattern and method of manufacture as regards the whole industry of the country. In other countries similar movements are taking place. Hitherto, in this country, the idea of standardisation has, to too great an extent, been confined to settling upon agreed dimensions of parts and the like. Standardisation, however, properly understood, covers a much wider field, including the standardisation of methods of manufacture and the fixing of standards of quality and performance. In such work our Institution should take a leading part. The Institution has, in collaboration with the other engineering societies, set up the Engineering Standards Association as the authority for engineering standardisation in this country. It would be a mistake, however, to leave everything to the association. The spade work, and especially the propaganda, must to a large extent be done outside it. It might be as well here to consider for a moment the idea, still very common, that standardisation retards progress. This fallacy was dealt with very effectively by a writer recently as follows ("Alfred Herbert, Ltd., Monthly Review," October, November, December, 1918):—

> Standards do not restrain improvement. On the contrary, if rightly understood, they promote improvement In any well-ordered works improvement becomes a specialised branch distinct from manufacture. Special attention is given by a special man or staff, to alteration of design and to complaints and suggestions from users. If the design is full of diversity there is no basis for improvement. As soon as it is standardised it becomes possible to localise faults. Some article turns out in use to be too weak or too long or too small in diameter. If the article was made in a diversity of strengths and sizes and quality of material, there is no telling whether or how it should be altered. Perhaps the complainant was merely unlucky in getting a short one or a weak one. As soon as it is proposed to set standards the designers are put on their mettle to find the right properties. If experience shows that their first efforts are in error they amend the standard. If the amendments are too frequent an investigation will probably take place to see whether such amendments were really justified by new circumstances, or were due to lack of care or skill in the earlier changes. Thus an incentive and an absolute premium is put on improvement.

It is a mistake in standardisation work to attempt to attain absolute perfection at the first trial. This results in very lengthy delays occurring in the issue of specifications. The method adopted by the American Society for Testing Materials of issuing tentative specifications has much to commend it. When issued in this way they are immediately subjected to practical tests and criticisms, and any weaknesses are soon found out or improvements suggested; thus more rapid progress can be made. The standardisation of the quality and testing of materials could be considerably extended with advantage in this country.

In the past the standard of quality and performance has mainly been a matter of tradition. Standards of workmanship, for example, have been handed down from workshop to workshop. The method whereby this kind of thing can be put upon a sound basis, however is illustrated in B.E.S.A. Specification No. 25 on "Errors in Workmanship." The necessity for fixing a standard of quality and performance is shown by the war, which, by its disorganisation and destruction, has appreciably lowered the standard of many industries, and has provided a possibility of a permanent loss, in some instances, of the former high standard altogether. Many of the Bulletins issued by the American Bureau of Standards are excellent examples of the standardisation of performance.

Almost the only similar things with us are the Institution Wiring Rules and the Factory and Workshop and Mining Regulations. There is a vast field of work for us to cover in the extension of these. "A good engineering job," however, is as capable of being as accurately defined as, for example, the temperature rise of a dynamo, and it should be one of the main objects of institutions such as ours to discuss such standards with a view of the re-levelling up and fixing.

It is intended during the forthcoming session to have a discussion one evening on some of the specifications issued by the B.E.S.A. This, in my judgment, should be a permanent feature in all future sessions, so that the specifications as they are issued should come up automatically for discussion by the members. It seems that this matter is of such importance that a special committee should be set up by the Council to deal with the question. At present we have the five sectional committees, who investigate progress in the subjects assigned to them, and take such steps that the Institution has brought before it particulars of all new developments. The committee I suggest, however, would be concerned with the consolidating of the position from time to time.

It is somewhat difficult to find a suitable name for such a committee. For the want of a better one I suggest "Standardisation and Recommended Practice Committee." Its work would not clash at all with that of the Engineering Standards Association, but would be confined to promoting discussions on, and recommending, the use of the specifications when issued, and for the preparatory work which is necessary to be done to enable the Standards Association eventually to prepare the actual specifications. It would also serve as a means of obtaining collective solutions of many problems which are unsolved at present because the information which would provide the solution desired is scattered, and therefore to a great extent valueless.

Siemens Dry Cells.

Messrs. Siemens Brothers & Company, Ltd., of Woolwich and London, have recently issued a new price list of their dry cells for general purposes, for telephones and house bell circuits, and of their pocket and electric torch batteries, etc. The Siemens dry cells, which have been a product of the Company's Woolwich Works for so many years, are now appearing under a new label. The introductory matter in the list includes some information which should help to remove some popular misconceptions regarding the employment of dry cells generally, and then particulars; with dimensions and weights and technical information concerning the various types of cells manufactured by the company are given. The Siemens cells embody a knowledge gained by continued research and applied to manufacture, and qualified judges accept them as a criterion for durability, as well as high and uniform output.

Illustrated particulars are also included of the Siemens "inert" cells which may, it is claimed, be stored for an indefinite period in any climate without deterioration. The special feature of these cells lies in the fact that when they leave the manufacturer's works they contain an exciting agent in an absolutely dry and inactive condition. No action will be found to take place within the cells, nor can any current be drawn from them until plain water has been added. Their electrical output is not reduced by keeping them unchanged in any climate, and it is claimed that they are superior to all other cells for which similar characteristics are claimed, and they possess all the properties of dry cells of the highest class. Instructions for charging the cells are included. Our illustration shows the new label which the company are now using.

Some Personal Problems in Electrical Development.*

By J. W. BEAUCHAMP.

Whilst our industry has been devoting its energies to war work an immense change has taken place in the general outlook towards electrical methods, and certain sections of our business now stand upon a slowly accumulated goodwill which at last promises adequate reward. Our work is founded upon the fact that man needs artificial light, artificial heat and mechanical power. These services have in the past all been attained by the consumption of some form of fuel, chiefly coal. When, however, we employ coal to produce electricity, we pass on to the user not a fuel, but rather a vehicle or carrier of energy which can be employed in the form of light, heat or power. The real point to be kept in mind is that the ultimate user really calls for these services—that is to say, he desires neither coal, gas or electricity as such, but only a form of energy that will do his work in the most economical manner. The conditions under which this form of energy is supplied are diametrically opposed to those which obtain in an ordinary trading concern, where the costs are closely proportional to the amount of the commodity produced, and where the expenditure can to a great extent be varied to meet fluctuations in demand, so that while private traders are allowed to follow the general upward movement in prices with but little criticism, they are usually ready to complain of an advance in price of gas or electricity, and to treat as a grievance changes in condition of sale or working, forgetting that it is undesirable that even a small section of consumers should be served at rates which entail a loss.

The principal problem before supply engineers at the present time is the hous hold consumer, who appropriates a small part of the machinery and mains system, requires service cable and fittings, and must bear his share of the cost of repairs, supervising, meter reading and accountancy. All these items have increased greatly in cost, and they must be recovered before the units demanded are taken into consideration. On the other hand, improvements in lamps, restrictions on behalf of coal saving and war time lessons in using daylight, together with economy generally, tend to reduce the demand for domestic lighting. To lower costs of supply and installation work, or to increase the use of electricity and so obtain a larger return from each connection, and bring down the cost of material and apparatus by enlarging the market for it, are methods of attacking these difficulties; but the second offers the greater and better prospect at the moment. It has been too much taken for granted that the consumer shares our interest in the intricate principles involved in our work. We talk to him in terms which only mystify, and have always tried to show him too much of the work, instead of concentrating upon the results. So far very little has been done to create a demand for electrical methods, quite apart from any question of the particular means to be employed; but this work, though excellently done in some cases, has suffered from having been localised, though an attempt is now being made to convince manufacturers, contractors and supply authorities that efforts and funds should be pooled. But an advertising scheme, through broadly conceived and well supported, will not by itself do what we want. In addition a sort of practical and spiritual support of all those electrical men who come in contact with the public is needed, and we should, therefore, endeavour to convert all the electrical supervisors and workmen from the narrow trading point of view to the "service idea." Any large trading undertaking is in the nature of public service, and is not merely an organisation to produce something and hand it over the counter; but is an attempt to build up a business which shall be as great a benefit to the community as to the owners, by offering something useful, teaching people to want it, and following up the business in such a way that consumers are satisfied, and become themselves unconscious canvassers for further business. Such methods can be most satisfactorily adopted in the case of the supply of electricity and electrical apparatus. We must first get the attention of the public by judicious advertising, remembering to place most stress on the final result and on the total cost and advantages of the services offered. Having stimulated interest it is next necessary to show that we ourselves appreciate the advantages of the methods we are recommending. It would be worth while in this respect for employers to assist their staffs to use electrical apparatus in their daily life, and encourage them to make a sympathetic study of its peculiarities and cost in their own homes. They would thus constitute a paid body of experimenters who would learn the difficulties at first hand, and help manufacturers by producing a volume of accurately observed experiments, besides fitting themselves to talk to the public about the use and cost of electrical apparatus. Much harm has been done by the employment of men who have never been trained to understand the development of electrical apparatus or the difficulties of manufacturers and supply engineers. It is a mistake to allow anyone to deal direct with the public unless he has a fair appreciation of the leading problems of supply and costs, and realises the great future for electrical methods. It is not for want of help that the average electrical man makes so poor a case for his goods; it is merely lack of the correct or popular point of view. This question of personal attention to the consumer is the first point in any propaganda scheme, without which most of our efforts must be wasted.

The next necessity lies in improving showroom displays, taking fuller advantage of exhibitions and gatherings of all kinds, and giving facilities for free trial of apparatus. At the present time electrical showroom displays are poor. If a lady asks what it costs to use, say, a kettle, the attendant, after wrestling for a minute or so with small ill-stamped figures, announces in a doubtful voice that it consumes about a half unit an hour. The lady, with the preconceived idea that electricity is expensive, will probably wonder if it takes an hour to boil, and no doubt will not know the price of half a unit. It is a pity that tariff cost labels for all electrical apparatus have not been used by manufacturers, and it is more to be regretted because the cost of using electricity can be stated so accurately. With regard to showrooms, the single appeal idea so well carried out by certain firms and some of our own West End shops is worthy of commendation. The display of wiring accessories is generally waste of space, and attention should be concentrated on the final piece of apparatus which burns electricity in light, heat or power. In considering the question of domestic application, the cost of the installation and the prejudice of the householder against changing his methods are important factors, and open up a wide field for intensive propaganda. The work is worthy of much trouble and considerable expenditure because the field is so vast. It is most essential to take advantage of certain circumstances which have arisen during the war. First, the great shortage of domestic labour, with the result that householders were forced to give attention to the improvement of their methods, particularly in regard to kitchen work. We should, therefore, emphasise the all electrical idea of a background of these changed conditions, and in careful relations to certain other directions in which the home equipment is now being modified, the underlying point being that we are not out to offer something solely different from that which now obtains, but to provide an important item in a complete revolution in home practice, and to give a service so superior, and of such a different character, that some comparison between the cost of using our old method and that at present employed has little meaning. Every effort should be made to get new lighting business even among old consumers, for it is improbable for many years to come that many houses will achieve such a fully electrified light as not to make it worth while for contractors to get closely in touch with them, and to interest their original lighting consumers in lighting developments. The housing problem is one which will interest people of all classes for many years to come, and if it can be shown to a man who is forced to put down a £1,000 or £2,000 on an old house that by a very moderate increase in his capital expenditure he can sell or arrange to equip that house, with our assistance, as to make it almost equal in comfort and convenience with the best that the modern architect can offer there are immense possibilities.

Hoist Accidents.—The Factory Department of the Home Office states that the dangers associated with the use of hoists of the cage type in factories and workshops are not sufficiently realised, and the Home Office has issued Safety Pamphlet No. 2 (6d. net), giving details of methods and appliances by which they can be avoided. The most fruitful causes of accidents are found to be crushes between the cage and the door lintels or other projections in the hoist well, and falls down the well. Practically the whole of the former would be prevented by fitting a collapsible gate on the cage itself, with an interlocking mechanism to ensure that, unless it is closed, the cage cannot be started. If gates are not practicable, projections in the well-shaft that cannot be removed should be bevelled off, and lintels of doorways and window openings should be provided with bevel boards. To prevent falls down the well, each doorway should have a door fitted flush with the inside of the well, and so constructed that it cannot be opened until the cage is at rest opposite it, and that it must be closed and fastened before the cage can be moved away.

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* Abstract of a Paper read before the National Association of Supervising Electricians.

Prices and Conditions for the Supply of Electric Power to Works.

At a recent meeting of the Manchester Association of Engineers a discussion took place on the "Prices and Conditions for the Supply of Electric Power to Works." The subject was dealt with from the point of view of the purchaser by Dr. W. Cramp, and from the point of view of the supplier by Mr. Julius Firth. We summarize below the remarks of the openers on the question of price, and give a short account of the subsequent discussion.

Dr. W. Cramp said: The question is at what price and under what conditions will it pay me to take the power for my works from the local power supply. The expression "will pay me" must be understood to have a wider significance than that of mere finance. such as worry and distraction of thought from more important issues, to which a money value cannot be set. Apart from these general considerations there are two cases between which must be distinguished, viz.: A new works and existing works. In the former a decision is easier, since shops and machinery can be selected and placed to take the greatest advantage of the source of power selected, and further, there is no prejudice and no incubus of undepreciated capital. In such a case then the problem simplifies itself to answering this question. At what price per kelvin can an individual factory generate power? The answer is complicated by the corresponding questions: What sort of a factory and of what size; how many hours per week does it run, and of what nature is the load? In a chemical works or dye works, for instance, hot water is required for industrial purposes. Whenever this is the case steam can be used as a source of power under very advantageous conditions. The power in fact becomes a bye-product, and it is impossible for a public electric supply to compete. Again, in some industries the converse is true, for heat is given out by the processes, which can be utilised for the production of power, and here again a public supply can hardly compete, as power is actually a bye-product.

The following are examples of load factors in various works: Flour mills, 50 to 85 per cent.; chemical works, 70 to 90 per cent.; machine tool works, 12 to 25 per cent.: and steel works, 25 to 40 per cent. Taking a special case, and assuming a load factor of 25 per cent., and a plant requiring a maximum of 1,000 kw.. such a works will not need a full stand-by set. Two Lancashire boilers, a 1,000 kw. steam-turbo alternator, condensing plant, stand-by lighting set, and engine and boiler room can be allowed. Prices recently obtained show that the cost would be about £20,000, excluding land. Allowing annual charges of 12½ per cent., coal 2 lb. per kelvin at 35s. per ton, we have annual charges, £2,800; coal, £3,500; labour, £650; oil, waste, stores and repairs, £350; giving a total of £7,300. The units generated are 2·2 by 10^6, and the price per unit is 0·8d. The price per unit corresponding to this load factor is 1d. per unit. Now, if this is the case for an electric generating set the result is still more marked where a works can be driven direct from a steam engine, since in this case the generator, the motors and the cables would not be required. The motors and cables in the above instance are not included as they are common both to the private plant and to the supply from a public source. If on the other hand we consider a small works requiring, say, 140 B.H.P. that can be driven from an engine of the Garrett type, the price per unit for a 25 per cent. factor is as follows:—Capital charges, £375 per annum; coal, £465; labour, £250; oil, waste, stores and repairs, £150; or a total of £1,240, giving an equivalent per unit of 1s. 3d. The cost of driving from the power mains in such a case would be as follows: Cost of motors, cables, switchboard, etc., £1,000; 12½ per cent. of this sum, £125; labour, oil waste, etc., £45, or a total cost per unit of 1·18d. So that in this case there is a small financial advantage in adopting power from the local supply.

The case of replacing existing private plants is more difficult. For if the plant power is modern the public supply cannot usually compete with it in running cost, especially when loaded with the cost of scrapping the existing plant. If it is old and approaching the end of its economic life the cost of replacing it may just turn the scale in favour of public supply. The following instance is typical:—A mill having a load factor of 45 per cent. and a maximum demand of 160 kw. has a steam plant, of which the engine is in good condition, but the boiler needs renewing. The value of the plant in the books is £700, of which £120 represents the boiler. The insurance is £12 per annum. The actual running costs are given below, and the local supply offers electricity at 1·14d. per unit. The capital cost of a new boiler is £1,500, and of motors and cables, £1,600. Will it pay to adopt electric driving? It will be seen that the steam plant is nearly down to its scrap value. Taking £100 per annum for interest and depreciation, the present actual cost of running by steam is:—Coal, £1,580; labour, £520; ashes, £10; oil, waste, stores, etc., £108; insurance, £12; interest and depreciation, £100 or a total of £2,330, adding interest, insurance and depreciation for the new boiler, less £100 for the old one, we get £220, or a grand total of £2,550. The cost of running electrically will be:—Energy (allowing for improvement of drives), £2,900; interest and depreciation on cost of motors, etc., viz., £1,600, less scrap value of steam plant, £300; *i.e.*, £1,300. Depreciation, etc., at 12½ per per cent., £162; labour, £50; oil, waste stores, etc., £48; or a total of £3,160. In this case it is evident that the capital cost of the two alternatives is so similar that it cannot affect the question; and the annual cost of electrical driving will be at least £500 more than driving by steam. To sum up, a public supply cannot at present compete with a private plant in a new works if:—(1) The load factor exceeds 25 per cent. and the M.D. exceeds 1,000 kw.; (2) The load factor exceeds 30 per cent. and the M.D. exceeds 600 kw.; (3) the load factor exceeds 50 per cent. and the M.D. exceeds 250 kw. In an old works each case must be determined on its merits. These rough limits take into consideration the fact that for 50 per cent. load factors and over considerable standby plant is necessary.

Mr. Julius Firth said:—The question is a difficult one because, broadly speaking, the cost to the supplier for any particular consumer's supply depends so largely on how much he has to incur capital expenditure or to what extent it can be met by increasing the load, and also because the answer depends, not on the arrangements of the power house, but on the algebraic sum of the peculiarities of all the other consumers who are connected to the same company's mains. For the consumer of electrical energy, the cost of supply depends on his demand judged only partly on its own merits and partly in relation to the demands of others. So that to charge for a supply on its load factor alone may be very unfair as two consumers with identical load factors may cost so very differently to supply. Again the "maximum demand" as measured in any actual quarter may be much less than in others so that the question as to whether the maximum demand should be charged for by the day, month, or year, is really beside the mark. The engineer cannot adjust the amount of plant standing in his station each month end. The fixed part of each consumer's payment should be based on the maximum load he is entitled to demand and not on the quarterly fluctuations of his load. Again, as every new consumer who increases the station's maximum load involves sooner or later the purchase of additional plant, such new consumer should be compelled to give some sort of guarantee of permanence. This is easiest done by an agreement to pay interest on the capital expenditure involved for a certain period.

Now, although it is possible to go into questions of load factor and time of maximum demand for each large consumer, it is desirable to provide a simple tariff that will mete out something like justice to the ordinary consumer. One of the first facts unearthed is that there is a class of consumers out of whom it is exceedingly difficult to see any way of making a profit at all; an extreme instance of this, the large private house having a large maximum demand, which, coming as it does right on the peak of the station's load, involves a maximum amount of capital to be expended in providing for it, whilst the units taken per annum, partly due to the house being shut up for long periods together, are quite out of comparison, small.

In the case of a company the prices charged should be as high as possible consistent with not imperilling the success of the venture. The prices charged should in fact be only limited by the general policy of increasing business. In the municipal enterprise, on the other hand, no profit, as such, should be earned. The plant was put down by the ratepayers for their own use and it should be the endeavour of the management that each owner-consumer should contribute to the common funds in accordance with what his supply costs to make and deliver. It might conceivably be *good business* for a company to charge a uniform rate of ½d. per unit to all comers irrespective of what each cost them, hoping to make up on the swings what they lost on the roundabouts.

Cantankerous consumers sometimes come with a story that they can make their own supply at a lower cost than that charged by the supply authority, but certain points are apt to be overlooked in this comparison. Some of these are:—(*a*) The greater reliability of a public supply as compared with any private plant ; (*b*) The much greater ease in extending the supply of power as required in large or small increments and at short notice ; (*c*) The fact that the public supply is always on tap is a real money saver. Departments can be run separately on overtime, office lights run all night at stock taking times, repair shops run at week ends, etc. ; (*d*) The much better use both energy and money can be put to in one's own business instead of in the very specialised and tricky business of power manufacture.

In this connection be it noted that a municipality can borrow its money at 5 or 6 per cent., whereas capital is surely worth three or four times this in one's own business. Besides these there are the obvious advantages of large over small power plants in first cost, running costs and the effect of the diversity factor on the load factor, but all these are, or ought to be, reflected in the cost per unit. Whereas a, b, c, d are all "thrown" and give facilities to the manufacturer in the conduct of his own business not given by the private plant. Again, in estimating the costs of a private plant there are two items that are often lost sight of. These are :—(*a*) Cost of management : for, although the wages of the driver and stoker are properly included, the time and thought given to that department by the heads of the firm are seldom mentioned. Also the office work involved is often not charged against the power production department. All this really has to be paid for in the case of the private as much as in the public supply ; (*b*) Rent of space and buildings is sometimes forgotten, together with rates and taxes, heating, lighting and establishment charges.

DISCUSSION.

Mr. S. J. Watson (Bury) said during the past 10 years substantially all the small users had been swept into the net of the public electricity supply ; there could be no question that private plants of small size were unable to operate at competitive prices. Capital charges were of great importance in any comparison of relative cost. A private plant might operate during part of the year only, but the capital expenses continued during the idle period.

Mr. Butterworth said even a municipal supply might fail, and a man who had two strings to his bow was in a better position. This was a consideration of some importance, especially in the case of a repair shop, which must be kept going at all costs and be able to go on by night or by day. At his own works they made their own current for lighting, and used the Corporation supply for power ; but they also arranged to take current for lighting from the Corporation supply if it should become necessary. If one supply failed the other would come into operation. Some of the machines were not wanted all the time, especially in the foundry. They could be driven from the lighting set or from the public supply if the necessity arose.

Mr. Bedson said 25 years ago he put down a plant of 600 h.p. direct-current dynamo driven by a triple expansion engine at 160 lb. pressure. The dynamo was run at 160 revs. per min., direct driven, and energy was supplied at ⅜d. per unit. That bore out what Dr. Cramp had said about private plant. Nevertheless, he was a great believer in municipal undertakings. In his own works he had installed 11,000 h.p. in motors supplied from the mains. He thought so large a contribution to the municipal undertaking was a help to the small users, and in his opinion it was quite right that the large consumer should have some advantage in view of the benefit he conferred upon the small consumer.

Alderman Walker said a contract was based on the conditions of the particular case, and it was because of the difficulty of explaining those conditions to other would-be purchasers that it was necessary to keep those agreements private and not publish them. When the negotiations were proceeding for securing a load it was remarkable how very different the conditions were in what appeared superficially to be very similar work. Suppose the case of a chemical process carried on near the generating station, taking current at the voltage and under the conditions generated, their own feeders drawing into the works, keeping off the system during the peak load. Under such favourable circumstances the consumer could very well be offered a price much below what the ordinary consumer would be required to pay, and it was to the benefit of the whole system that that should be so. When such a customer was brought on the bus bars it pulled down the general cost.

Heating and Cooking Notes.

New Apparatus.

The cessation of war work, dating back to the Armistice twelve months ago, has naturally led to a return to the production of peace-time products. As a result a number of new types of heating and cooking apparatus have been produced by various manufacturers. Whilst progress is desired, and no one wishes this section of the industry to stand still, nevertheless the greatest drawback at the present time to the development of the use of electrical apparatus for heating and cooking is the cost of the apparatus and necessary wiring. So far as the apparatus is concerned this cost can only be reduced by bulk production and simplification of designs. Undoubtedly the need exists for a standard type of element which can be fitted to any type of radiator or cooker frame. It would have been just as logical for each manufacturer of electric lighting fittings to so design their fittings that only their own type lamps could be used, as it is for manufacturers of heating apparatus not to decide amongst themselves on a standard size element and adapt their frame designs accordingly. The manufacture of electric lamps progressed from the carbon filament stage to the present day half-watt lamp, but the stages of progress did not deter the public from installing electric light because they could change old lamps for new at a reasonable cost. Many a consumer is, however, deterred from adopting electric cooking and heating because the feeling exists that a comparatively costly cooker or radiator may be out of date, so far as the elements are concerned, in about two years. The use of standard size elements would remove this difficulty and hindrance to the development of the use of electric cooking and heating.

The Silverdale Miniature Hotplate.

Small cooking devices which can be used off an ordinary lamp holder on a lighting circuit always provide a valuable means of converting consumers to the use of electricity for cooking purposes. In this connection the Silverdale Miniature Hotplate, recently placed on the market by the London Electric Stores, is a welcome addition to this class of apparatus. The consumption is 150 watts, and the hotplate is intended for such purposes as boiling water for the early morning cup of tea, or for shaving water, or heating children's food. We illustrate a general view of this piece of apparatus in Fig. 1, and it will be noticed that it is supplied complete with a length of flexible cable and cocus adapter.

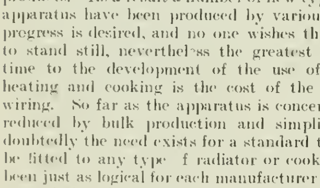

Fig. 1. The Silverdale Miniature Hotplate.

The Quain Immersion Heater.

An immersion heater, sold at the popular price of 15s. complete with flex and cocus adapter, and which can be removed from the liquid whilst on circuit, is certainly a development in British manufacturing, which will remove the necessity of purchasing apparatus of similar type manufactured in America. The heater is constructed of a high grade nickel-chrome alloy spiral resistance wound and mounted on a support of pure silica which is enclosed in a quartz silica casing, thus allowing the heater to be run equally well in air or in a fluid. We also understand the heater may be plunged into ice cold water without cracking. The whole is affixed to a wooden handle and protected by a nickel-plated heavy gauge wire frame. Such a piece of apparatus can be used for many household needs in the shape of warming water, food, &c., and, in addition, is a serviceable accessory in the doctor's or dentist's surgery.

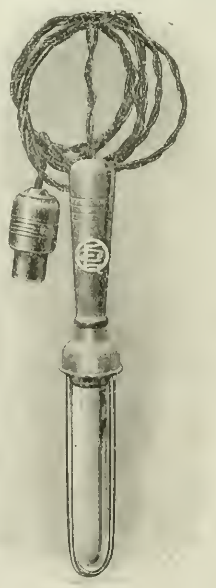

Fig. 2. Quain "Thermaglo" Immersion Heater.

Any food, *e.g.*, milk, left on the heater on removal from the fluid is immediately evaporated, and therefore there is no trouble with cleaning as was often the case with nickel-plated encased type immersion heaters. Also the absence of a metal casing makes the heater more efficient. The consumption is 200 watts, and a general view of the heater is shown in Fig. 2. A larger size, consuming 1,000 watts, is made for commercial purposes. The selling price of the larger heater is 4 guineas.

Imports and Exports Regulation Bill.

This Bill, which was introduced into the House of Commons last week by Sir Auckland Geddes, proposes to constitute a Trade Regulation Committee, to regulate the importation of goods with a view to preventing dumping, safeguarding key industries and industries affected by the depreciation of a foreign currency, to regulate temporarily the exportation of certain goods, &c.

The proposed "Trade Regulation Committee," will consist of the President of the Board of Trade, the Financial Secretary to the Treasury, the Parliamentary Under-Secretary of State for Foreign Affairs, the Secretary of the Department of Overseas Trade (Development and Intelligence), the Permanent Secretaries of the Board of Trade, the Comptroller of the Department of Overseas Trade, and 10 members of the House of Commons, to be nominated by the House.

The following is an abstract of the essential parts of the Bill:—

PREVENTION OF DUMPING.

The Board of Trade on being satisfied (*a*) that goods of any class or description produced or manufactured in any country outside the United Kingdom are systematically and in substantial quantities being imported into or being sold or offered for sale in the United Kingdom at prices below the foreign value, or that there are good grounds for apprehending that such importation or sale is about to take place; and

(*b*) That the production or manufacture of similar goods in the United Kingdom is or is likely to be thereby adversely affected, may by order apply the Act to goods of that class or description, if imported from or if made or produced in any country outside the United Kingdom or such country or countries as may be specified in the order.

Any such order may provide that goods to which the order applies shall not be imported unless there are produced to the Commissioners of Customs and Excise (*a*) a sworn declaration by the consignor stating the foreign value of the goods and the country of manufacture or production of the goods; and

(*b*) A valid certificate from the proper officer that to the best of his knowledge and belief the statements contained in the sworn declaration by the consignor are correct: and

(*c*) A declaration by the importer as to whether the goods are being imported on or after sale to a person in the United Kingdom or without previous sale to such a person: and

(*d*) In the case of goods imported on or after sale to a person in the United Kingdom, such evidence as the Commissioners may require for the purpose of ascertaining the import price as defined in the Act of the goods, and whether any and, if so, what rebate, commission, discount, or other advantage of any kind, has been or will be obtained by the purchaser in respect of the sale; and

(*e*) In the case of goods imported without previous sale to a person in the United Kingdom a declaration as to the name and address of the person at whose order or disposition the goods are held.

While an order applying the Act to any goods is in force, no person shall import into the United Kingdom any goods to which the order applies, other than goods imported without previous sale, if the import price of the goods as ascertained by the Commissioners, is less than the foreign value of the goods.

While an order applying the Act to any goods is in force no person shall on the first sale of any such goods which have after the date on which the order came into force been imported into the United Kingdom without previous sale, sell the goods at a price which is less than the foreign value of the goods.

If any person sells any goods in contravention of the provisions of this section he shall be liable to forfeit such sum as the Board may demand not being greater than the value of the goods.

"Foreign value" means the price calculated in sterling which at the date of the issue of the certificate to be issued by the proper officer was being charged for goods of that class or description in similar quantities for consumption in the country of production or manufacture, after deducting any excise or other internal duty leviable in that country, or, if no such goods are sold for consumption in that country, the price which, having regard to the prices charged for goods as near as may be similar when so sold or when sold for exportation to other countries, would be so charged, after deducting any such duty as aforesaid, if the goods were sold in that country.

SAFEGUARDING OF KEY INDUSTRIES.

The Board may be order (*a*) Prohibit the importation of any or all of the goods specified in Part I. of the Second Schedule or of any particular class or description of such goods; and (*b*) on being satisfied that there has been such a depreciation in the sterling value of the currency of any foreign country as, not being adequately compensated by increased cost of production in that country, is causing or is likely to cause sales in the United Kingdom of the products or manufactures of that country to take place in substantial quantities at prices substantially below those at which similar articles manufactured in the United Kingdom can be sold, and that action under this provision is otherwise desirable, prohibit the importation of any class or description of goods manufactured or produced in that country.

The Board have power by licence to authorise the importation of any goods or any class or description of goods prohibited to be imported under this part of the Act. If the Board refuse to grant a licence the applicant may appeal against the refusal to the Trade Regulation Committee.

OVERSEAS TRADE (CREDITS AND INSURANCE).

For re-establishing the overseas trade of the United Kingdom or any branch or part of that trade, the Board may, with the consent of the Treasury, where it appears to the Board advisable so to do by reason of circumstances arising out of the present war—

(*a*) Make arrangements for granting in connection with export trade credits up to an amount not exceeding at any one time the sum of twenty-six million pounds; and

(*b*) Undertake the business of insurance (including re-insurance) of any goods where risks of an abnormal or exceptional nature are involved.

The First Schedule gives a list of orders requiring approval of the Trade Regulation Committee, which include the following:—

Power to apply Part I. to goods imported at prices below foreign value.

Power to prohibit importation of goods in Schedule II., Part I.

Power to prohibit importation of goods in case of depreciation of foreign currency.

Power to fix amount of fee on licence for importation of goods in Schedule II.

Power to fix rate of payment for licence for importation of goods prohibited to be imported under sec. 9 (1) (*c*).

Power to fix maximum prices for certain goods if sold in United Kingdom.

In Part I. of the Second Schedule is a list of goods the importation of which may be prohibited are derivatives of coal tar, certain colours, synthetic perfumes, photographic chemicals, certain organic chemicals, analytical re-agents and fine chemicals; also optical glass (including lenses, prisms and like optical devices), scientific and illuminating glassware, laboratory porcelain, scientific and optical instruments, tungsten powder and ferro-tungsten, arc lamp carbons and carbon electrodes, magnetos and permanent steel magnets, and gauges.

Another Electrical Contract for Switzerland.

We regret to notice that **St. Helens** Corporation has felt itself compelled to accept the tender of a Swiss firm for a 500 kw. turbo-alternator.

In submitting the report of the Electricity Committee on the matter, the chairman (Mr. Varley) pointed out it had been agreed by the Council that a large increase must be made in the machinery of the power station in order to put the town in a safe condition and to provide for extensions in electrical supplies to local works. When the tenders were received they found that on the machine which was to cost £20,000 the Swiss firm offered a price which was £4,178 less than the tender of any English firm that they could recognise. The tender amounted to £28,700 altogether, and the amount above £20,000 was for a condensing plant, which would have to be made by a Bolton firm. They had discovered that the Swiss firm had supplied a machine to York Corporation, and it had worked satisfactorily for four years without ever needing overhaul. No English firm would give delivery under a penalty, but the Swiss firm had guaranteed delivery within six and a half months, as compared with nine months. The English tenders since their receipt had gone up 7½ per cent. owing to increases of wages, but the Swiss tender was settled at one figure. One English firm had offered a price which was £3,464 over the Swiss tender. York Corporation had inquired into the conditions of labour and wages in Switzerland, and found they were satisfactory to the local trade unions.

Ald. **Bates** said they accepted the Swiss tender because they guaranteed a fixed price of £20,000, which was a very big consideration.

Mr. **Waring** said that the idea of giving work to a foreign firm infringed a principle that he was anxious to see maintained. Before work was sent abroad every effort should be made to get an English firm to do it. He moved that the matter be taken back for further consideration.

Mr. **McCormick** said he was at the committee meeting when the matter was gone into very carefully, and if they gave the work to a British firm it would cost 27½ per cent. more. At first he took the same attitude as the mover of the amendment, but on reflection he felt he could not justify his position to the ratepayers of St. Helens if he spent the extra money in order to keep the work in England.

Mr. **Guy Pilkington** said one important point was that the Swiss firm would give them a machine three months earlier and that would enable the local works to give employment all the sooner to a greater number of people. The fact was that the British firms were all so full of orders that they felt that they could put on a big price.

The amendment was defeated by 16 votes to seven, and it was then decided to accept the tender of the Maschinenfabrik Oerlikon.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Modern Machine Shop Construction, Equipment and Management." By Oscar E. Perrigo. (London: Hodder & Stoughton). Pp. 384. 25s. net.

"Principles and Practice of Electrical Testing as Applied to Apparatus, Circuits and Machines." By R. G. Allen, B.Sc. (London: Longmans, Green & Company.) Pp. 363. 18s. net.

"Elements of Vector Algebra." By L. Silberstein, Ph.D. (London: Longmans, Green & Company). Pp. 42. 5s. net.

"A Piece Rate System and Notes on Belting." (Two Papers on Scientific Management.) By F. W. Taylor. (London: G. Routledge & Sons). Pp. 230. 5s. net.

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Electricity Supply and the Ministry of Transport.

The House of Commons provided another of those surprises with which it is so fond of startling its members, when the Report Stage of the Electricity (Supply) Bill was reached last week. In Committee an amendment was carried against the Government in spite of the protests of the Home Secretary, substituting the Board of Trade for the Ministry of Transport as the supreme authority. On the Report stage the Committee was in its turn thrown over, and the Ministry of Transport was once again constituted the authority which is to make or mar the future of electricity supply. To the ordinary mind the whole thing seems a little puzzling and rather waste of time. We hope the matter is now settled once and for all, but the Bill has not yet reached the Statute Book, so that there is a chance that the Electricity Supply Commissioners may find themselves placed under still another Ministry.

Assuming that the change is final, the fact that the electrical re-organisation of the country is to be confided to the Ministry of Transport may not be without far-reaching results. The question at issue is not merely one of the rival claims of two Government Departments, but the much more fundamental one of the ultimate object of the Bill. What is that ultimate object? Stated in a few words it is that electricity supply for all purposes shall be made available to the public at large at the lowest possible price. Such an ideal can only be reached if generation is concentrated in a few super-power stations and operating generally is made as economical as possible. It certainly will never be reached if these problems are left to the tender mercy of "parish-pump" politics. Now, among the largest potential consumers of electrical energy at the present time are the railway companies. Extensive schemes for the electrification of suburban and even main lines are being prepared, and the resulting load is one which from the point of view of load-factor alone will be very advantageous even to a super-power station. At the same time railway electrification introduces problems of its own into the question. Reliability of supply is of the greatest importance, and on the electrical side it is desirable that the frequency should not exceed 25. It has been stated that the frequency in the Electricity Commissioners super-power stations will be 50.

For these reasons when it was proposed to hand over electricity supply questions to the Board of Trade the railway authorities obtained the insertion of an amendment which practically allowed them to employ their own generating plant. To that extent the amendment struck at one of the objects of the Bill, which is to limit the number of power stations erected, and to place all that are erected under the Electricity Commissioners. Railway generating stations would then have been under the control of the Ministry of Transport, and all others under the Board of Trade. This in a few years' time would have led conceivably to two independent systems, one for railways and one for industrial systems, and would have removed all possibility of their ever being unified.

With the re-transfer to the Ministry of Transport this difficulty is to some extent removed. But the railway companies are more than a little nervous of what the effect of bringing their stations under the control of the Electricity Commissioners will be. An opportunity has been taken by the authorities to remove this nervousness by excluding railway and dock generating stations from acquisition. But there are arguments on the other side. As Sir Eric Geddes has stated, "the moment you electrify a railway you sink a large fixed capital on that line, and the greater the density of traffic the greater the benefit from the electrification. . . . You create immediate and direct interest on the part of transportation to develop industries." This, we feel sure, the railway companies will realise if they do not do so at present. They will be willing to supply power and lighting consumers with electrical energy from what were originally intended for traction stations, and will be able to attract employers of labour to parts of the country served by their system not only by prospects of low rented land, small rates and good siding accommodation, but by offers of cheap electrical energy. At the same time there are cases where railway companies can most profitably take their power supplies from stations not owned by themselves. And this they will be no doubt willing to do.

In the foregoing we have used the phrases "traction stations" and "privately owned stations" for convenience only to describe the state of things which exists at present where a distinction has to be made as it were between conflicting interests. But this is not the way matters must be looked at in future. A given super-power station must be in a position to supply all the requirements of the district whatever those requirements may be, and must be operated in the interests of all those who are being supplied and not in the interest of this or that faction. At present we too often hear that blessed phrase "safeguarding of interests," which seems to give as much comfort to some people as "Mesopotamia" did to the old lady. In truth, the only interests which must be safeguarded are those of the public, and it is just those interests which are too often neglected. The Electricity Commissioners will be an independent body, independent even of the Ministry of Transport, and safeguards are proposed which will ensure this being the case. It will be their duty to carry out the provisions of the Bill, which is becoming more and more satisfactory from every point of view, and we feel sure they will perform their duties in the general interest of all concerned.

Reviews.

Electricity in the Service of Man. Vol. II., section 2. By R. Mullineux Walmsley, D.Sc. (London: Cassell & Company, Ltd.) Pp. xxvii.+692. 10s. 6d. net.

Section 1 of this volume was published in 1913, and contains Chapters I., II., III. and IV. on continuous-current generators, alternators, generating stations and continuous-current motors. Section 2 follows on with Chapters V. to XIII., dealing with alternating-current motors, testing, static transformers, kinetic transformers, secondary cells, rectifiers, transmission and distribution, sub-stations and protective gear. Section 3, we understand, is in course of preparation.

Section 2, with which we are concerned at present, is written in the same style as the first section—that is to say, it is mainly descriptive of practical applications of electricity. It is intended to show the progress of modern manufacture, and, therefore, the author has borrowed largely from manufacturers' catalogues and bulletins for the descriptions of their machines and apparatus. Unfortunately, however, very few comparisons are drawn between the various methods of manufacture, so that much of the value of the descriptions is lost. For instance, in the first chapter on alternating-current motors, the author describes the use of open, semi-enclosed and totally-enclosed slots, but gives no clue as to why one variety should be used in preference to another. Then, again, in the chapter on transformers, the relative advantages of the star-star, star-mesh, &c., connections are not discussed, although all these methods are described, including the star-zig-zag connection.

It is, of course, hardly reasonable to expect that everything used in modern practice could be described, for each chapter would then become a volume in itself, but there are several additions which would, perhaps, increase the utility of the book. For example, only one design of self-starting synchronous motor is described, and there is no description whatever of phase-advancers. However, on the whole, the descriptions are representative and only the manufactures of well-known firms are included.

In most of the chapters a short account of the theory involved is given after the descriptive portion, and this will no doubt be revised in any future editions. Perhaps, owing to the times in which the book was written, the author was not able to expend so much care as he would otherwise have done. We notice that he has fallen into the fairly common error that an induction motor, when run backwards, acts as a generator. It is clear, however, from the circle diagram, to which is devoted a folding plate, that this is not the case, because the machine continues to take power from the line between the short-circuit and infinity points. We are also told that a motor, starting by being switched direct on the line, takes a large starting current if under a heavy load ; but, as the starting current is the short-circuit current, the load cannot have any effect on its magnitude, but only on its duration. A new and simple method of starting a two-phase squirrel-cage motor is mentioned, which takes advantage of the *fact* that the pressure between successive lines is less than the full pressure of each phase separately. A rather curious reason is given for choosing different numbers of slots in the stator and rotor of a polyphase induction motor. The author tells us that if the number of slots is the same on stator and rotor, *obviously* there is no reason why the motor should start in one direction rather than the other.

In the chapter on static transformers, there is an unfortunate misprint. The text reads, "Since there is *no* alternating current flowing through the primary windings, there will be an alternating magnetic flux in the iron." The word "no" should obviously be "an," but there is no explanation of why this current should flow. At the bottom of page 929, the *sum* of the ampere-turns of primary and secondary is described as driving the flux through the closed iron circuit, and is therefore neglected, but it is not till the bottom of the next page that it becomes clear that the secondary ampere-turns are considered as negative. This is very confusing to the student.

Apart from these criticisms this section of Vol. II. is on the whole a very good description of modern practice, and all the diagrams are clear and readable. It seems rather unfortunate that the author prefers the words monophase, diphase and triphase, which, although doubtless correct, are hardly used in modern engineering circles. R. G. JAKEMAN.

Molesworth's Decimal Tables. By Sir G. MOLESWORTH. (London : E. & F. N. Spon.) Pp. vii.+118. 2s. 6d. net.

This little pocket-book contains a complete list of decimal tables which should be very useful to engineers. It is divided into eight sections, dealing respectively with length, square measure, cubic measure, weight, angular measurement, time, money and miscellaneous. The latter section, among other items, relates British thermal units to kilogramme-calories, and contains trigonometrical tables, squares, cubes and other mathematical data. This strikes us as one of the most complete sets of tables of this description within a small compass that we have seen.

Radiometallography.

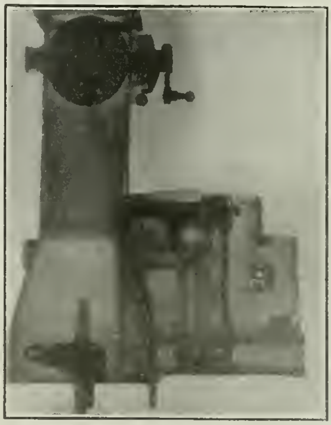
By T. THORNE BAKER.

Some conception of the interest that has been aroused by the application of the X-rays to the examination of metals was gathered from the variety of Papers read at the recent joint meeting of the Faraday and Roentgen Societies, which made it evident that a large number of important engineering firms are taking steps to determine how far radio-metallography will be of value in industrial testing and research.

Little is, however, known generally as to the type of apparatus which is being used, and some notes on the apparatus available, and that which is now under construction, may be of interest.

It has been definitely established that the very penetrating rays—which will pass through two to four inches of hard steel—are of extremely short wave-length, and are dependent on the voltage of the high-tension current applied to the Coolidge tube. The voltage used is usually from 120,000 upwards, but as the quantity of energy affects the exposure, an ample supply of current must be available in addition, in order to admit of practically short exposures being given.

With a Coolidge X-ray tube run at about 80,000 volts, and a current of a few milliamperes passing through the tube, exposures can be made through the thickest parts of the body in a fraction of a second. When we attempt to penetrate a piece of steel 1 cm. in thickness, a voltage of 120,000 and current of 2 milliamperes would probably necessitate an exposure of three to five minutes.


X-RAY PHOTOGRAPH OF DAMAGED CARBURETTER.

The exposure has been defined by Laby and Allen as that given by the expression V^2it/d^2, where V is the voltage applied to the tube, i the coulombs passing through it for t seconds, and d the distance of the focal spot from the photographic plate ; within fairly wide limits the density obtained in the negative appears to depend fairly definitely on the exposure so determined.

For a moderate thickness of metal, or for the examination of timber, arc carbons for electric furnaces and so on, an induction coil capable of giving a spark in air of from 16 in. to 20 in. will be found satisfactory. But the induction coil is not suitable for prolonged exposures or continuous work, and has the further drawback that the inverse current must be carefully suppressed by the use of rectifying valve-tubes. These valves require constant adjustment, as they "harden," or increase in vacuum, like an ordinary X-ray tube, and if one tube be used on each side of the X-ray tube—*i.e.*, between each tube and coil terminal, the two valves require to be well balanced.

There is little doubt that the high-tension transformer will become generally adopted for radio-metallography, as not only can the secondary voltage be varied to suit the degree of penetration desired, but the amount of current passed through the tube can be varied independently of the voltage, whilst heavy discharges can be given for prolonged periods with little danger of breakdown. One of these transformers at present being built will, it is hoped, enable 10 in. of steel to be penetrated.

A typical equipment designed for radio-metallography is as follows :—

A closed iron circuit high-tension transformer, of ten inches nominal spark-gap, with synchronous motor for running off an alternating-current circuit ; with direct-current supply a motor-generator would, of course, be employed. A high-tension rectifying disc, to supply direct current to the tube ; this works out much more simply than the rectification of an induction coil discharge by means of valve tubes.

Discharge rods, for measuring the alternative spark-gap—*i.e.*, the gap across which the discharge will just spark when the tube is being run.

An ammeter reading to, say, 100 milliamperes.

Switchboard with ammeter and voltmeter for the primary current, pole reverser, current regulator and switches, &c.

Small transformer for generating the low voltage current used in heating the tungsten spiral of the Coolidge tube, with regulator and ammeter.

Auto-transformer control.

Coolidge tube.

This apparatus is suitable for general radio-metallographic work, and will admit of the examination of steel castings up to 2 in. or 3 in. in thickness. Apart from the actual items of the installation, considerable attention must be paid to the protection of the operator. For this reason the switchboard and exposure switch should be placed in a cabinet separated from the room or cubicle where the actual exposures are made, and lined with lead 10 mm. in thickness. The tube itself, preferably fixed *below* the table or bench on which specimens are placed during photography, must also be enclosed in a heavily lead-lined box. The weight of lead used in securing really efficient protection from harmful effects may easily run into a ton or more, and is of course a costly item, though of the most vital importance.

The photographic work itself has already been dealt with by several authors, and special X-ray plates, heavily coated with silver bromide, have been prepared for the purpose, as well as special intensifying screens, which reduce the exposure to about a fifteenth of what would be necessary otherwise.

But as it is necessary to surround the object to be examined with a lead diaphragm, this metal as well as means of adapting it to the objects, must be available in plenty. That the care and expense involved are justified, however, appears to be agreed upon by those qualified to express an opinion.

Some idea of the scope of the work may, perhaps, be gathered from the accompanying illustration. This is a radiograph of an aeroplane engine carburetter, taken in its entirety on a plate 15 in. by 12 in., with only three seconds' exposure, by which an internal fault was revealed without taking the carburetter to pieces.

How Mining Engineers Can Assist Industry.*

By E. P. HOLLIS.

The application of power to the mining industry is one of the greatest instruments for increasing production in that industry, and if it be applied thoroughly and properly you will be able to render immense service to the country. Now people who talk glibly about efficiency have, as a general rule, very little idea what it means, and they seem to think that it only means concentration of will power for a man to work efficiently or to take one or other of correspondence courses which are so profusely advertised in our papers. Now, when you come to think of it, you will realise that we never learn efficiency as we learn geography, arithmetic or engineering. A man is left more or less to himself to pick up what he can of the subject, and I also point out that on very few occasions in our daily lives are we shown any examples of efficiency. No matter where you look about you will find that everything is done inefficiently. You may not know that it is done inefficiently unless you have an inside knowledge, but if you are able to look into things you will come across a most inglorious record which is not always open to the view of the casual observer. Our railways are most inefficiently conducted. The distribution of our food products also tells the same tale. Many a street has ten milkmen serving it. The general business training of the public is so bad that I can tell you that 75 per cent. of the people replying to a business letter do not quote references. When you get inside the factories you will find that inefficiency is rampant simply because nobody knows any better. Storekeeping, for example, is a most vital factor in a works organisation, and is notoriously inefficient.

There is, therefore, a great need for some systematic teaching of efficiency, and efficient methods. But however efficient one man may be, he may have the whole of his efficiency rendered worthless by his environment and the people who work with him. It is a very unfortunate thing that good workmen are very often spoiled by bad management. Further, efficient methods are of no use in one man. You must have good team work if you are going to have efficiency, so that everyone works with a common object, and there is complete co-ordination, each man being trusted to do his own section without having to explain in detail to his chief how he is going to do every little thing. At the present moment we are up against all kinds of factors which make for inefficiency. We have restriction of output, objections to the introduction of machinery, and other such things, and the Government is wholly at fault because they have not taken the trouble to combat the false doctrines on which these practices are based in the proper way, at the proper time, and in the proper place.

It has been alleged that there has been a failure to develop the mines during the war period with a consequent reduction of output, and here again the engineer has had little or no say in the matter. But we have to assume that all these factors will in a short space of time be mitigated or completely eliminated, and that their influence upon production will become less pronounced, and that the engineer will have a fuller play and will be unhampered by these restrictions.

Our real problem is then, given full freedom, how can the engineer produce production from the mines? The only way to increase production is to put the planning of the production scheme entirely in the hands of the skilled mining engineer. Let us think what the members of this Association do in the course of their daily work. They control the entire power plant of the mine, they tend the power-house, the winder, haulages and coal cutters, each of which are instruments of production. Now in a factory you have what is termed a production officer, a man who plans out the way the work is passed through the shops, who allocates jobs to the various machines, who, seeing that if one section of the machine shop is acting as a "bottle-neck" immediately procures additional machinery for that section, and who in general sees that the fullest utility is made of every detail of the plant. He times the operators and sees that they work efficiently without undue fatigue, and he procures for them every instrument for maximum production. In mining work the increase of production has never been considered properly in this way. You will find in a mine all sorts of "bottle-necks" which as practical men you will have met from time to time. There have been mines in which the winding plant was inadequate to deal with the heaviest output that could be procured if every section of the mine were working to its maximum. There have been mines in which the haulages have been inadequate to handle all the coal that could be produced.

You remember that during the last session I initiated a discussion upon the merits and demerits of electrically driven coal cutters, and I was greatly surprised by the general consensus of opinion in their favour. As an electrical engineer I have known that the coal cutter was one of the most difficult pieces of machinery to design and run, but it was very clear from the remarks you made on that occasion that the electrically driven coal cutter had won its spurs and was a most potent factor for increasing production. In fact, it is now realised that the electrically driven coal cutter is the only method of getting maximum production contingent of course upon the circumstances being favourable for its use. What you have to guard against very strongly is the introduction of a few of these machines in a casual way, for you will know that this is no proper way of testing their effect upon production. Maximum production can only be obtained by machine mining on an intensive scale, and that does not mean merely putting a few coal cutters into a mine. It means very much more than that. You have to begin by saying, "we are going to get a maximum output from our mine. How are we going to get it?" You have to lay out your mining scheme with the application of a maximum number of machines. You have to see that the method of working is adapted to the machines. You have to provide not merely an adequate, but an over-adequate haulage system so that there are never times at which this system is overstrained and congestion occurs at any part of the working. You have to see that the winding plant is large enough to handle the output expeditiously. You have to see that the various ways and roads about the mine are never congested. You have to see that the best winding system and the best haulage system available are installed. You have to lay down properly equipped repair shops for all kinds of plant lay in sufficient spares, and standardise the plant throughout. More particularly, you have to make sure that adequate protection against breakdown is provided so that it is never possible for a section of the mine to be shut down through a breakdown of the plant serving it. The care with which the plant in the mine is attended has also a bearing upon production. If, through inefficient or inadequate care the plant breaks down the whole working of the mine may be disorganised, the scheme put out of gear, and in consequence there is a big delay in output which cannot be made up for a considerable period. That will be avoided if the authorities put in properly skilled attendants.

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* Abstract of the Presidential Address to the Association of Mining Electrical Engineers (Warwickshire and South Staffordshire Branch).

There is without a doubt no industry into which the same degree of skill in electrical engineering is put as in the mining industry. The mining industry has in this Association a special Association caring for the application of power to production. No other industry can show anything of the kind or approaching it, and it therefore is a matter of great importance that the mining industry should make great use of the skill which it has at its disposal. That skill is in your possession, and if you find that inadequate use is being made of it, then it is for you to push and see that your experience is turned to account. From my own knowledge I am quite certain that the mining electrical engineer is not sufficiently consulted, and therefore does not apply himself as closely as he might to the problems of production. If some incentive were given, if it were known to the mining electrical engineer that his experience is valued, and if it be appreciated that he can give most valuable advice and that his experience fits him for grappling with the problems involved in increasing production, then he will be given incentive to apply his knowledge to increasing production. These facts must be brought home to those in authority. I plead most earnestly with the many managers and directors who are members of this Association that they will make the utmost use of the engineers, mechanical and electrical, who are engaged upon mining work. They are earnest and enthusiastic men, and if their energies be turned in the proper direction and duly appreciated, many of the problems met in increasing production will be rapidly and satisfactorily solved.

Correspondence.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In my capacity as general treasurer of the British Association for the Advancement of Science I made, before the Thursday evening discourse at the recent Bournemouth meeting, the following remarks:—

> Ladies and Gentlemen: You are aware that after paying printing and office expenses, the funds of the British Association are devoted to scientific research. For more than 80 years we have spent more than £1,000 a year on research, long before ordinary people had heard of research.
>
> Every year we form many research committees: each of them is formed of the foremost men of science of Great Britain, who receive none of the money themselves, and their accounts for mere out-of-pocket expenses are carefully audited. These researches in the past have created some entirely new sciences, have led directly and indirectly to the creation of many new industries, and they have largely produced the world's present natural knowledge. And now to my point. Yesterday a very prominent member of the Association asked me about our finances. I had to admit that even before the War we were meeting with difficulties due to the increased cost of printing and other things; that, since the War we have been behindhand to the extent of more than £1,000 every year, and that we have never yet asked for the help of moneyed men. The only gift we have ever received from a moneyed man was a voluntary gift from Sir James Caird, who handed me £11,000 at the Dundee meeting. My questioner said we ought to ask for help, and that he was willing to start a fund with a sum of £1,000. At this moment he does not wish to have his name mentioned.
>
> I need not dwell on the importance of our research work, as I feel sure that every person who has himself done original work shares my opinion that when we limit our expenditure on research, and especially on pure scientific research, we shall begin to be a bankrupt association—bankrupt, that is, morally from the point of view of science, if not actually in the financial sense.
>
> The moneyed men of Great Britain are most willing to help any good object when they get proof that it really is a good object. We cannot complain of want of their help for they did not know the facts. At the same time, the treasurer of an Association with such a record as ours does not feel happy at the prospect of begging for help.

In the last two days of the meeting following that on which I made this statement the fund was raised to a total of £1,475. I intend to publish in due course a list of names of donors and donations.

To illustrate by many instances (as I might) our claims as to the importance of our researches would unduly prolong this letter, and any selection of a few examples would be unrepresentative. I will cite a single illustration—the National Physical Laboratory, the scene of researches of which the importance to the nation during the war and earlier cannot be overestimated, had its origin (if its antecedents be traced backward) in the Kew Observatory, which was maintained by the British Association from 1842 to 1872, in which period the Association spent some £12,000 on its upkeep.—I am, &c.,

London, W. 1, Nov. 21, 1919. John Perry.

COAL PROFITS AND THE GOVERNMENT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: As one who has had commercial interest in coal matters in the past, may I crave space for a few remarks upon the subject of the expressed intention of the Government to introduce a Bill to limit for the current year the profits in the coal trade to 1s. 2d. per ton. Against this contemplated limitation it is difficult to speak too strongly, for such an interference with the liberties of private enterprise is full of menace to all British industries, and will constitute a most dangerous precedent. If once enforced in respect to the coal industry, no British industry will be secure from similar Government inroads.

This proposed interference with coal trade profits is not only unjust in principle, but is also of no advantage whatever to those most concerned—the general public—in respect either to increasing the output of coal or to lowering the price. The injustice lies in the fact that the Government proposes to apply the proposed limitation of profits to only one industry—the coal trade. Why this particular industry should be singled out for this mischievous handicapping is best known to those who have advised the Government to take the step.

As regards benefiting the public, no support for the proposed restriction of profits can be found in that direction. The effect will be quite the reverse. A limitation of profits can only mean the plunging of a number of colliery concerns into financial trouble, which will lead to embarrassed working and doubtless in some cases to actual closure.

The Government seems to forget, too, that the coal industry is a "wasting" industry, and by its nature a somewhat speculative one. It is essentially an industry in which reserves of capital are particularly necessary to provide against contingencies. Coal seams can be worked out, faults can appear, involving possibly great loss; floodings, explosions and other disasters are not unknown, and to these labour troubles may be added. Why, in the face of all these factors, the Government should plunge so essential an industry—the acknowledged "key of key" industries—into further difficulties is a subject of astonishment to most people. One has to turn back to Stuart days—the days of "benevolences" and forced loans—to find a precedent for this latest proposed Government "snatch" at private earnings.

Collieries in this country are largely owned by shareholders, scattered throughout the length and breadth of the land, and drawn from all classes, from the highest to the humblest thrifty small-holder. These are the people who will suffer from this inroad on the coal industry, and, if this is permitted in respect to that industry, all other industries—the iron trade, shipbuilding, shipping, textile industries, and even trade papers—may be similarly harassed in the future. It behoves, therefore, that all interested in the industrial welfare of the country should unite in protesting against this ill-advised intention of the Government.—I am, &c.,

London, S.W.11, Nov. 19. W. H. Harvey.

Electricity (Supply) Bill.

In the House of Commons on the 20th inst., on the Order for the consideration of this Bill as amended,

Mr. Shortt moved a new clause transferring to the Minister of Transport all the powers and duties of the Board of Trade under the Act, or the Electric Lighting Acts, or any other local Act relating to the supply of electricity. He reminded the House that this power was originally proposed in the Bill setting up the Ministry of Transport, but he withdrew it from that Bill in order that the matter might be dealt with in the present Bill. The two things absolutely essential to the industrial and social development of this country were transport and power. Transport without power was of no avail. And power must be developed as cheaply and efficiently as possible. It was no good having cheap power if it might fail at any moment, and it was no good having certain power if it was too expensive. Electricity was in the future probably going to be one of the main sources of power. Though private enterprise had done well in the past, a great deal had yet to be done which required driving power. The question that arose was, which of the existing departments was the best from that point of view? He did not think anyone would suggest the setting up of a new Ministry at present. The Board of Trade had done excellent work in the past, and had a very good staff, but that staff was framed for supervision and for enforcing regulations; in fact, rather to curb than to encourage enterprise and initiative. There was no staff of engineers or trained electricians, and the Board of Trade would have to do the equivalent of setting up a new Ministry for the work, because it would have to organise an entirely new staff. The Ministry of Transport, on the other hand, was bound to have highly skilled engineers and electricians upon its staff; the very *raison d'être* of its existence was that it should force, drive and encourage. The Government were convinced that it would be detrimental, almost to the point of destruction of the Bill, unless it was under the one Department which was really and properly fitted to carry out its provisions. It was admitted that, before any good could be done, the transport system of the country must be co-ordinated and unified. Equally, if there was to be a really efficient service of electricity, there must be unity and co-ordination in that. It was just as important to have co-ordination between transport and power as co-ordination in transport and co-ordination in power.

Mr. N. Chamberlain said he was still unconvinced of the desirability of the proposed change. If the clause was passed, it would be exceedingly unpopular in the country. The Ministry of Transport was going to be a great user of current, and would, therefore, be looked upon as a competitor with other users of current. If there was any difference of opinion between the local authorities and the Ministry the latter would not be in an impartial position to judge.

Major Lloyd-Greame, who said that the merits of the clause were not discussed in Committee, felt that the Ministry of Transport was the natural Department to which to send the Bill.

Sir A. Geddes explained that the Board of Trade, many months before he joined it, had agreed that these powers would be better administered by the Minister of Transport. He had come to the conclusion that those powers would be better exercised by some other Department than the Board of Trade. Industries were at present concentrated in a few very populous areas, though a large number of them could be carried out with greater advantage and more economically in less densely populated parts of the country. As that congestion of industries in particular areas was due to easy access to the coalfields, it was hoped by the distribution of electrical power all over the country to limit the growth of our great industrial cities. If there was to be a Department to look after the distribution of power, it surely could be more economically done by the Ministry of Transport.

Sir J. Fortescue Flannery said he had authority to state that the Provincial Association of Electrical Supply Companies, representing more than 100 supply companies, were in favour of the clause.

Mr. G. Balfour said it was a substantial grievance, that, although when certain members last week suggested that more time should be allowed before the Report stage of the Bill was taken, the Ministerial reply was that there would be ample time for the consideration of amendments, notice of the amendment now before the House had not been placed upon the Order Paper by the Government until that day. He contended that no case had been made out for the clause on commercial and technical considerations, and that the proposal was not justified from the point of view of public policy. The Department to which it was proposed to transfer the control of electricity was already overburdened, and required the whole of its time calmly to work out the enormous problem of transport. He urged, too, that the control should not be put into the hands of a Department which had a great interest in subordinating industrial electricity supply to the railway interest.

Sir E. Geddes said that it was no desire to have more work for the Ministry of Transport that made him speak in favour of the clause, but an honest and earnest opinion that it was best for the promotion of electric power in the country that that should be done. They set out with the idea, as far as possible, to have one control of electric power, so that, although it might be generated at different voltages and frequencies, what he would call "the gauge" should be the most appropriate and should not be mixed. We had mixed the gauge on the railways and on the canals, and we were going on the same lines in mixing it up in electricity. If there was any industry which lent itself to a general development of electricity it was the railways. Although they used only one-fifth of the current, it was a very important fifth, and greater stress might be laid on it than the mere proportion warranted. The moment they electrified a railway they sank a large fixed capital on that line, and the greater the density of the traffic the greater the benefit from the fixed work that they would put in. The better the load factor the cheaper the electricity. The moment they carried high-tension electricity down a line into a rural area, where they might develop housing, they created an immediate and direct interest on the part of transportation to develop industry, to get a load factor by the use of electricity, and to get a denser traffic on the line that was electrified. There was no other industry to which that applied. At present the number of power stations in London was 79; there were 50 different types of generators, 10 different periodicities and 32 different voltages. In London alone five-elevenths of the electricity generated was used for transportation. Electrification schemes were under consideration for the Midland, the Great Eastern, the South-Eastern and the London, Brighton and South Coast Railways. They were all proposing to go in for electrification. Was it wise or prudent to do what the Committee had done and keep that railway electrification under one Ministry and the rest of London under another? The balance of advantage was in favour of combining the whole electrical user in one Ministry. He thought it would improve the measure to put in safeguards which would bind his successors, and which would ensure that the Chief Commissioners should be independent. There had been an impression that the Chief Commissioner-designate might not be in favour of the transfer, and would not be prepared to work under the Ministry of Transport. He was glad to be able to say that as long ago as July he came to a complete understanding with Sir John Snell, who was quite prepared to transfer, and the rest of his staff would be transferred also to the Ministry of Transport.

Viscount Elveden said he was alarmed because of the intention to get the power for the railways from the same source of origin as for the rest of the community. Experts told him that was all wrong. He was sure that somehow or other a trade union might interrupt not only the inter-communication of the whole country, but also the whole industries of the country on a minor dispute.

Sir W. Pearce said all industrial and manufacturing opinion was in favour of these powers going to the Board of Trade.

The clause was read a second time without a division.

An amendment by Lieut.-Col. Sir F. Hall to provide that the power of appointing Electricity Commissioners should be exercised by the Board of Trade was withdrawn in favour of an alteration suggested by Mr. Shortt providing that the power should be exercised by the Ministry of Transport "with the concurrence of" the Board of Trade.

On Clause 1, which provides for the appointment of Electricity Commissioners, an amendment that no Commissioner should have, directly or indirectly, any share or interest in any undertaking for the supply of electricity was agreed to.

On Clause 7, which provided for the acquisition of generating stations, Mr. Grundy moved an amendment for the inclusion in the ambit of the clause of railway generating stations, dock generating stations and private generating stations.

Mr. Shortt hoped the amendment would not be pressed, and that he would be allowed to move that the debate be adjourned. When the Bill was in Committee, he and his advisers considered the position of railway companies carefully, and did so in consultation with those members who were interested in railway matters. The position as regarded the railway companies as the Bill came through Committee was upset, and he personally, on behalf of the Government, agreed. But subsequent reflection made it less clear that the arrangement he then made a wise one. He had put down an amendment to leave out from the operation of the clause railway and dock generating stations.

Sir F. Banbury said that some weeks or months ago a prominent member of the Board of Trade made an arrangement with the railway companies which resulted in the acceptance of an amendment by the Government. Now, for the first time, amendments appeared upon the paper dealing with that agreed amendment. All parties, he thought, would recognise that an agreement made must be kept.

On Monday Mr. Shortt withdrew his amendment. He said he had forgotten that he had been a party to the agreement with the railway Companies and dock authorities which bound him. The exclusion from the Bill only affected existing generating stations; extensions, new generating stations and wayleaves would be included. Having regard to a subsequent amendment which he would ask the House to accept, dealing with the rights of the railway companies when they were taking electricity from a district electricity board to demand what frequency they liked, he was quite satisfied that the arrangement made with the railway companies was a perfectly proper one.

Major Barnes moved an amendment providing that the acquisition of generating stations should be subject to payment to the owners of "compensation" instead of "the standard price." It was proposed to acquire compulsorily generating stations belonging to local authorities, stations belonging to companies operating under Provisional Orders and stations belonging to power companies. A different method of compensation was to be applied in each of those cases, but the difference was not in the character of the undertaking, but solely on the difference in ownership.

The amendment, which was supported by Mr. Marriott and Mr. Geo. Balfour, was rejected by 204 votes to 44.

The House agreed to an amendment by Mr. Shortt, substituting for the words in the Bill offering to local authorities, as an alternative to annuities, the cost of the site and the construction of generating stations and main transmission lines, less depreciation, the words, "a capital sum calculated in like manner and on like principles as the standard price in the case of a company."

Mr. G. Balfour moved an amendment that in determining the standard price in the case of a generating station, or main transmission line belonging to a company or person, there should be an addition to the cost for appreciation or a deduction from it for depreciation. The Bill merely provided for a deduction for depreciation, and he said a sum of £100 spent before the war would to-day be represented by a cost of £300.

The amendment was negatived, and on the motion of Mr. **Bridgeman**, the following proviso, at the end of Clause 7, was agreed to:—"Provided that, if in any case it is proved to the satisfaction of the Electricity Commissioners that, owing to exceptional terms of purchase contained in the special Act or order relating to a company, the standard price, as calculated as aforesaid, would work an injustice, the Electricity Commissioners shall, on the application of the company, refer the matter to an arbitrator to be appointed by the Board of Trade for his determination whether any and, if so, what addition to the standard price, as calculated as aforesaid, should be made."

On Clause 9, which places restrictions on the establishment of new generating stations, **Lieut.-Col. Sir F. Hall** moved an amendment, providing that in the case of a dock undertaking, as well as in the case of a railway, using or proposing to use electricity for traction, consent to establish a new generating station should not be refused unless a district board was willing and able to supply the power. The amendment was agreed to; and the words in the clause providing that the supply of electricity by the district board should be "at such frequency as the railway company requires" were deleted.

On Clause 11, which defines the power of district boards in respect of the supply of electricity, Mr. **Bridgeman** accepted proposals made by **Lieut.-Col. Sir F. Hall** to remove lighting authorities and tramway companies or authorities from the list of exceptions to the provision that a district board should not supply electricity in the area of supply of any authorised distributors without the consent of those distributors.

On Clause 12 (Transfer of undertakings to boards), Mr. **Bridgeman** moved the addition of words giving the local authority whose undertaking, in whole or in part, is transferred to the district electricity board, the option of receiving payment in "either one or more annuities or a capital sum calculated in like manner and or the like principles as the standard price in the case of a generating station is to be calculated."

The amendment was agreed to, as was a further amendment which moved by Mr. G. **Balfour**, to provide that where a district electricity board which has already taken over the generating station or main transmission line belonging to a company purchased the whole remaining part of the company's undertaking, the purchase terms shall be a sum equal to the amount of capital expenditure on the remaining part prior to the date of vesting, together with any additional capital expenditure since that date.

On Clause 13, which provides when a generating station of a power company is vested in a district electricity board that if the company so require the board shall purchase the whole of the undertaking upon the terms of paying the fair market value which is to be determined in default of agreement by arbitration, Mr. **Shortt** moved an amendment providing that the arbitrator might add to the terms such a sum as he found to be the costs properly incurred by the company as incidential to the arbitration, and this was agreed to.

On Clause 15 (Subsidiary powers of district electricity boards), **Sir F. Hall** moved to add the following proviso:—"No order shall be made authorising the abstraction of water from any dock regulated by Act of Parliament or from the Manchester Ship Canal, except with the consent of the owners thereof, and subject to such terms and conditions as any be agreed." The words referring to the Manchester Ship Canal were omitted from the amendment and it was then passed.

Capt. **Bowyer** moved to qualify the provision in the clause authorising the utilisation of forms of energy other than electricity by adding: "Provided always that such district electricity board, local authority, company, or person shall in no case have the power to enter into arrangements for the supply by the board of any form of energy, other than electricity, in any area or district within which any undertakers may be authorised by Parliament to supply such form of energy unless and until such undertakers consent thereto, and then only upon such terms and conditions as may be agreed upon with such undertakers."

The amendment was accepted, and on Clause 17, which deals with compensation for deprivation of employment suffered by any officer or servant of an existing undertaking,

Mr. **Shortt** moved to omit a provision that every officer or servant affected should be entitled to count any temporary absences caused by exigencies of war as regular employment within the meaning of the section, and to substitute the words: "Where any such officer or servant was temporarily absent from his employment whilst serving in or with his Majesty's Forces or the forces of Allied or Associated Powers during the present war, such service shall be reckoned as service under the authorised undertakers in whose employment he was immediately before and after such temporary absence."

The amendment was agreed to.

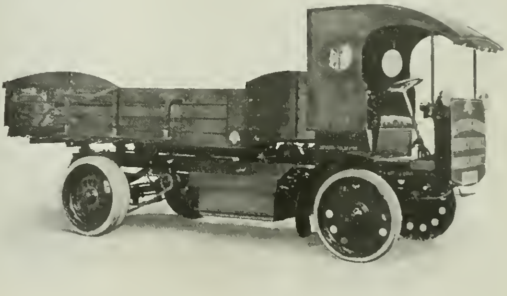
To Clause 26, which authorises the Electricity Commissioners to require any authorised undertakers to amend or alter the type of current, frequency or pressure employed by them, an amendment was agreed to providing for an appeal by any authorised undertakers to the Board of Trade, and if the Board were satisfied that compliance with the order would entail unreasonable expense, they might direct that the order should not apply to those undertakers, or apply only subject to such conditions as they might prescribe. Another amendment was also agreed to providing that a special order made by the Electricity Commissioners under sec. 28, in place of a provisional order, should be laid before each House of Parliament, and should not come into force until approved by a resolution passed by each House.

The Report stage was concluded.

Roads and Transport Exhibition at the Agricultural Hall.

The Roads and Transport Exhibition, which was held at the Agricultural Hall, Islington, from Nov. 20 to 27, was really the outcome of a successful National Road Conference and Exhibition held in 1915, under the auspices of the County Councils Association. It has certainly been an improvement on this occasion to include a more representative display of transport vehicles. To a certain extent problems of Roads and Transport have been viewed from antagonistic standpoint rather than one of co-operative endeavour. The one is intimately bound up with the other, and only by mutual co-operation and understanding can there be any hope of solving the present difficulties of transport and road maintenance. The war, and finally the railway strike, has given that recognition of the value of power propelled road transport, which was previously lacking, and it is to be hoped that the newly established Ministry of Transport will succeed in promoting greater co-operation between the various means that exist for the transportation of goods and lead to the adoption of more improved and efficient methods. In addition to the main exhibition which occupies the ground floor of the hall, there is also a Public Works Exhibition, held under the auspices of the Municipal Agency, Ltd., which occupies the gallery. A number of interesting Papers were read and discussed during the period that the exhibition was open, these meetings taking place in the Berner's Hall.

The exhibition was formally opened by the Right Hon. Sir Eric Geddes, G.B.E., K.C.B., M.P., Minister of Transport, at 3 p.m., on Thursday, Nov. 20. Naturally the transport exhibits are mainly concerned with sanitary, road building and general municipal requirements, such as steam and petrol and electric-driven road rollers, street sweepers and sprinklers, water carts, tipping wagons and fire engines. Practically all the bodies of the tipping wagons are automatically operated either by electrical, hydraulic means or through the original propelling agent by means of gearing. Ease of operation and rapidity in tipping naturally has considerable effect on the cost of transport of road material. Dealing with the Transport Section in the main hall the following exhibits particularly attracted our attention:—



View of 3½-Ton "Orwell" Electric Lorry.

Tuke & Bell, Ltd., Stand 11, *Row A.*—A Tuke-Bell "Constable" tipping wagon trailer, with gears arranged for side tipping, the method of lifting and the unusual height of the lift being particularly noticeable. The appliance is also made as a tipping body for electric vehicles. The material can be tipped by one man in 90 secs., and falls entirely clear of the wheels.

Lacre Motor Car Company, Ltd., Stand 1, *Row B.*—This firm exhibited a type "L" road sweeper, capable of sweeping a width of 7 ft. 6 in., and of spraying the road by means of a series of water nozzles fixed on the front of the vehicle. Also a combination vehicle suitable for use as a lorry, tipping wagon, or water cart. The three-wheel type of vehicle made by this firm looks decidedly novel, and a factor which is added to by the unusual height of the driver's seat. The combination wagon should be particularly serviceable in small country districts.

H. G. Burford & Company, Row B, Stand 4.—A type of loading truck made with a skeleton frame and detachable body, the body being run off from the frame, which operation can be performed by one man. The idea is to have series of bodies so as not to delay the vehicle during loading and unloading.

Maudslay Motor Company, Ltd., Row B, Stand 7.—An end-tipping wagon, petrol driven, and made with a body divided into four compartments, each holding one ton, with the idea that coal, etc., can be delivered in one ton lots.

Ransomes, Sims & Jeffries, Row B, Stand 8.—The electric vehicles exhibited on this stand attracted considerable attention, particularly the 3½-ton "Orwell" electric tipping wagon. The wagon is of the standard "Orwell" type, the tipping gear being operated by electric motors driven off the Exide Ironclad Battery. There was also shown a 3,000 lb. industrial Electric Truck equipped with a portable pneumatic outfit for road repair work.

Edison Accumulators, Ltd., Row B, Stand 11.—The exhibits here comprised a standard type Edison 2-ton tipping wagon and an "L" type elevating platform truck.

Tilling-Stevens, Ltd., Row C, Stand 5.—The main attraction at this stand was a Petrol-Electric Fire Tender, fitted with a fire escape. The chassis was designed for fire engine purposes, but it is similar in main principles to the well-known Tilling-Stevens bus chassis. Ease of control and quick acceleration, characteristic of this system of propulsion, should make this system particularly suitable for fire brigade purposes.

There was also exhibited a 2½-ton petrol-electric chassis fitted with a hand-operated tipping wagon.

General Vehicle Company, Ltd., Row D, Stand 1.—A 3½-ton G.V. Vehicle equipped with a Craymer patent unloader attracted so much attention that it must have been the envy of neighbouring standholders. The idea underlying the "Craymer" device is particularly neat. It essentially resembles a series of telescopic compartments made up by a series of boards connected together by pivoted tie-bars, the last board forming the back board of the wagon. As each sectional load is put on the vehicle a board forms a division for that section, and when unloading the sections slide forward to the back of the wagon, each sectional board falling over and lying on the tail board when the sectional load has been tipped. Provided the sectional loads are put on in the correct sequence this method provides a very easy means of quickly transporting and unloading a variety of materials, such as would be required for road work.

Public Works Exhibition in the Gallery.

The New Transport Company, Ltd., Row B, Stand 7.—Literature, blueprints, etc., were shown here with a view to arousing interest in the Gattie system of Transport, designed for the purpose of economically and quickly handling a variety of goods transport in densely populated areas. The principle of the method is an electro-mechanical machine which automatically controls and sorts parcels of merchandise.

Electric Appliances, Ltd., Row B, Stand 13.—This exhibit was confined to Imperial Vacuum Cleaners of the light portable type, operated by means of a fan driven by an electric motor. Though small in size, and light in weight, these little machines are quite effective for the purpose for which they are designed, and they are very nicely finished.

The Beck Electric Washer, Row F, Stand 8.—This firm were showing electrically-driven washing and ironing machines, and giving demonstration of laundry work in progress. In the washing machine a small electric motor drives a rotating drum, through a change-gearing device, which causes the drum to rotate in alternate directions. In the ironing machine an electric motor causes a roller to rotate and feed the article to be ironed over the ironing shoe. But why not employ all electric means? It was regrettable to notice that a gas geyser was employed to heat water, and gas was employed in the ironing machine to heat the ironing shoe. For both purposes electricity could have been employed to advantage, and the devices would then have justly earned the title electric washing and ironing machines.

The attendance did not seem to be very large on the day our representative called, but those that were there were taking a decided interest in the exhibits; and, of course, merely curious visitors are of little gain.

In conclusion, a word to the organisers. A little more effective publicity would certainly have aroused more interest in the exhibition, and, secondly, the arrangements of numbering the stands did not provide the easiest means of locating any particular exhibit. The various rows, A, B, and C, etc., should have been more plainly marked. All stand numbers should have borne the number and row, instead of, as in many cases, the number only.

Glasgow Housing and Health Exhibition.

We learn that the Housing and Health Exhibition, which was held at Glasgow from 8th October to 1st November was a great success, and was visited by 450,000 people. In a recent issue we gave some particulars of the exhibits, which included a number of interesting electrical displays. The Corporation electricity department stall, measuring 40 by 20 ft., was divided roughly into six sections, and was an island stand around which hundreds of people could watch the various apparatus at work. It is thought that this type of stand is more effective than a model house. The cooking range was shown under working conditions, an experienced baker working behind an open counter, turning out large batches of fancy cakes daily. Over £100 was drawn by selling the material thus produced. Cookers were also shown by the Carron Company, the Falkirk Iron Company, the Jackson Electric Stove Company, Messrs. Belling & Company, and the Premier Electric Heaters. A skilled operator from one of the electric laundries in the city demonstrated electric ironing and the "Thor" electric washing machine and ironing machine was on view. Imperial, Premier and Hoover vacuum cleaners were shown in operation.

In electric fires Berry's magical outfit, fitted in ornamental dog grate was much admired, and representative designs of the Falkirk Company, the Carron Company, Messrs. Belling, the Quead and Credenda Companies were on view, as were also the American hotpoint hedlite heater, and pedestal fires by the Credenda Company, and the Ediswan Company. In water heaters there was the Falkirk Company's calorifier sets and the geyser type by the British Electric Trading Company. For the first time in this country there was shown the Filbar electric water boiler for domestic tea-making, shaving, etc. This apparatus provides boiling water up to two pints in 30 to 60 seconds. The stand also contained an excellent display of kettles, coffee percolators, teapots, bed-warmers, immersion heaters, cigar lighters, table and floor standard lamps, etc.

View of the Glasgow Electricity Department Exhibit.

Flood Lighting for Protection.

Remarkable testimony to the value of flood lighting for protective purposes was provided during the recent railway strike by the use of B.T.H. projectors at Lot's-road Power Station. These projectors are mounted on tripod stands, and can be swivelled horizontally and vertically. Each projector is equipped with a 1,000 watt Mazda half-watt type lamp. It was found that two or three watchmen, each having under his control a B.T.H. flood-light projector, could maintain close observation over the whole area from which interruption was likely to proceed. The slightest movement of a twig or piece of paper could be clearly seen at a distance of 300 or 400 ft., and it would have been quite impossible for any ill-intentioned person to have approached the power station unobserved. Obviously, the use of flood-light projectors for protective lighting has considerable advantages, since one watchman so equipped has an enormous radius of effective observation. To maintain an equally thorough guard without flood-lighting would require a platoon of men. Another good point about flood-lighting is the rapidity with which the projectors can be installed, the only preliminary necessary being the provision of leads from the nearest available source of energy. The British Thomson-Houston Company, Ltd., of 77, Upper Thames-street, who manufacture and supply the projectors and lamps, will be pleased to give to interested readers full information in regard to the characteristics and varied applications of B.T.H. flood lighting

Commercial Topics.

The Price of Coal.

The unexpectedly large drop of 10s. a ton in the price of coal for domestic purposes is very welcome, as it will probably mean an end of the upward tendency of charges for electricity which has prevailed during the past two or three years. The reduction will apply to electric supply and gas undertakings, and arrangements will be made to secure a corresponding reduction in the price of electricity for domestic lighting and heating. It is not clear at present how this reduction will be effected, and it may introduce complications for electric supply authorities, especially for those whose output is mainly used for power and industrial purposes. In regard to electricity works, the ability to obtain good steam coal is at least as important as to secure a cheap supply. Hitherto many undertakings have been obliged to use coal of a very inferior quality, and even refuse, and we hope that the Coal Controller will now see that supplies of suitable coal are available.

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Lights on Vehicles.

The recent changes in the Orders relating to the lights to be carried on vehicles has produced a good deal of dissatisfaction, and we are pleased to see that the Ministry of Transport has formed a Committtee of 12 members to consider and report on all questions relating to lights to be carried on vehicles and as to lighting-up time. The Committee, which held its first meeting on the 19th inst., is designated the "Lights on Vehicles Committee." The chairman is Sir Henry Maybury, Director-General of Roads, Ministry of Transport, and the offices of the Committee are at No. 6, Whitehall-gardens, S.W.1, where communications should be sent. The Committee will submit an interim report on the requirements as to lights to be carried on vehicles and as to lighting-up time under the Lights (Vehicles) Order of Dec. 16, 1918.

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Anti-Dumping Legislation.

There is general agreement that some protection is required against the dumping of cheap foreign goods in this country, but it is doubtful if the method proposed in the Imports and Exports Regulation Bill, which is abstracted in another column, is the most desirable or the most effective one. We dislike the idea of Government control and it seems to us that the scheme will place too much power in the hands of Board of Trade officials and of the new Trade Regulation Committee. Apparently, there will be no direct representation of commercial or trading interests, or of the general public on the Committee, which will inevitably develop into the usual bureaucratic Government department, and, judging by its constitution, it will inevitably be controlled by the Board of Trade.

One may, therefore, safely predict what will happen to manufacturers and consumers when the Bill has been passed, and in this connection the experience of Principal Laurie under the existing regulations as to the import of articles is interesting. In a letter to "The Times," of the 24th inst., Dr. Laurie states that "The unhappy user (of dyes) has to apply to the Board of Trade for a licence each time he imports, and never knows when permission may be refused by some official in Room 236, against whose decision there is no appeal. The Board in one aspect is a dye manufacturer to about one and a half millions, in the other aspect can forbid competition from rivals. The wretched user of the imported dye never knows at what moment his supply may be cut off, and therefore dreads to extend his business. To take another section, the prohibition of fine chemicals, optical and scientific instruments and chemical glassware is striking a serious blow at all scientific teaching and research. Not only are the prices disgracefully high, and in many cases the quality scandalously bad, but the two or three firms to whom this valuable monopoly has been granted cannot, or do not, choose to supply the demand. While schools and colleges are clamouring for material, they talk of delivering in six months, and the Board of Trade prohibits importation from France."

Certainty and stability of conditions are essential to successful trading, and there can be no serious development, no good progress made while business men are subject to the control of Government bureaucrats. In fact, the present Bill seems to contemplate the creation of a species of "super-bureaucrat," for though the Bill gives a right of appeal from decisions of the Board of Trade to the Trade Regulation Committee, several officials of the Board will be on both and the final decision may rest with those who heard the case in the first instance. There is no definition of a "key industry in the Bill," but a list is given of the articles which may be prohibited. This list will certainly not satisfy those connected with the electrical industry. The Bill confers extensive powers upon the Board as to licences, prices, &c.

In view of the controversy as to the legality of the Import Restriction Regulations of the Board it is interesting to note that sec. 19 (1) of the Bill provides that "goods prohibited to be imported by virtue of this Act shall be deemed to be included among the goods enumerated and described in the table of prohibitions and restrictions in words contained in sec. 42 of the Customs Consolidation Act, 1876." This seems like an attempt to justify past acts of the Board and should lead to an interesting debate. We also notice that clause 21 states "Information and documents required under this Act to be given or produced to the Board or the Commissioners shall not be published except in cases where the person giving or producing the same otherwise agrees, or where publicity is specially authorised by the order or regulation by which the requirement was made."

Though the Bill is one which may be converted into a useful measure some of its provisions require careful examination in Committee.

Electricity Supply.

Coun. Cameron has been appointed convener of the Hamilton Electric Lighting Committee.

Dublin Corporation has been authorised to raise a loan of £64,976 for extensions of the electricity undertaking.

Whitehaven Council has sanctioned an expenditure of £1,680 upon extensions of the electric supply mains.

Capt. H. P. Waterhouse has been re-engaged as mains engineer at Worcester.

An inquiry was held at Birkenhead on Tuesday into the application of the Corporation for sanction to borrow £21,331 for extensions of plant and mains.

Willington Urban Council has invited the Newcastle-on-Tyne Electric Supply Company and Messrs. Strakers & Love to quote for the supply of electricity in the district.

Bath Electric Lighting Committee recommends the City Council to apply for sanction to borrow £15,000 for laying new mains in Tiverton, a large working class district.

Halifax Corporation propose to put in a 10,000 kw. turbo-generator and other plant at the electricity works, and an application has been made for sanction to borrow this sum.

The Lyric Theatre (Hammersmith, London) is probably the first theatre in this country to adopt Electric Heating. In the whole of the building and offices electric radiators have recently been installed with satisfactory results.

Hull Electricity Committee has instructed the City electrical engineer to report on the prospects of facilitating the lighting of streets and houses with electricity. Owing to the demand for electrical engineers to provide against breakdowns the Committee propose to expend £46,000 on the purchase of additional machinery.

After considering a report by the electrical engineer (Mr. H. Morton, and the water engineer (Mr. W. T. Ward) upon the proposal to utilise the water-power at Llyn Dulyn, Llandudno Urban Council has abandoned the scheme in favour of an offer of the North Wales Power & Traction Company to supply electricity in bulk to the Council.

The second complimentary dinner to ex-service employees of the Birmingham electric supply department who have been demobilised during the past six months was held on Saturday last. About 80 men were then given a cordial "welcome home" by their colleagues. Mr. E. J. Jennings presided at the dinner and subsequent concert, in the unavoidable absence of Mr. R. A. Chattock, and gave the toast "Our Guests" in fitting terms.

At the meeting of the London County Council on Tuesday a report was submitted by the Special Committee on London Electricity Supply, which recommended that the Committee should confer with representatives of the Conference of Local Authorities owning electricity undertakings in Greater London, and take any other necessary steps, with a view to the preparation of a comprehensive scheme of electricity supply for Greater London, under the provisions of the Electricity (Supply) Bill. The report and recommendation were adopted.

In future the Cardiff Electrical Committee will supply the Tramways Committee with current. The Committee has passed a resolution expressing the high appreciation of the services rendered by Mr. Arthur Ellis in his capacity as electrical engineer and manager of the Corporation tramways for nearly 20 years, and tendered to him their sincere and hearty good wishes for his future success. The testimonial will be engrossed on vellum, signed by the Lord Mayor and Town Clerk.

In reply to a question as to whether any difficulties were being placed in the way of the public obtaining electric current, and as to why the chairman of the Cardiff Trades and Labour Council had been unable to obtain a supply, Mr. Ellis said they had been unable to obtain cabling or meters. They had received 258 applications for current during last week. The chairman (Sir John Courtis) also explained that whereas the gas company had power to install private supplies, the Corporation had no such powers, but the Bill now before Parliament would give the Corporation such powers.

Stepney (London) Borough Council has decided to become a member of the Electrical Development Association. The Council has applied to the London County Council for sanction to borrow £116,500 for extensions of plant at the Limehouse generating station. It is proposed to install two 35,000 lb. boilers, with mechanical stokers, economisers, chimneys, motors, fans, pipework, &c., and one turbo-generator of between 5,000 kw. and 8,000 kw. capacity, switchgear, steam, exhaust and other pipework, &c. The complete scheme would consist of three additional 35,000 lb. boilers and two additional 10,000 kw. turbo-generators, the extension of the boiler-house buildings, extension of wharf and provision of a jetty into the river, new pump room, and additional coal and ash handling plant, river pipework and suction wells.

Hereford Corporation has received sanction to borrow £15,000 for the electric supply undertaking, including £7,000 for two transformer stations, £3,000 for h.t. cable and transformers to supply Hunderton and £2,500 for new services.

In regard to the proposed supply to the rural areas, the following Rural District Councils have approved of the proposed extensions. Bromyard, Dore, Hereford, Kington, Ledbury, Leominster, Ross, Weobley, West Dean and Whitchurch. The Roads and Bridges Committee of the Herefordshire County Council have authorised the County Surveyor to give provisional consent for overhead wires where the same pass along or across main roads.

Electric Traction.

Mr. J. Hague Pillar succeeds Ald. T. Baker as chairman of the Plymouth Tramways Committee.

It is estimated that the cost of laying a double tramway track in Bute-street, Cardiff, will be between £25,000 and £30,000.

Penzance Guardians require tenders by Dec. 17 for the electric lighting of their Madron institution. Tenders to the Clerk, 8, Parade-street, Penzance.

The last of the woman conductors left the service of the Underground Railways on the 18th inst., and were presented with certificates for their services by Lady Stanley.

Edinburgh Tramways Committee recommend the Council to abolish penny fares and to substitute 1½d. stages, as suggested in a recent report from Mr. Pilcher, the tramways manager.

Preston Tramways Committee recommend that six single-deck cars be purchased from the Sheffield Corporation at £350 each and repaired, &c., at an estimated cost of £100 each.

In the Bill which is to be promoted by Salford Corporation in the 1920 Session of Parliament, authority will be sought to construct new tramways within and beyond the borough, to run motor omnibuses, to extend the electricity undertaking, &c.

The directors of the Lancashire & Yorkshire Railway Company propose to adopt electric traction on the line between Southport and Ormskirk, a distance of about 10 miles. It is also reported that the directors have under consideration the question of electrifying the Southport and Preston and the Burscough Junction and Preston lines.

In answer to a question the Minister of Transport (Sir E. Geddes) has stated that he has asked Mr. C. H. Merz, whose knowledge of the application of electricity to traction was unrivalled, whether in certain circumstances he would assist the Ministry of Transport in questions of Electric Traction. As Mr. Merz was abroad, the matter could not be carried further at present.

In reply to a question in the House of Commons, the Parliamentary Secretary to the Board of Agriculture (Sir Arthur Boscawen) has stated that proposals for the construction of Light Railways (of a total mileage of 968) in agricultural districts have been received from 19 County Councils and agricultural executive committees. No estimates of the cost of the schemes have been made by the Board, but estimates will be drawn up by the Ministry of Transport in respect of any schemes which the Government propose to adopt.

Miscellaneous.

A mass meeting of the south-eastern district of the Society of Technical Engineers will be held at the Central Hall, Westminster, S.W.1, on Tuesday next at 7 p.m. The speaker will be Mr. C. H. Wordingham, C.B.E., M.Inst.C.E., M.I.E.E.

We are glad to hear that that ever-welcome annual, "Winter's Pie," will be published on Dec. 1, and, judging by the list of eminent authors and artists who have contributed to its pages, it will undoubtedly come as a cheery gleam. "Winter's Pie" is published at 6, Great New-street, London, E.C., and is obtainable at all booksellers and bookstalls, 1s. 6d. net.

The Controller of Coal Mines has suspended those provisions of the Household Fuel and Lighting Order, 1919, which limited the quarterly consumption of users of gas and electricity. The provisions requiring that anthracite, coke and briquettes should be obtained only from the merchant or dealer with whom the consumer is registered have also been suspended.

The Eastern Telegraph Company announce that, owing to the accumulation of traffic caused by interruptions of main line cables, they cannot satisfactorily cope with the increasing number of messages, and they again urge the public to reduce the number and limit the length of their telegrams as much as possible.

In reply to a question in the House of Commons the Assistant Postmaster-General (Mr. H. Pike Pease) stated that a number of automatic telephone exchanges have been established, and others will be installed in places where inefficiency and economy they are likely to be superior to manual exchanges. Recent tenders showed that the prices asked by manufacturers for automatic apparatus was extremely high, and almost prohibitive. Reports received about telephone services in other countries were generally to the effect that the efficiency and cost of the services had been seriously affected by the same causes as in the United Kingdom.

In the House of Commons, on the 19th inst., Mr. Lunn asked the President of the Board of Trade whether Messrs. Vickers, Limited, had recently acquired an interest in the Swiss electrical engineering firm of Brown, Boveri & Company; whether, under the terms of the arrangement, Brown, Boveri & Company undertook to do no business within the British Empire; whether Brown, Boveri & Company recently tendered for an electrical contract with Edinburgh Corporation at a figure £70,000 below that of any of the competing British companies; and whether he proposed to take any action to prevent such agreements in restraint of competitive trade.

In reply, Mr. Bridgeman said he understood that the facts were as stated in the first part of the question; but he had no information as to the details of the arrangement. He was aware that Messrs. Brown, Boveri & Company's recent tender for an electrical contract placed by Edinburgh Corporation was much below the tenders of British concerns; but he understood that the difference was not so great as stated in the question. He was not clear that the last part of the question arose in that case.

Tenders Invited.

Bournemouth Tramway Committee require tenders by noon Dec. 15 for the supply of 20 bogie electric tramcars. Specifications, etc., from the general manager.

Birmingham Corporation Electricity Supply Department want new or second-hand turbo-alternator plant up to 5,000 kw. Particulars from the City Electrical Engineer, Mr. R. A. Chattock.

Tenders are invited for the supply at the Davyhulme Sewage Works, Urmston, of three 30 h.p. three-phase induction motors, &c. Specification from the Secretary of the Rivers Department, Town Hall, Manchester, and tenders by Dec. 1.

Tynemouth Corporation invite tenders for the supply of some three-core insulated lead-covered cable for 6,600 volts, four pair paper-insulated lead-covered telephone cable and three-core cable carrying conductors for Merz-Price protective gear. Tenders to the town clerk, Mr. Stanley Wilson, by Dec. 1.

Tenders are required by Jan. 20 for supply, &c., to the Australian Commonwealth Postmaster-General's Department, State of Victoria, of Automatic Telephone Switchboards at Collingwood, as per schedule 1,583. Tender forms, &c., from the High Commissioner, Room 406, Australia House, Strand, London, W.C.

Belfast Corporation invite tenders for the manufacture and erection at the new harbour power station of steam, water and other pipework. Specifications, &c., from the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, S.W.1.; or Mr. T. W. Bloxam, M.I.E.E., city electrical engineer. Tenders must be lodged in the Town Clerk's office, City Hall, Belfast, by Monday Dec. 22.

Appointments Vacant.

A chief assistant is required for the engineering department of the Borough Polytechnic Institute (salary £350–£10–£450). Particulars and forms of application from the Principal.

Lecturers in physics and mechanical engineering are required at the Birmingham Municipal Technical School. Salary £180, rising to £380, plus war allowance of £75 to £78. Particulars from the Secretary, Suffolk-street, Birmingham.

A chief lecturer in electrical engineering (salary £300–£10–£450 per annum) and an assistant lecturer in physics (£250–£10–£350) are required at West Ham Municipal Technical Institute. Applications to the Principal, Romford-road, Stratford, E.15, by Dec. 15.

Visiting teachers of electrical workshop classes (two evenings a week) and electric wiring (one evening) at the L.C.C. Hackney Institute. Application forms from the Education Officer, Victoria Embankment, W.C.2, and forms must be returned by 11 a.m. on Dec. 1.

A chief instructor in physics and electrical engineering is required for the Seddon Memorial College, Auckland, New Zealand. Commencing salary £400 per annum. Particulars from the High Commissioner of New Zealand, 415, Strand, London, W.C.2. Applications by Dec. 6.

A head of the engineering department of Darlington Technical College is required. (Salary according to qualifications, rising to £450 per year); also a lecturer in physics (£160, rising to £350). Particulars from the Director of Education and applications by Dec. 6.

Business Items.

Owing to the increase in the electrical and general engineering contracting business hitherto carried on by the Canute Airplane Company, Sugar House-lane, Southampton, a new company was registered on the 14th inst., which will trade under the name of the Cray Installations, Ltd., with office, showroom and stores at 72b, High-street, Southampton. Manufacturers and factors are requested to forward catalogues, &c.

Capt. J. Young, A.M.I.E.E., who since his demobilisation from the R.A.F. in May, has managed the electrical contracting department hitherto carried on by the Canute Airplane Company, has been appointed managing director of the Cray Installations, Ltd., electrical and general engineering contractors.

The Warsaw Company for Trade and Navigation, Ltd., whose head offices are at Nowy Swiat 35, Warsaw, have opened branch offices at Holland House, 1-4, Bury-street, London, E.C.3 (Avenue 655), and at 20, Chapel-street, Liverpool (Central 2,284), and Mr. Robert T. Chapman has been appointed Manager of the Company for the United Kingdom.

Mr. D. M. Watson, B.Sc., A.M.Inst.C.E., has entered into partnership with Messrs. Dodd & Dodd, M.Inst.C.E., civil and consulting engineers, of County Chambers, Corporation-street, Birmingham. Mr. Watson has both American and English experience of professional work, while Messrs. Dodd & Dodd have had some 35 years' experience in the design and construction of civil engineering work in England and abroad. The name of the new firm is Dodd, Dodd & Watson.

The C.E.A. Company, Ltd., wholesale and export electrical supplies, of Diana-place, Euston-road, N.W., have ready their special C.E.A. November catalogue, and will mail it to purchasers, together with their interesting list entitled "Heating by Electricity." Three of their leading lines (which have been recognised by many well-known big firms) are their 5 ampere p.b. switch on cream base, their reliable C.E.A. dry battery and their extra heavy type e.g., s.c. holder, with cast dome and rings. The company are able to give exceptionally big deliveries from stock and to give special quotations to factors. Indents are specially invited from shippers for these goods or any other electrical accessories, as their export department is now in a condition to cope with large contracts.

Companies' Reports, &c.

The British Electric Traction Company, Ltd., has declared a half-yearly dividend on the 6 per cent. cumulative preference stock.

The directors of Petters Limited have declared a half-yearly interim dividend at the rate of 5 per cent. per annum (6d. per share), tax free.

The Adelaide Electric Supply Company, Ltd., recommend a final dividend on the ordinary shares of 7 per cent., making 12 per cent., free of British income tax, for year ended August 31.

The directors of the Melbourne Electric Supply Company, Ltd., recommend a final dividends on the Consolidated ordinary shares of 5 per cent., making 10 per cent. free of British income tax, for the year ended August 31.

The Anglo-Portuguese Telephone Company, Ltd., is inviting offers for 250,000 ordinary shares of £1 each, payable 2s. per share on application, 3s. on allotment and the balance in instalments of 5s. each. The issue is made at par, the present quotation for the shares. The company, which was incorporated in 1887, operates a system of telephones in Lisbon and Oporto, and in the surrounding country within a radius of about 19 miles of Lisbon and 12½ miles of Oporto. A Government trunk line between Lisbon and Oporto is connected with all the company's exchanges. The original concession of 1887 was replaced in 1901 by a new concession running to 1937, and containing ample provision for compensation in the event of the business being then taken over by the Government. In May, 1919, the company was granted a 30 per cent. increase in its tariff to meet the higher cost of working. The new capital is required for urgent extensions and improvements at both Lisbon and Oporto, and the prospects justify the proposed capital expenditure of £250,000. The list will close on Dec. 2, and further particulars will be found in the prospectus advertised in another column.

At the first annual meeting of the British Internal Combustion Engines (Ltd.), which was held recently, the Chairman (Mr. R. H. Wheeler) reported the progress made by the two companies (the Green Engine and the Aster Engineering companies) in which the company was interested. The Aster engine was well known as a power unit in connection with road transport, electric generating sets, electric welding, wireless telegraphy, ships' liahting, etc. The Aster Company was fully booked up with profitable orders for more than a year ahead, and was further developing the manufacture and extending the markets both here and abroad for its own specialities. The works were being enlarged and additional machinery was being installed. These associated companies were pioneers in the development of the internal combustion engine for aviation, road transport, and the generation of electricity, and they were in a position to take full advantage of the great future before this industry.

Mr. J. H. Armstrong presided over a special meeting of the Newcastle-upon-Tyne Electric Supply Company, Ltd., on Monday, when a resolution was passed to increase the capital by £3,500,000 by the creation of 1,500,000 7 per cent. cumulative preference shares, 1,000,000 5 per cent. preference shares, entitled to share further in the profits after 8 per cent. has been paid on the ordinary shares, and 1,000,000 ordinary shares. The chairman said that, as a public utility company, they had certain statutory obligations, and had to look several years ahead in preparing for developments, as a considerable period of time was necessary for the provision of new plant. Most of the new capital was needed to meet commitments entered into in 1917 and 1918. The 7 per cent. cumulative preference shares would provide for the completion of the present programme, and with that he believed they would be able to meet the load to be expected when industry had settled down. The company had applications for 86,000 h.p., considerably exceeding the munitions load lost on the cessation of the war. By the time the whole of the new plant was running the directors anticipated a saving of £100,000 per annum. The further £2,000,000 of capital was proposed to meet future developments. They had, he added, been in negotiation with the North-Eastern Railway Company regarding the supply of power for the proposed electrification of the main line from York to Newcastle.

The report of the Montreal Tramways Company for the year ended June 30 last states that the revenue from Feb. 10, 1910, to June 30, was not sufficient to meet the requirements under the new contract by $1,364,112, of which $692,694 is payable to the City of Montreal when received. The gross income for the year was $2,303.784, and expenses were $1,800,537, leaving a balance of $503,246, which, added to $536,572 from last year, after sundry deductions, makes a total of $1,039,818. The directors have authorised an issue of $4,000,000 of 5 per cent. debenture stock, and of this amount $1,000,000 was sold during the year. The board regrets that the increase in the rates of fares during the year did not provide sufficient revenue to meet the whole of the interest allowances, and in consequence the regular quarterly dividends on the common stock for the year were deferred. A Board of Conciliation authorised a general increase in wages to all employees, effective from July 1, 1919, amounting approximately to $1,100,000. The Tramways Commission rendered their decision on Aug. 29 last, granting a further increase in the rates of fares, but this decision has been appealed from. The gross earnings from operations under new contract (from Feb. 10, 1918, to June 30, 1919) were $11,572,210; operating expenses and taxes $6,640,715, operating profit $45,927, maintenance and renewals $2,098,121, total $8,784,764; balance, $2,787,447; allowances due company—6 per cent. on capital value $3,018,224, 6 per cent. on working capital $40,645, 7 per cent. on additions to capital $32,919, expenses of financing $251,353, total $3,343,142; debit balance $555,695, payable when earned. The city rental was $692,694, contingent reserve $115,722, total $808,416, leaving debit balance of $1,364,112.

The twenty-fifth ordinary general meeting of the Amazon Telegraph Company, Ltd., was held last week, Mr. Charlea W. Parish (Chairman of the company) presiding. In moving the adoption of the report and accounts, Mr. Parish said that during the early part of the financial year they were still working under war conditions, but shortly after the signing of the Armistice business on the Amazon appeared to be improving. That, however, had been unexpectedly followed by extreme depression, chiefly due to the continued crisis in the rubber industry. The rise in the rate of exchange during the latter part of the year had added to the difficulties of the situation. Their traffic receipts amounted to £61,265, compared with £59,158 for the previous year, an increase of £2,107. Ordinary international and local traffic bad both increased, but the local deferred service appeared to have reached its limit, at any rate for the time being. Press messages, which naturally increased during the war, were considerably less. The working expenses were £33,413, compared with £31,598, an increase of £1,815. The gross profit was £49,624, an increase of £767. In regard to the current year, their traffic receipts were between £2,000 and £3,000 more than for the same period last year. The price of fine hard Para rubber still remained at a low figure, namely, about 2s. 6d. per lb., and until some rise in price took place, or the rate of exchange fell, he did not see how there could be any revival in the wild rubber trade on the Amazon. Increased attention was being given to the cultivation of cotton, and other trades were developing in a small way.

The report was adopted, and the retiring directors and auditors re-elected.

The 18th annual general meeting of Drake & Gorham, Ltd., was held on the 19th inst., when the chairman (Mr. B. M. Drake, M.I.E.E.) congratulated the shareholders on the past year's working. For 1917-18 the profit was £18,781, but in the past year it had increased to £27,136, though that was subject to a large deduction for excess profits duty. That tax should, in his opinion, have been abolished as soon as they were able to turn their attention to peace requirements and the rebuilding of their shattered trade. It surely was a mistake to restrict turnover to the 1914 standard. Previous to the war the British electrical industry was dominated by Germany, and therefore paid inadequate dividends, so that it was specially hard hit by that method of taxation just when a chance of expansion occurred. In addition to country house lighting, with which their name had been intimately associated for the past 33 years, they had been busy on industrial work, and had been fortunate in securing the services of Mr. Holbrook Gaskell, O.B.E., M.I.E.E., A.M.I.M.E., until recently the chief engineer of the United Alkali Company, who had been responsible for the electric equipment of their various works at home and abroad on a large scale. It was essential that any scheme for the adoption of electric driving of works should be considered as a whole to ensure that the money was spent to the best advantage. The selection of the most suitable plant from the products of the various manufacturers was a main element of success, and that knowledge they claimed to possess. The 10,000 kw. generating station they had been equipping was not yet completed, owing to builders' strikes; but when working it should compare favourably with any other station of like capacity. They had had a considerable staff of men engaged at Palmer's Shipbuilding & Iron Company, both on power work in the shipyard and also on lighting, as well as the equipment of new vessels for the Admiralty and the mercantile marine. Industrial work had also been carried out for many leading firms, and they had been engaged throughout the year on important work for the Admiralty. The had also undertaken contracts for the Salford Rolling Mills, the Gibralta Mill and the Grecian Mills, and for Messrs. S. Fox & Company, of Sheffield; also lighting and power for a number of other large factories. In addition, they were engaged on electric driving schemes for the Dacca Twist Company and others. The cotton mill driving equipment of 1,000 kw., which they erected several years ago, continued to work satisfactorily. They had been fully occupied in meeting the arrears of country-house lighting which had accumulated during the war, and the advent of the small, self-contained generating sets, which could be started by merely closing a circuit and left to stop themselves when the battery was full, had brought electric lighting within the range of many who could not previously afford to make use of electricity for lighting and labour-saving apparatus in their homes. They had opened an office in Belfast for running a number of important sole agencies for Ireland, and negotiations were in progress for others. Their works had been busy throughout the year and showed a large increase in profit.

Electric Vehicles.

A considerable number of commercial accumulator-driven vehicles had been supplied, and valuable experience had been gained with various types of chassis. Up to the present the company had restricted its operations to Lancashire and Cheshire, but arrangements were being made for supplying those vehicles wherever required. There was a considerable demand by municipalities for refuse collection, in which large economy had been shown over horse traction, as well as for brewers' requirements and all short range delivery purposes. The main difficulty at present was to provide the vehicles fast enough to meet the orders received. Trucks for handling luggage at railway stations and goods in factories had proved their worth, and their use was rapidly extending. They found it advisable to separate the wholesale department entirely by transferring the business to another company, Drake & Gorham Wholesale, Ltd. The new Manchester offices had proved a success. The rapid increase in turnover in all spheres of the company's operations might necessitate the consideration of raising fresh capital before long. It had become necessary to find fresh accommodation for their head offices, and they had been fortunate in purchasing a long lease of 36, Grosvenor-gardens. The necessary alterations were in hand, and they hoped to move at the beginning of the year.

New Companies.

CHAIN ROLLER BEARING COMPANY, LTD. (160,003).—Private company. Reg. Oct. 27. capital £150,000 in £1 shares (70,000 preferred ordinary and 80,000 ordinary). Objects: to acquire from F. Brierley the benefit of certain inventions relating to chain roller bearings, ball bearings, anti-friction and mechanical bearings, &c. First directors are H. Fildes, E. W. Buckley, R. A. Greig, H. Hollingdrake and J. A. K. Ferns. Solicitors: A. E. Ferns & Company, Stockport.

DEWHURST & PARTNER, LTD. (160,314) Private company. Reg. Nov. 5. capital £5,000 in £1 shares, to carry on the business of iron-founders, mechanical engineers, manufacturers of electrical apparatus and implements, &c. First directors are H. Marryat and M. Dewhurst (both permanent). Reg. office: 28, Hatton Garden, E.C.

EAST LANCASHIRE MOTORS, LTD. (160,317)—Private company Reg. Nov. 5. capital £5,000 in £1 shares. Objects: To carry on the business of mechanical, electrical, general and motor engineers, &c. Reg. office: 19, Railway-road, Blackburn.

ELECTRIC FABRICS, LTD. (160,709)—Private company. Reg. Nov. 18, capital £3,000 in £1 shares. Objects: To acquire a patent granted to C. S. Davidson for the heating by electricity of sheets, rugs, foot warmers, &c., and to enter into an agreement with C. S. Davidson, H. Hawkins and F. J. Hawkins. First directors are C. S. Davidson, H. Hawkins and F. J. Hawkins. Reg. office: 128, London-road, S.E.1.

ELECTRICAL SPECIALITIES COMPANY, LTD. (160,673)—Private company. Reg. Nov. 17. capital £3,000 in £1 shares (1,000 preference). Objects: To carry on business as indicated by the title. Reg. office: 33, King-chambers, Angel-street, Sheffield.

GUPPY & LLOYD, LTD. (160,509)—Private company. Reg. Nov. 12. capital £1,000 in £1 shares. Objects: To carry on the business of electrical, mechanical and general engineers, &c. First directors are C. Guppy and G. E. Lloyd, of Leigh, Lancs. Sec., C. Guppy.

HARPER BEAN, LTD. (160,415)—Reg. Nov. 7. capital £6,000,000 in £1 shares (3,000,000 8 per cent. cumulative preference and participating), to carry on the business of manufacturers, repairers and storers of and dealers in motor and other cars, vans, carriages, omnibuses and vehicles, tramcars, aircraft and tractors, &c., mechanical, electrical and general engineers, &c. Solicitors: Slaughter & May, 18, Austin Friars, E.C.

LIGHTING & GENERAL TRADERS, LTD. (160,326)—Private company. Reg. Nov. 5, capital £4,000 in £1 shares, to take over the business carried on by C. B. Bennett at 7, Butler-street, Moor-lane, E.C., as the Lighting Accessories Company, and to carry on the business of lighting accessories merchants, &c.

MARINE & MECHANICAL ELECTRIC WELDING COMPANY, LTD. (160,559.)—Private company; reg. Nov. 13, capital £10,000 in £1 shares, to carry on the business of electric arc and oxy-acetylene cutting and welding of metals and alloys, engineers, &c. First directors are J. M. Gilchrist, T. Ballantine, and W. Pollock. Reg. office, 3, Lloyd's-avenue, E.C.

PRIMARY ELECTRICAL ENGINEERING COMPANY, LTD. (160,531)—Private company. Reg. Nov. 18, capital £1,000 in £1 shares, to carry on business as indicated by the title. First directors are W. Baxter, J. Hill, W. Ogden, J. Smith and J. Taylor. Reg. office: Victoria Mill, off Hollins-road, Hollinwood, Oldham.

Prices of Metals, Chemicals, &c.

Tuesday, Nov. 25.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£113 0 0	£1 0 0	—
Electrolytic bars ...	..	£115 0 0	—	£2 0 0
H.C. wire basis......	per lb.	1s. $3\frac{3}{8}$d.	—	$\frac{3}{16}$d.
Sheet	,,	1s. $4\frac{1}{16}$d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. $7\frac{3}{8}$d.	—	$\frac{3}{16}$d.
Brass 60/40—				
Rod, basis	,,	0s. $11\frac{7}{16}$d.	$\frac{1}{16}$d.	—
Sheet, basis	,,	1s. $2\frac{5}{8}$d.	—	—
Wire, basis	..	1s. $2\frac{1}{2}$d.	—	—
Iron—				
Cleveland Warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis	..	£32 10 0	—	—
Lead Pig—				
English	,,	37 15 0	£2 5 0	—
Foreign or colonial	,,	37 0 0	£2 15 6	—
Tin—Ingot	..	289 0 0	£5 0 0	—
Wire, basis	per lb.	0 3 7	1d.	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £22 10s.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6d.

Shellac.—550s.-555s. December delivery 545s. to 555s.

Rubber.—Para fine, 2s. 6d.; plantation 1st. latex 2s. $5\frac{1}{2}$d. lb.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W. T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From The Electrician, Nov. 25, 1882.]

Electric Lighting at Maidstone.—The Dog Show held at Maidstone last week was satisfactorily lighted up with Brush lamps by the South Eastern (Brush) Electric Light Company.

Life of a Maxim Lamp.—At the New York Post Office it has been found that the average life of a Maxim incandescent lamp (the ordinary 50 c.p. type) is nearly 1,900 hours. About 25 per cent. of the lamps in this office have burnt 3,000 and 4,000 hours.

Electric Light on Ships.—The "Malabar," Indian troopship, which is undergoing extensive overhaul and repairs at Portsmouth, is to be lighted by the electric light. The Edison incandescent system is the one selected, and the installation will be undertaken by the contractors. Each deck will be illuminated by A and B lamps.

Electric Light in Dundee.—Commercial-street, Dundee, is now lighted by five Brush lamps. The lighting is, by arrangement with the Police Commissioners, to last over one month as an experiment. The work of erecting the lamps, &c., was superintended by Mr. W. C. Martin, district electrician and manager of the Brush Company in Scotland. One of Robey's vertical engines is used to drive the dynamo machine.

Lightning and Telephone Wires.—A Continental paper, entitled "L'Europe," says, with reference to the recent thunderstorms which have occurred throughout the whole of Europe, that, contrary to the opinion of some, telephone wires have in no case been a source of danger. At Brussels, Ghent, Antwerp and elsewhere, where lightning fell with disastrous effects, the telephone lines remained intact. At Berlin, again, not a wire was damaged.

The Ferranti Machine.—As a good deal has been said about this dynamo machine lately, and as the most conflicting rumours are abroad concerning it, we may say that we have the best authority for stating that a Ferranti machine has been run recently with satisfactory results, and that experiments as to its efficiency, &c., are being conducted. We shall hope to be able at no distant date to publish some figures relating to these experiments, and to give some account of the nachime.

Electric Light in Engineering Works.—The 16 Brush lamps that have been in use for some little time at Hawthorn's engineering works at St. Peter's, near Newcastle-on-Tyne, have been increased to 32. Messrs. Leslie, of Hebburn, who have also been using 16 Brush lamps for some time, have had 24 more erected in their works, making 40 lamps altogether. The plant in both cases has been supplied and erected by the Hammond Electric Light and Power Company, of Cannon-street, E.C.

Electric Inter-communication on Trains.—A good illustration of the need of this mode of inter-communication between passengers and guards was afforded on a German railway the other day whilst travelling between Lottringhausen and Hörde Stations, near Dortmund in Westphalia. A fire broke out in a carriage of the train, the fire increased as the train progressed, and it was only by dint of much shouting that the unfortunate passengers at length attracted the attention of the guard, and were released from their perilous position.

A New Electrical Paper.—We have received a copy of "L'Elettricita," a new paper, devoted to electrical subjects and published at Milan. The first number contains a portrait and memoir of Alexander Volta, a description of the telephone, an article on the applications of electricity, &c., and concludes with an article on electrical navigation. We notice a sentence in this article which is rather amusing. The writer is talking of steam yachts, which he says are now owned by numbers of "milord Inglesi, lords scozzesi, nobile yankees e principi russi." "L'Electricita" begins with eight pages and an outside sheet.

Electric Lighting in a Cotton Mill.—The Kingston Cotton Mills of Messrs. Wright, Turner & Sons, at Pendleton, employing 700 hands, are now lighted up by the Edison system. At present two dynamos only are running, these being capable of supplying current for 500 incandescent lamps of 16 c.p.; but eventually it is in contemplation to run 1,000 lamps. Two Siemens arc lamps are used to light the mill yard. The actual number of incandescent lamps in use is 540. The work has been carried out by the Edison Company, of Manchester, under the superintendence of their engineer, Mr. Ruddle.

Professor Palmieri.—The death is announced of Signor Luigi Palmieri, well known in connection with the observatory on Mount Vesuvius. Although better known as an observer of earthquake phenomena, Prof. Palmieri was not unknown in the electrical world. "L'Electricite" says that we owe a simple form of electromoter to him, constructed on the same principle as that of Pelletier. He applied his instrument to the construction of an original apparatus, designed to discover the frauds perpetuated by the vendors of olive oil in Italy. M. Palmieri, our contemporary says, had peculiar ideas as to the production of electricity. He thought that the condensation of the vapour of water disengaged large quantities of it.

Transmission of Power to a Distance.—In a note on the subject of M. Marcel Deprez's experiments at Munich, our contemporary, "La Révue Industrielle," says: "The return of 60 per cent. quoted by M. Deprez (*see* Electrician of Nov. 4th, p. 589) was purely electrical, whilst the useful (*industriel*) return, that is to say, the ratio, of useful work (measured on the brake at Munich) to work expended (measured on the dynamometer at Miesbach) was 30 per cent. at the most, or barely half. The result, therefore, as announced to M. Deprez by the Committee at Munich, is that the 'electrical return measured varied from 50 to 60 per cent., whilst the useful return (rendered *industriel*) ranged from 25 per cent. in the first experiment (the generator making 1,000 revolutions) to more than 35 per cent. in the second one (the generator making 2,000 revolutions).'"

THE ELECTRICIAN

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Notes.

Carbon Arcs for Searchlights.

THE advances made in the design and manufacture of metal filament lamps, both of the vacuum and nitrogen-filled types, seems in recent years rather to have drawn attention away from the older arc lamp. But there is still much to be learnt about the latter type of illuminant, and especially about the suitability or otherwise of various kinds of carbons for different conditions of working. For this reason, no doubt, the Paper read by Mr. CLIFFORD PATERSON and his colleagues before the Institution of Electrical Engineers resulted in a most interesting, not to say critical, discussion, though this is not to say there was no sense of disappointment. For, as was pointed out by a number of speakers, the Paper really describes a series of laboratory tests on large carbons, and, except that these carbons were burnt in a searchlight lamp, the connection of the results with searchlights is not very clear. It does not follow, for instance, that the carbon which shows the best performance in the laboratory is also the most suitable for, say, anti-aircraft work. On the other hand, it is contended that though this may be true the testing of carbons under laboratory conditions is a necessary preliminary to their practical trial out of doors in order that the effect of certain variables may be determined and the way thus cleared for what are admittedly the more difficult investigations. This argument is, we think, to some extent fallacious. The conditions of working, as Capt. YORKE hinted, are so different that it does not follow that laboratory results will be any help to those working on the problem in the field. There are really two sets of problems to be considered, and while it is true they are interdependent they are also to a large extent separate. But the results given in the Paper did not altogether escape criticism, even when considered purely from the laboratory point of view. Mrs. AYRTON, of whose work on this subject it is unnecessary to speak, showed that the authors, in supposing that the candle power emitted would change considerably with the potential difference across the arc, had forgotten the diminishing effect of the obscuration by the negative as the arc is shortened, owing to the negative becoming more pointed. Practice again conflicted with theory when Mr. HADYN HARRISON pointed out that what is wanted is a knowledge of the total luminous flux that falls on the mirror. This cannot be obtained from the Paper, though it is undoubtedly the criterion when judging the value of carbons for searchlight work. In our opinion in this research Mr. PATERSON and his colleagues have, to some extent, followed the example of those excavators who attempt to deduce the appearance of an ancient Egyptian palace from a few detached ruins still half buried in sand. We hope, like the excavators, they will continue to clear away the sand, but we shall not be surprised if, as they proceed, they find it necessary to revise some of their earlier opinions.

The Coal Prices Muddle.

THE Government and all its various departments and sub-departments move in mysterious ways. The latest example of this is the sudden enforced reduction in the price of household coal by 10 shillings a ton after official and semi-official announcements had been made that no such reduction could be expected. This reduction, it appears, is also to apply to all coal used in generating electricity and gas for purely domestic purposes. This is an example of unconscious humour. The domestic consumer is already beginning to ask how soon he may expect to get his electric light for less, but it is doubtful whether any reduction will be possible. Taking the conditions at Manchester as an example, the load on the various stations in that city is mainly power, only about 8½ per cent. of the total output being used for lighting and lighting consumers are able to obtain their light at the present rate simply owing to that fact. In their case, then, the result of the order is more likely to lead to a rise in price than a reduction, which is not exactly what was intended. It is a surprising position, and whatever we may think of it we do not envy those whose business it is to explain to the irate consumer why a reduction in the price of coal should make his lighting bill go up: the maximum demand system will be easy to this task! Even in the cases where the load on a station is mainly a lighting one, it is doubtful whether any great reduction in the price of energy can be made, as so many other factors come into consideration. The cost of generation and distribution, of which wages and bonuses form a large proportion, will not be much affected by the change, while stocks of coal which have been bought up at the old prices will have to be expended before anything much can be done. The whole thing indeed forms an excellent argument against legislation in a hurry, which, far from conferring any benefits, generally renders confusion worse confounded.

How the Progress Department Assists.

The functions of the Progress Department in works have been a matter for some discussion of late, and in spite of diversity of views expressed, it is apparent to all that the department has a place in the organisation of the engineering factory. In the series of articles under the heading of "How the Progress Department Assists," the concluding part of which appears in this issue, two points are emphasised by the writer, viz.: (1) That the Progress Department *can* be of assistance to every phase of the factory organisation—management, administrative and productive, and (2) that the value of that assistance is dependent upon the use made of the Progress Department by the sections concerned. The first part of the article deals with the assistance the department renders to the management, and it is the attitude of the management which determines, to a very great extent, the degree to which the Progress Department can assist the administrative and productive sections. If the department is thoroughly exploited by the management, then it enjoys a position of some importance, and as such is of great value to the factory organisation. If, on the other hand, the functions of the department are restricted, then as a natural sequence its activities are restricted, and it remains just a department. Assuming that the management recognises the value of the Progress Department, the attitude of the other sections must necessarily affect the amount of assistance rendered, and in regard to the administrative section the writer is of the opinion that professional jealousy prevents this section from taking full advantage of the assistance offered. In many factories the Progress Department is an unknown quantity, and the fact that its activities are constantly extending, tends to make it an object of suspicion. The costing, rate fixing, store and purchasing departments are each engaged upon a specific duty, the limits of which are clearly defined, and they are apt to consider the offer of assistance from the Progress Department in the light of an interference. This should be an out-of-date point of view nowadays.

This is also too often the attitude taken by the departmental foremen, and makes the task of the progress man extremely hard, but it is all due to a misapprehension, for a little clear reasoning must convince the foreman that, in order to carry out his work efficiently the progress man must assist the foreman. This assistance would, however, be considerably augmented by a manifestation of good-will on the part of the foreman towards the progress man. The contention that the Progress Department is able to render assistance to the shop operators will no doubt be refuted by those anxious to prove that no bond exists between Capital and Labour. The fact that the Progress Department stands for efficient factory organisation must, however, commend itself to the workers, for they know, better than anyone else, the advantages enjoyed in a factory worked upon systematic lines, in comparison with the factory where everything is done in a haphazard manner.

The case for interference does not arise. The Progress Department is interested in delivery and output, and anything having a bearing in this direction must receive the attention of the progress man. The Progress Department links up the various interests, providing a smooth machinery for facilitating the progress of work through the shops, thereby discharging the commitments of the firm in regard to delivery, increasing output, and, as a natural sequence, making the way for an increased intake. It is in the faithful discharge of its legitimate duties that the Progress Department assists all other sections of the organisation, taking over, not the legitimate duties of these sections, but a mass of vexatious detail which, under haphazard management, they must of necessity handle, even though it has but a remote bearing upon the real business of the department. For these reasons we feel that Mr. Hiscox's articles will prove of great value in assisting towards a more desirable state of things.

A Scheme to Waste Electric Power.

In another column of this issue we call attention in some detail to an attack by Lord Moulton on the Electricity (Supply) Bill which recently appeared in one of our daily contemporaries. But while this article covers most of the ground, there are one or two points of more general interest to which we may refer here. Lord Moulton, like a good many other critics, ignores, or fails to realise, the real purpose of the Bill, which is simply to increase the amount of power used in industry and so to raise the output per worker. To do this means electric power at rock-bed prices. Unless manufacturing costs can be reduced as much as possible, British industries cannot hold their own in the test of keen international competition, which will obviously occur now that the war is over. The foregoing is the unanimous conclusion of the Board of Trade Committee, and it is to provide for this that the Bill was framed. The Bill, indeed, stands or falls by this one criterion—cheap industrial power. Lord Moulton, we find, takes a great deal of space in trying to prove that heating by gas is more economical than heating by electricity. But the last thing that the Bill caters for is electric heating. The Board of Trade Report places every other use prior to this and then only includes it under the heading of "domestic labour-saving apparatus."

The other points towards which Lord Moulton directs attention are the increased danger from strikes, when supply is concentrated in a few super-stations, and the colossal nature of the speculations involved in the erection of the latter. As to the first point, if cheap power means increased production and therefore higher wages and greater national prosperity, the risk is more than balanced by the advantages, to say nothing of the tendency of prosperity generally to alleviate industrial unrest. As to the second point, the "Government" is not, as Lord Moulton claims, proposing "to embark on huge schemes of a most speculative type." The Bill as now amended gives full scope for the existing undertakers to work out co-operatively their own plans. If Lord Moulton wishes to do a public service, he could on this point assist by using his influence when the actual schemes are being formulated and "Orders" being made, to see that public credit is pledged only where absolutely necessary, and that full use shall be made of private capital where same is forthcoming. In this he would have our hearty support, as such procedure would certainly minimise any chance of the exploiting of the supply industry by theoretical nationalisers. Any statesman who can help towards keeping politics out of the consideration of practical schemes will be doing the greatest of services towards their success.

The Registration of Engineers.

As foreshadowed in Sir John Griffith's Presidential Address, it is now announced that the Institution of Civil Engineers are making application to Parliament during the ensuing session to obtain powers to establish a register of civil engineers and to prescribe the qualifications and to hold examinations for the purpose of enabling such persons to qualify for registration. It has generally been considered that the engineering profession suffers under a disability in that there are no rigid qualifications which a man must possess before he may call himself an engineer. Thus, in this country there have been cases of workmen in a small way of business as wiremen, or even plumbers, calling themselves electrical engineers, and the general term "engineer" is applied in the United States to the man who drives a locomotive, a term to which he is hardly entitled despite his undoubted aristocratic position at the present time. We, therefore, welcome the efforts of the Institution of Civil Engineers to put this matter on an official basis, but we are sorry to see that the action is being taken, we will not say without consultation with, but at any rate without the official sanction of the two other main engineering institutions. The term "civil engineer" in its widest sense is often taken to include all engineers except those belonging to the purely military class; and this has always been the view taken by the Institution of Civil Engineers, but engineering is such a wide subject and covers such a multitude of activities that it is not surprising to find that many fully qualified members of the engineering profession do not belong to the oldest of the Institutions. While, therefore, hoping that the Institution of Civil Engineers will press their claim forward, we should like to see them arrange with the Institutions of Mechanical and Electrical Engineers to make joint application to the Parliamentary authorities for the object that they have in view. When the necessary powers have been obtained, we see no objection to the Institution of Civil Engineers keeping the required register, but we think that the application would have more force the more weight it has behind it. And we certainly hope that membership of the Institution of Civil Engineers will not be made a necessary preliminary to registration.

Royal Engineer Volunteers.—The London Army Troops Companies have ceased to exist, as all non-commissioned officers and men were discharged on September 27th. The officers, with the exception of the Commanding Officer (who is now the sole official representative of the Corps), relinquished their commissions on October 17th. It is expected that there will be a balance of the funds available for charitable purposes.

Army Wireless Information.—An Army Council Instruction states that it has been decided that military or civilian experts employed on wireless duties in the Army shall be allowed to publish scientific Papers in this country, providing that they do not make any detailed reference to service sets, or give other information which the authorities consider should not be divulged. The form of publication may be either in a journal or by lecture after the draft of the Paper has been submitted to the War Office for censorship.

Rontgen Society.—At the invitation of the Royal Photographic Society an exhibition of prints illustrating the employment of the X-Ray is being organised by the Röntgen Society. The exhibition will be held at the Royal Photographic Society's House, 35, Russell-square, London, W.C., from Jan. 6 to Feb. 7th, 1920, and will be open daily from 11 a.m. to 5 p.m., admission free, and on the evenings of Jan. 6 and Jan. 13 till 9 p.m. On the former date an elementary lecture on "The X-Rays approached from the Popular Standpoint" will be given by Dr. George H. Rodman, F.R.P.S., and on Jan. 13 a discussion will be opened by Major G. W. C. Kaye, O.B.E., on "Some Aspects of Radiology," both these lectures will commence at 7 p.m.

Society of Technical Engineers.—The fourth general meeting of the South-Eastern District of this Society was held on Tuesday, Dr. J. F. Crowley presiding. Mr. C. H. Wordingham, who addressed the meeting, said the main object of the Association was unquestionably to enable force to be employed. Force, although essentially regrettable, was sometimes necessary. Technical engineers found themselves entirely left out of consideration in the Whitley Councils. They could not join the employers, and most of them would not join the manual workers, and they felt they ought to have an organisation. The Society aimed at having within its membership all branches of technically trained engineers, and must get the right men to guide them. They must take care that no ill-advised or ill-considered action was taken, especially in the early stages, and they should be able to do a great deal to uphold the dignity of the profession and to influence the trend of events in the country.

Water Power in Dutch Borneo and Sumatra.—At a time when water-power resources all over the world are being exhaustively studied, it is not surprising to find that a full survey of the resources in Borneo has been undertaken by the Dutch Government. Falls on the Kajan River and the Tangga falls on the Asahan River have been examined, and another larger fall above the latter is now known to exist. The available horse-power discovered is estimated at 500,000 H.P. Various other rivers in the Central Celebes, including the La Rona which is estimated to be capable of furnishing 150,000 H.P. at a commercial figure, have also been studied. In Sumatra and Central Celebes the total power available is of the order of 1,000,000 H.P.

Industrial and Scientific Research in South Africa.—In the 1918 report of the Industries Advisory Board and the Scientific Committee of South Africa, which have recently been amalgamated, it is stated that the question of the production and the utilisation of electric power for industrial purposes and the erection of large plants at various centres for the electrification of railways, which would also serve as valauble centres for the disposal of power to industrial concerns, are under consideration. The desirability of the standardisation of supply is urged. Legislation exists in the Transvaal for the control of electric power supply undertakings, and when necessary such legislation would doubtless be extended on suitable lines to other provinces. The report also refers to the work done in connection with fertilisers, &c.

Diesel Engine Users Association.—At a recent meeting of this Association the progress made in forming the Provisional Committee for the proposed Research Association for Liquid Fuels under the Government scheme of industrial research was reported. There was also a discussion on the subject of Connecting Rod Bolts. Mr. Geo. W. F. Horner said, taking all circumstances into account, he was not in favour of periodic heat treatment of Connecting Rod Bolts. Mr. H. Squire showed that the annealing process had practically no effect on the material. Mr. A. W. A. Chivers did not consider periodic heat treatment necessary. Another point brought out in the discussion was the importance of taking precautions to prevent any overstrain on the bolts when tightening up, and it was suggested that some form of gauge should be employed to note the elongation caused by the bolting up of the nut.

Royal Institution.—The following are among the Lecture Arrangements at the Royal Institution before Easter, 1920. Prof. W. H. Bragg: Six Lectures adapted to a Juvenile Auditory on "The World of Sound"; Sir John Cadman: Lectures on "Modern Development of the Miner's Safety Lamp"; and "Petroleum and the War"; Prof. Ernest Wilson: Two lectures on "Magnetic Susceptibility"; Lieut.-Col. E. Gold, D.S.O., two lectures on "The Upper Air"; Sir F. Watson Dyson, Astronomer-Royal: Three Lectures on "The Astronomical Evidence Bearing on Einstein's Theory of Gravitation"; and Prof. Sir J. J. Thomson: Six Lectures on "Positive Rays." The Friday Evening Discourses will begin on Jan. 16, at 9 p.m., when Prof. Sir James Dewar will deliver a Discourse on "Low Temperature Studies." Succeeding discourses will probably be given by the Hon.

Sir C. A. Parsons, Mr. S. G. Brown, Prof. W. M. Bayliss, Dr. E. J. Russell, Mr. W. B. Hardy, the Hon. J. W. Fortescue, Prof. J. A. Fleming, Mr. E. McCurdy, Prof. Sir J. J. Thomson and others.

The Theory of Radio-Direction Finding Apparatus.—The "Journal" of the Franklin Institute for September contains a contribution by Capt. A. S. Blatterman, of the U.S. Army, on the above subject. In radio-stations it is sometimes possible to hear signals with the antenna disconnected, passing waves inducing sufficient E.M.F. in the coils of the receiver to produce audible signals. An investigation was accordingly carried out to determine the most efficient shape of coil to receive signals in this way. The effect of position and shape of the coil, with a view to direction-finding, was also studied. At first sight it would appear that the coil would be more effective the larger its cross-section and the greater its time-constant, also that the loudness of the signals is inversely proportional to the square of the wave-length. This, however, is not borne out in practice. There is a certain size of coil which gives the best results for a given wave-length, apparently because the resistance of the coil varies with the wave-length. For very long wave-lengths the resistance is normal. As the wave-length is shortened, but, as the frequency is increased, the resistance increases slowly until it is two to three times its ordinary value, and then subsequently increases very rapidly. The reception is, therefore, bad at high frequencies, but a type of coil can be specified to give the best results. As regards the directional characteristics of this type of receiver, the height above the ground appears to be a highly influential factor. Under certain circumstances it was possible to hear signals issued by all the high-power European stations in an ordinary room.

Obituary.

We regret to have to announce the death on the 26th ult. of Mr. Thomas Fletcher, a well-known figure in the telephone and telegraph world; in fact, the father of the telephone in this country, and very much regretted in an even wider field of electrical engineering. Mr. Fletcher was born in London in 1849, and educated at Victoria College, Jersey. He commenced his business career with a London architect, but in 1868 entered the engineering department of the United Kingdom Telegraph Company, with whom he stayed until 1870, when he entered the service of Messrs. Henleys, the well-known telegraph contractors. In 1873 he accepted an offer made by Sir William Thomson (later Lord Kelvin) to assist in developing his siphon recorder for submarine cables at the Glasgow University, and he was also engaged on the testing of the Brazilian submarine cables being made by Messrs. Hoopers, at Millwall, to the specifications of Sir W. Thomson and Fleeming Jenkin. In 1874 he returned to Henley's service, and spent considerable time on submarine cable-laying expeditions. He was afterwards in the Post Office with Mr. W. H. Preece (later Sir W. Preece). With Mr. Preece's introduction, he entered the service of the newly-established Telephone company in 1878 as engineer, and remained in that service through its many changes as the United Telephone Company and later the National Telephone Company, until January, 1912, when he went over with the staff to the British Post Office, where he remained until his retirement in the spring of 1914. During his long connection with the telephone service his large experience and ability were of great value, especially in overcoming the many difficulties of the early days, and there is no doubt the rapid development of the business was in great measure due to his skill and ability in dealing with the situation. The interment in the City of London Cemetery on the 1st inst. was attended by a number of his old colleagues and others, including Messrs. Aitken, Brien, Davies, France, Francis, Gall, Kingsbury, Kipping and Poole.

Personal.

Mr. R. W. F. Harrison has resigned the assistant secretaryship of the Royal Society, owing to ill health. Mr. Harrison has been connected with the Society for a period of 24 years, and the Council desire to put on record their high appreciation of the great ability, conspicuous zeal and devotion to the interests of the Society which he has exhibited throughout his tenure of office. It is interesting to note that on the 1st of January next he will have held office for a longer time than any of his predecessors.

We regret to learn that Dr. Cecil Lyster, who has been in charge of the electro-theurapteic department of the Middlesex Hospital for some years, is now lying in a critical condition owing to his self-sacrificing devotion to duty. Dr. Lyster has for some time applied himself to the study of X rays and their use in the treatment of diseases, especially of cancer. Like so many others who have worked in this field he has fallen a victim to exposure to the rays, and although he has manfully struggled against the resulting disabilities it is no longer possible for him to continue his work.

Arrangements for the Week.

FRIDAY, Dec. 5th (to-day).

Institution of Electrical Engineers—Students' Section.

7 p.m. At the City and Guilds Technical College, Leonard-street, Finsbury, London, E.C. Paper on "Thermionic Magnifiers," by Mr. H. M. Barlow.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Paper on "Some Notes on Extra High Tension Switchgear," by Mr. E. F. Hetherington.

Technical Inspection Association.

7.30 p.m. At the Society of Arts, John-street, Adelphi, London, W.C. Paper on "Inspection and Testing of Materials," by Messrs. R. D. Summerfield and H. J. Davey.

MONDAY, Dec. 8th.

Royal Society of Arts.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Synthetic Drugs," by Dr. J. T. Hewitt, F.R.S. (Lecture II.)

Institution of Mechanical Engineers—Graduates' Association.

8 p.m. At Storey's Gate, Westminster, London, S.W. Paper on "Large Boiler Units," by Mr. R. J. Glinn.

TUESDAY, Dec. 9th.

Institution of Electrical Engineers—North Midland Centre.

7 p.m. At Midland Hotel, Bradford. Discussion on "The Linking-up Report," to be opened by Mr. T. Roles.

Institution of Electrical Engineers—Scottish Centre.

7.30 p.m. At 207, Bath-street, Glasgow. Paper on "Scientific Works Management," by Capt. J. M. Scott-Maxwell, M.C.

Junior Institution of Engineers,—N.E. Section.

7.15 p.m. In the Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Paper on "Notes on Design and Construction of Polyphase Induction Motors," by Mr. S. H. Moore.

Institution of Electrical Engineers—North-Western Students' Centre.

7.30 p.m. At Holdsworth Hall, Deansgate, Manchester. Paper on "Protection of Alternating-Current Circuits and Apparatus," by Mr. E. T. Norris.

WEDNESDAY, Dec. 10th.

Royal Society of Arts.

4.30 p.m. At John-street, Adelphi, London, W.C. Trueman Wood Lecture on "Some Possible Sources of Energy," by Sir Oliver Lodge, D.Sc., F.R.S.

Association of Engineers-in-Charge.

7.30 p.m. At St. Bride Institute, Bride-lane, Fleet-street, London, E.C. Paper on "Industrial Reconstruction," by Mr. A. Ramsay.

THURSDAY, Dec. 11th.

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Scientific Works Management," by Capt. J. M. Scott-Maxwell, M.C.

Institution of Automobile Engineers. Graduates' Section.

8 p.m. At 28, Victoria-street, London, S.W. Debate on "Worm *v.* Bevel Drive."

FRIDAY, Dec. 12th.

Physical Society.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers to be read: "First Steps in the Experimental Analysis of a Galvanic Cell," by Prof. W. M. Coleman; "Radiation from a Perfectly Diffusing Circular Disc," by Mr. J. W. T. Walsh, M.A.; "A Comparative Method of Testing Thermionic Valves for Passing No Reverse Current at High Voltages," by Dr. N. W. McLachlan; and "On Recording and Reproducing Sounds by Means of Light," by Dr. A. O. Rankine.

Society of Technical Engineers—Woolwich Branch.

7 p.m. At Royal Oak Hotel, New-road, Woolwich, London, S.E. Paper on "The Proper Position of the Engineer in Political and Industrial Circles," by Mr. E. C. de Segundo, A.M.Inst.C.E.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Paper on "A Walk through the Shops at Richborough," by Mr. R. S. Kirlew.

SATURDAY, Dec 13th.

Stoke-on-Trent Association of Engineers.

7 p.m. In the Council Chamber, Town Hall, Hanley, Stoke-on-Trent. Paper on "The Casting of Refractories for the Metallurgical and Engineering Trades," by Mr. B. T. Allen.

Birmingham and District Electric Club.

7 p.m. At the Grand Hotel, Colmore-row, Birmingham. Annual General Meeting.

Carbon Arcs for Searchlights.

By C. C. PATERSON, O.B.E., J. W. T. WALSH, M.A., M.Sc., A. K. TAYLOR and W. BARNETT.

This Paper describes a series of experiments undertaken at the request of the Admiralty (D.T.M. Dept.) and is published by permission. The object was (*a*) To develop the best method of testing carbons in order to prove their value for searchlights. (*b*) To compare the relative qualities of existing carbons, other than flame carbons, for producing high-intensity searchlight beams. (*c*) To determine what improvement can be made either in the carbons themselves or in the methods of burning them.

It was at first proposed to make measurements of illumination at different parts of a searchlight beam under actual working conditions in the open, but the sources of error encountered were so great as to cause this method to be abandoned in favour of an indoor method of test, at any rate for the first series of experiments. Some account of the methods tried is given in the Paper. The chief difficulties met with were the scattering of light by particles of moisture, draughts, the position of the positive carbon in relation to the mirror and variations in the carbons themselves.

In the laboratory the carbons were burned in an integrating photometer of cubical form, and simultaneous measurements were made of the average candle-power given by the arc and of the surface brightness of the positive crater. By this method a comparison was made of 13 different types of carbon, both those already in use in the British and French Services, and others specially prepared by the General Electric Company. Experiments were made with two devices having for their object the control of the arc and its maintenance in a central part of the crater to ensure even burning of the carbons. One of these was an electromagnetic device, while the other depended upon a slow rotation of the positive carbon.

In the method of test which was adopted the carbons were examined alone without any mirror. Two quantities have mainly to be considered: (i.) The total flux of light emitted by the carbons alone. (ii.) The intrinsic brilliancy of the positive crater. Of these the second is the more important, since it is a measure of the intensity in the beam of the projector. If crater brilliancy can be accurately measured it provides a direct criterion of the ability of the carbon to yield a high intensity beam, provided the searchlight is adjusted to give a beam of minimum divergence. If, however, a beam of given divergence is obtained, the intensity will be directly proportional to the total flux of light given by the positive crater whatever its size or brilliancy. For this purpose, therefore, the more important factor is the total flux emitted towards the mirror, or, what may be taken as proportional to it for ordinary carbons, the average candle-power of the crater in directions embraced by the mirror. It follows that improvements in ordinary searchlight carbons are mainly obtained by reducing the diameter of the positives if the current is to be kept at the same value. This does not apply to flame carbons. It is, of course, obvious that a quantity which it would be useful to measure in addition to the total flux is the flux emitted within the solid angle embraced by the mirror; but the difficulties of making measurements of the light emitted within a given solid angle have resulted in the decision to postpone this and to base the preliminary results given in this Paper on the measurements of total flux, which are more readily obtained.

The principle of the integrating globe photometer has been employed, but, following a suggestion by Dr. W. E. Sumpner† that, to a fairly close approximation, a whitened cube would give as good results as a sphere, this form of integrator has been adopted for the purposes of the present investigation. It is necessary, however, to choose for the calibration of the cube a standard lamp which has approximately the same distribution of light as the lamp to be tested. The integrating cube used in the present investigation has 8 cubic metres' capacity (2 metres side). The arc lamp is entirely controlled from outside the cube. Two images, in directions at right angles to each other and to the axis of the carbons, are projected through the walls of the cube permitting examination of the arc while burning. The electrical measuring instruments, feeding and locating arrangements, and electromagnetic control are manipulated from outside, so that there is no necessity to open the cube except to change carbons. Ventilation is provided by means of adjustable shutters at the sides and top. Readings are taken simultaneously of crater brilliancy and candle-power. The brilliancy is measured by projecting a magnified image of the front of the crater along a photometer bench. By the use of a negative lens placed where the image comes to a focus, any small part of the crater image can be isolated and the intensity at this point determined. A detailed description of the apparatus is given in the Paper, together with the steps taken to calibrate the cube, arc lamp and other equipment used. For calibrating the cube a 240 volt, 1,000 watt vacuum lamp was used with a fairly closely fitting opaque hood, the combination giving a Rousseau diagram corresponding very closely to that of an arc lamp. Calibration was performed daily owing to the gradual discoloration of the white walls of the cube. The comparison lamp was an ordinary grid filament lamp operating at 200 volts. The normal brightness of the crater is given by

$$B = \frac{C't'(x')^2 R}{r^2 n m} \cdot \frac{1}{(x')^2}$$

where C' is the candle-power of the comparison lamp, t' the transmission coefficient of the colour filter, x', the distance of the comparison lamp from the photometer, r the radius of the positive lens, n the transmission coefficient of the positive lens, m the reflection coefficient of the mirror, and R is the illumination at the screen plus the illumination at the photometer determined by actual measurement, using a portable brightness photometer; by measurement of magnification and allowance for the absorption of light in the lens system Q; by substituting for the arc a 500-watt "Point-o-lite" lamp, the surface brightness of a part of the plate of this lamp having been previously determined in candles per square millimetre on a standard photometer bench by measurement of the candle-power of the known small area of its surface viewed through a pinhole of accurately determined diameter.

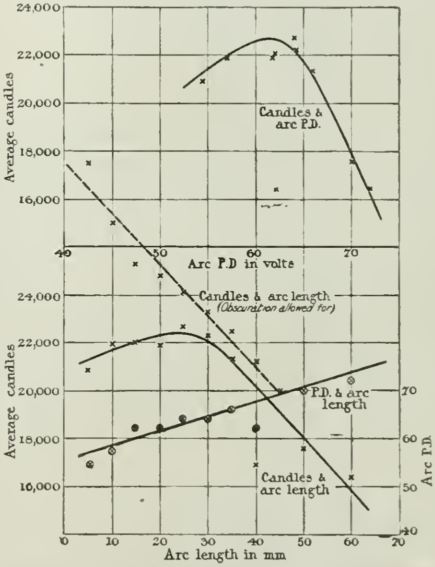

Fig. 1.—Variation of Candle-power with P.D. and Arc Length. G.E.C. "Apostle" carbons (+ve 28 mm., —ve 16 mm.) impregnated, at 180 amperes

The first seven carbons which formed the subject of this investigation were originally supplied for a comparison of their light efficiencies with that of a special impregnated carbon developed by Messrs. W. Heape and H. B. Grylls. Subsequently, and as the result of conclusions drawn from these tests, a series of carbons was specially made up and supplied by the General Electric Company, with the object of obtaining the best type of carbon for an average burning current of 200 amperes. Tests were also made with the electromagnetic control device developed by Capt. Yorke, of the London Electrical Engineers. The lamp in which the carbons were burned was an old Crompton type for the 90 cm. searchlight with automatic and hand-feed gear.

It was at first thought that the candle-power would vary both with a potential across the arc and with the current, but a careful investigation showed that while the P.D. and the arc length increased or diminished together, a large change in these quantities produced no sensible alteration in the average candle-power. Fig. 1 shows a series of measurements of the average candle-power from 28 mm. impregnated "Apostle" carbons when taking 180 amperes at arc potentials varying from 55 to 72 volts. The points corresponding to arc lengths less than 35 mm. cannot be said to indicate a definite variation of candle-power in either direction. It is clear from the observations shown, and others made subsequently, that an increase in arc length or P.D. does not produce any increase in candle-power. The general position may be summarised as follows :

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* Abstract of a Paper read before the Institution of Electrical Engineers.

† "Illuminating Engineer" (London), 1910, Vol. III., p. 323.

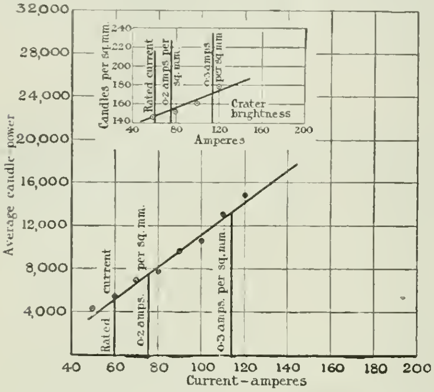

Fig. 2.—Candle-power, Crater-brightness and Current Curves.

Type of carbon.	+	−	Rated current.	Inclination.
Plain.	22 mm. solid	12 mm. cored.	60 amperes.	Carbons axial.

A long arc, for any given carbon, whether from impregnated carbons or not, implies a high potential; and a short arc, a low potential. In order to obtain, under working conditions, a given amount of light from a given positive carbon, it is only necessary to pass through it a given current, the voltage across the arc and the arc length required to avoid hissing being immaterial. A positive carbon taking 200 amperes at 70 volts, *i.e.*, 14 kw., will emit the same light as one taking 200 amperes at 100 volts, *i.e.*, 20 kw. From the point of view of light emission from the positive crater, the extra 6 kw. are wasted. In order to ensure, however, that all but a very small proportion of the light directed towards the mirror from the positive carbon misses the negative, it is necessary for the arc length to exceed a certain minimum figure (for a particular diameter of positive and negative carbons), as mentioned in par. 10 above, and to obtain carbons which will take the maximum current through the positive crater at this minimum arc length, thus securing all the light possible with the minimum amount of dissipation of heat at the arc.

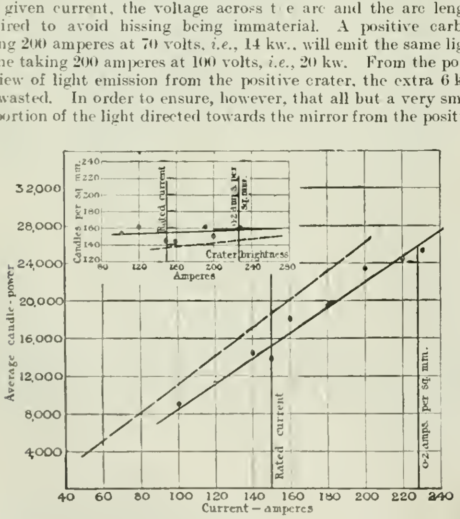

Fig. 3. Candle-power, Crater-brightness and Current Curves.

Type of Carbon.	+	−	Rated current.	Inclination.
Plain.	38 mm. solid.	20 mm. cored.	120-150 amperes.	Carbons axial.

The above discussion leaves out of consideration any specific differences there may be in the light emission of different carbons, *i.e.*, in the capacity of one type of carbon to give more light than another for a given current. The whole investigation shows that, for the types of carbon considered, there is no sensible difference either in average candle-power or in crater brightness for carbons of the same diameter run at the same current. The efficiency in candles per ampere, however, increases somewhat for the same current density as the diameter of the positive carbon is increased; it is reasonable to attribute this, at least in part, to the greater relative cooling surface of the smaller carbons. A number of curve sheets, of which we reproduce examples (Figs. 2 to 5), are given in the Paper to support these conclusions. The large curves are for average candles plotted against current; the small curves at the top of the sheet are for crater brightness in candles per square millimetre plotted against current. Each curve sheet gives for one of the types of carbon the result of a long series of measurements of candle-power and crater brightness at different values of current. The (candle-power)/(current) curve for carbon No. II. (Fig. 2) when burned with the Yorke electromagnetic control, has been taken as a convenient reference line for purposes of comparison between other carbons, and this has been shown as a broken line on all curve sheets. For crater brightness a dotted reference line has been drawn by connecting two points whose co-ordinates are obtained thus: the

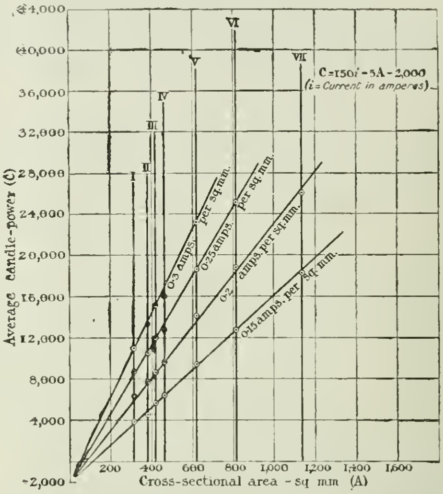

Fig. 4.—Average Candles and Nominal Area of Uncoppered Positive Carbons at Four Current Densities.

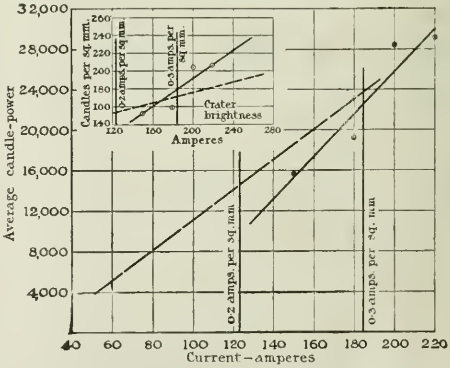

Fig. 5.—Candle-power, Crater-brightness and Current Curves.

Type of Carbon.	+	−	Rated current.	Inclination.
Plain.	28 mm. cored coppered.	16 mm. cored.	—	Carbons axial

abscissæ are the currents corresponding to densities of 0·2 and 0·3 ampere per square millimetre of the carbon considered, while the ordinates are the crater brightnesses of the reference carbon at the same current densities. Each circle marked on the curves represents the mean of a large number of observations.

The results obtained with two of the uncoppered carbons are shown in Figs. 2 and 3. Fig. 2 deals with a solid Army carbon (G.E.C. "Apostle" grade) 22 mm. in diameter, rated at 60 amperes per square millimetre. On the whole, good running was obtained without the electromagnetic device currents up to 100 amperes could be taken, and with this device it was possible to run up to 130 amperes. The P.D. across the arc ranged from 50 to 80 volts for arc lengths varying from 10 mm. to 40 mm. and with currents varying from 50 to 120 amperes. The results on this carbon have been used as a reference as stated in par. 13. Fig. 3 was an Army solid carbon ("Apostle" grade), 38 mm. in diameter, its rating being 150 amperes, or only 0·132 ampere per square millimetre. This arc was often difficult to control and gave irregular results at current above 200 amperes. The arc length varied from 15 to 30 mm. for currents of 120 to 230 amperes, and the arc P.D. from 60 to 86 volts. It was impossible to get currents exceeding 230 amperes to run steadily.

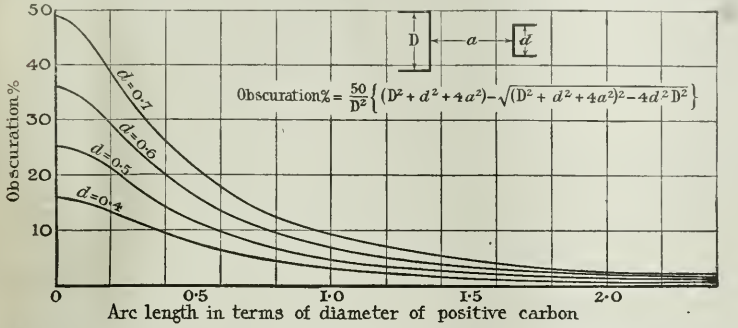

FIG. 6.—CURVES SHOWING PERCENTAGE OF THE TOTAL LIGHT EMITTED FROM A RADIATING CIRCULAR DISC OF UNIT DIAMETER, WHICH IS OBSCURED BY A CO-AXIAL CIRCULAR DISC OF DIAMETER *d* SITUATED AT A DISTANCE *a* FROM, AND PARALLEL TO, THE RADIATING DISC.

[NOTE.—All dimensions are in terms of the diameter of positive carbon.]

Fig. 4 gives a set of curves embodying the results of the average candle-power tests on the seven uncoppered carbons tested. It is seen that for all these carbons the average candle-power depends only on the current and the nominal area of the positives. The empirical expression obtained for these curves is of the form $c=A\,i+B\,a+C$, which gives the average candle-power for any carbon in terms of the current and area, where i is the current and a is the nominal cross-sectional area of the positive in square millimetres. For these carbons $A=150$, $B=-5$, and $C=-2{,}000$. Hence it is seen that the average number of candles per ampere tends to increase with the area for a given current density. It appears that no appreciably greater efficiency can be obtained by increasing the diameter of the positive beyond 28 mm., since the rate of increase at this point in candles per ampere for a large percentage change in the diameter is very small. Further, as a result of this investigation it was found that the maximum current which any uncoppered carbon could carry without overheating was given approximately, for the sizes used, by the empirical formula $i_{max.}=1{\cdot}8d^{1\cdot4}$ where d was the diameter of the positive in millimeters. By comparing this with the expression for candles per ampere given above, it was found that the maximum candles per ampere should be obtained with a positive 34 mm. in diameter taking some 250 amperes. This gave 124 candles per ampere, a result almost identical with that obtained with the 28 mm. diameter carbon at 154 amperes, viz., 123 candles per ampere. The fact that the candle-power values for each current density lay regularly on a system of straight lines showed that none of these carbons possessed any noticeable superiority in specific light emission. All the positives were uncoppered, and it was found that as the current density was increased beyond about 0·3 ampere per square millimetre the carbons became very hot, especially the larger sizes, and began to disintegrate on the outer surface. For further work at high current densities and to use carbons of 28 mm. diameter, therefore, it was decided to have all the positives coppered.

The results obtained with one of the coppered carbons is shown in Fig. 5. This was of "Apostle" grade, 28 mm. in diameter, its rating being 110 amperes or 0·18 ampere per square millimetre. It was run at currents from 150 to 220 amperes and a P.D. ranging from 58 to 86 volts with an arc length of 25 to 42 mm. The thickness of coppering on these carbons was 0·06 mm. This apparently resulted in an increase in the slope of the (candle-power)/(current) curves, and in shifting the intercepts on the axis of the current. This last was equivalent to an increase in the size of the carbon. It is probable that the relative irregularity of the results was due to the difficulty in maintaining a uniform crater at current densities exceeding 0·3 ampere per square millimetre. At 220 amperes the average candle-power of the six carbons did not differ by more than 13 per cent. from the mean. In all cases the negatives were of 16 mm. diameter and heavily coppered, as it was found that if smaller ones were used the coppering volatilised and the carbon gradually disintegrated and diminished in diameter when the current exceeded 180 amperes.

It is clear that at some of the shorter arc lengths employed during the course of the investigation, the proportion of light obscured by the tip of the negative carbon cannot be altogether neglected. The amount of this obscuration can be readily calculated if it be assumed that (i.) the positive crater radiates as a circular disc emitting light according to the cosine law; and (ii.) the negative may be regarded as a circular disc parallel with the positive and at a distance from it equal to the arc length. Of these assumptions the first is probably very close to the truth for all ordinary carbons, but the second assumption is open to question on two counts: (*a*) the diameter of the negative carbon becomes considerably reduced at the end, and (*b*) the effect of obscuration by the stem of the negative carbon with its holder is neglected. Another effect, which tends to offset the result of the reduction in diameter of the negative, is the reduction in the diameter of the positive carbon. These effects, which to a certain extent will counteract one another, will only modify a value that is, in itself, a correction. Neglecting these corrections, the percentage of the light emitted from a positive crater of diameter D which is obscured by a negative of diameter d at an arc length a is given by the formula:—

$$\frac{50}{D^2}\left\{(D^2+d^2+4a^2)-\sqrt{[(D^2+d^2+4a^2)^2-4d^2D^2]}\right\}$$

The values of this expression for three different sizes of negative, and at all arc lengths, are given in the curves of Fig. 6, where all dimensions are expressed in terms of the diameter of the positive. There is one other consideration which cannot be neglected. For a 36 in. projector of about 16·5 in. focal length, only 70 per cent. of the total light from the crater falls on the mirror. All the obscured part of the light is within the angle embraced by the mirror, so that the effective obscuration of the useful light is 1·4 times that given by the formula, *i.e.*, in the example cited above the obscuration is approximately 10 per cent.

A Magnetic Survey of New Zealand.—A complete record of the investigations carried out under the auspices of the New Zealand Government, on the mainland and adjacent islands, was recently presented before the Royal Society of London by Dr. C. Coleridge Farr, and is now available in pamphlet form. The record is a comprehensive one, and in the case of some of the islands observations presented considerable difficulties. An appendix by Prof. Marshall refers specially to regions which show magnetic disturbance. The survey owes its origin largely to the author and to Mr. P. Baracchi, Government Astronomer for the Colony of Victoria, who secured the co-operation of the Royal Society in 1897 and brought the matter before the Australian Association for the Advancement of Science in the subsequent year. The support of the Commander-in-Chief of the Australian Naval Station, the Shipmasters' Association of New Zealand and other bodies interested was secured and finally the New Zealand Government was approached, observations commencing in 1899.

A Scheme to Waste Electric Power.

The present is not a time when it is desirable to waste anything, and any scheme deliberately put forward with that end in view would rightly receive the greatest condemnation. But matters are not really so bad as are indicated in the title to this article or as the "Daily Mail" would have us believe. For our contemporary, fresh from its attacks on tramways, has now turned its attention to the Electricity (Supply) Bill, and has enlisted the services of Lord Moulton to demonstrate the drawbacks which will be caused to the public by the passing of what it calls a "visionary scheme," in other words, the Electricity (Supply) Bill. This Bill the "Daily Mail" puts in the same category as the Government's housing scheme. It is a pity however, that, while going as far as they have done to give publicity to the views of those who are opposed to the development of electricity supply, they have not taken more trouble to ascertain exactly what these views are. Lord Moulton's point, as we understand it, is that it is more economical to use our coal resources in producing gas than in generating electricity, and that the Electricity (Supply) Bill will put a premium on the waste of coal. These views he is, of course, entitled to hold, but he approaches perilously near to a pitfall when he says that electric power is lost for ever if it is not used moment by moment as it is generated," and the "Daily Mail" has not exercised its usual omniscience when it accepts this statement at its face value.

It is only a week or two ago that we referred to Lord Moulton's views on the subject of electricity supply, and to the figures given by Sir Dugald Clerk to prove that the energy in coal can be best used by turning it into gas. When, however, these arguments are reproduced in full in so public a manner as was the case last week, we may, perhaps, be forgiven for once more calling attention to the effect such misleading statements must have on the mind of the man in the street, and pointing out that though electrical engineers can, of course, see the obvious fallacies in the arguments, the same does not apply to the general public. We, as electrical engineers, may have our doubts as to whether the Electricity (Supply) Bill is going to confer quite all the advantages that its promoters claim for it, but at the same time we think it will be disastrous from every point of view if it were to be thrown out in the Lords as a result of such arguments as those brought forward by Lord Moulton. The blow to the prestige of the electrical industry would be heavy indeed. It is, therefore, desirable that those whose duty it will be to consider the Bill should be made aware that there is another side to this question of relative efficiencies, and that the arguments in favour of gas supply can be controverted.

Turning first to the question of thermal efficiency, Sir Dugald Clerk states that of every hundred Neal units in coal used at the gas works the consumer receives 71 per cent., while, on the other hand, the electricity consumer receives only 7·6 per cent. "These figures," says Lord Moulton, "are sufficient to show how unwise it would be in the interests of economy of our coal resources to try to supplant gas by electricity. The flaw in this argument lies in the fact that the large heat return which the gas authorities claim is available when coal is used by them is given in the mixed form of gas, coke and tar. Now, of these, gas cannot be used with the same efficiency as electricity. In the first place it is a fuel—that is, it cannot be used as supplied, but must be burnt, and though its thermal efficiency may not be wasted at the gas works it is wasted by the consumer, so the result is the same. Coke, except when burned in bulk and in specially constructed apparatus, has only a low efficiency as a heat raiser, and is, moreover, an unpopular fuel in the home. The third product, tar, does not count as a fuel at all. It may be roughly stated that of the heat energy contained in the coal used for the manufacture of gas there is 23·5 per cent. in the gas produced, 52·6 per cent. in the coke as sold, and 6·6 per cent. in the tar residual, the remaining 17·3 per cent. being used and lost in the process of manufacture. These figures are therefore considerably lower than those given by Sir Dugald Clerk, and it is probable that the percentage of heat energy in the coal made available to the consumer for useful work from gas and coke is really about 27·5.

If we assume for the moment, however, that all our light, heat and power distributed is as gas, it is very doubtful whether Lord Moulton's contention that it is as practicable to erect large gas works and distribute from them energy as efficiently as from super-electricity stations would be physically possible. Again, it is stated that the gas engine is as efficient as an electric motor. We may admit this, but efficiency is not the only factor to be taken into consideration. There is convenience, cleanliness and flexibility. To mention only one point, it is not to be thought of that any manufacturer would dot his works with small gas engines, each of which would require skilled attention, in preference to putting down a similar number of electric motors. Another argument which Lord Moulton brings forward against the proposals laid down in the Electricity (Supply) Bill is that it will open the way to industrial mischief—*i.e.*, by concentrating electricity supply in a few stations it will be easy for dissatisfied employees to put the whole energy supply of the country out of action. This can surely hardly be a serious argument. To-day there are about 600 electricity supply stations in the country, the staffs of which are members of one or other of several trade organisations, and are united in standing firm for what they consider to be their rights. If they should decide to take the drastic action suggested by Lord Moulton it would be as easy for them to do so at present, as it will be when the development foreshadowed by the Electricity (Supply) Bill is an accomplished fact. Indeed, when sections of the community decide to attack the remainder in the wholesale manner suggested we may be certain that the end of our civilisation is near, and it would matter very little whether we were using gas, electricity or radium as a source of energy. It may not, however, be amiss to point out that while electric distribution systems are easy to damage, they are almost as easy to repair. This hardly applies to gas distribution.

Perhaps it may be considered that in taking the attitude we have done with regard to Lord Moulton's remarks and our contemporary's endorsement of them, we are treating the whole matter of gas propaganda too seriously, but it must be remembered that when their case is put forward with such authority there will be a certain number who will be convinced, willingly or unwillingly. The facts may be briefly stated as follows: The gas authorities probably accept the position that electricity is rapidly becoming, and will in future actually become, the sole form of illuminant. This is only a matter of development. The same applies equally to power supply. In both these cases we can see the end clear before us. The field where development, however, is not so satisfactory, and where there is a certain amount of waste in using electrical energy is in heating and cooking. The propaganda issued by the British Commercial Gas Association pays full attention to this, and allows the public to assume that the waste which they claim is associated with the use of electricity for heating applies to the use of electricity for everything. Electricity supply has an excellent case, and though gas propaganda of the kind mentioned is certainly dangerous it need not be taken too seriously. But the fallacies underlying their arguments must be pointed out from time to time and, what is even more important, electricity must be pushed for all purposes on all occasions. That is where we fail at present. We may wonder, perhaps, whether the gas people are acting in their own best interests in opposing the centralised control of electricity supply. For we have yet to learn whether our ability to secure business and spread the benefits of our service will be improved by this development. It all depends on how everyone works for the common welfare. The Electricity (Supply) Bill contains a good deal in the nature of compromise, and we fear that it is becoming obvious that the district boards are likely to preserve within their folds some of the persons whose methods of "parish pumpism" have done much to cause the adoption of a reactionary policy in so many electricity supply undertakings.

We may conclude by saying that we have no animus against the gas authorities, indeed, we admire their enterprise, and we regret that such a spirit should have been introduced into a discussion where each side may be allowed to hold its own opinions. In this connection we may quote some remarks made by Lieut.-Col. H. W. Woodhall, in a Paper read before the Southern Association of Gas Engineers and Managers, which we are able to reproduce from an account given in the "Gas World." Col. Woodhall says: "For many years the relationship with those who should be our good friends, the electrical engineers, has been marked by an acerbity for which no justification existed, and which was much to be regretted. No good purpose could be served by endeavouring to place the blame for this on any particular shoulders, but what was eminently desirable was that present-day misunderstandings should be removed, and that instead of competing with one another, we should join hands and pool our resources for the advancement of science and the benefit of our consumers. One hears many suggestions in connection with the super-power stations, including one that they carbonise coal in bulk and sell gas companies their surplus gas as a by-product. It does not much matter to us how the result is attained; but it must be evident to anyone who has studied this subject that, while the electricians have much that would be valuable to us, the by-products of our works are more than ample to keep the ordinary town electric generating station provided. . . . Both industries are indispensable servants to the public. Anything that can be done to bring these two important industries together must materially assist in this vastly important problem of to-day—the conservation of the fuel of the nation."

Reception Intensity of Wireless Waves.

By A. PRESS.

A number of empirical formulæ have been suggested for use in radio-transmission calculations. Again, theoretical formulæ have been suggested based upon the idea that the *law of distance* depends in the main upon refraction and reflection. In fact, Dr. Louis Cohen, who is the originator of the mathematical empirical methods in use has gone so far as to deduce a formula empirically to make the facts fit the above theory of reflection. In the following Paper the writer will first show that the mathematical solution of the vertical grounded antenna problem on the simple basis of Maxwell's differential equations for a unionised dielectric leads to an exponential law that corresponds rather singularly with the empirical formula of Dr. W. H. Eccles as determined by the latter in the summer of 1914. Secondly, it will be shown that the suggestion of Dr. Cohen (*see* THE ELECTRICIAN, February 25, 1916) that a multiplying term $(1+Ar)$, where A is a function of the wave-length also follows from the simpler theoretical basis. In the present development the rotundity of the earth has been neglected.

The flat earth case is assumed with the vertical grounded antenna having sinoidal distributions of current and voltage along its length. Indeed, the exponential term arises due to the sinoidal distributions along the sending antenna wire.

Two sets of waves are in fact sent out from a vertical grounded antenna. One set of waves is due to the current in the vertical antenna setting up a system of concentric magnetic loopings about the wire as an axis, together with a dielectric displacement current parallel to the antenna, but oppositely directed to the current of the antenna. This system of waves will be designated as galvanic radiation. A second set of waves is produced because of the condenser effect of the antenna with respect to earth. In this case the dielectric displacement current has two components—viz., a radial component away from the wire and a component parallel to the conductor itself to allow for the bending of the dielectric displacement stream lines as they pass from the antenna to earth. The latter system will be designated as voltaic radiation.

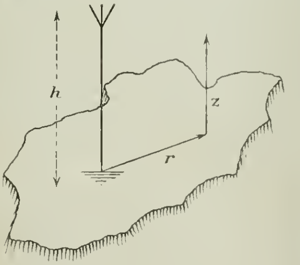

FIG. 1.

Solving in cylindrical co-ordinates then for heights less than the antenna height h (*see* figure), if i_r is the radial component of current density in the dielectric about the wire we have for sustained waves

$$i_r = \frac{akV}{\sqrt{a}} \cdot \sin\left(\frac{\pi z}{2h}\right) \cdot \cos pt \cdot \frac{v_0}{\lambda\sqrt{r}}\, \varepsilon^{-\frac{2\pi N}{\lambda}(r-a)} \text{ (voltaic radiation).}$$

$$i_r = \frac{1}{4\sqrt{a}} \cdot \sin\left(\frac{\pi z}{2h}\right) \sin pt \cdot \frac{I_0}{h\sqrt{r}} \cdot \varepsilon^{-\frac{2\pi N}{\lambda}(r-a)} \text{ (galvanic radiation).}$$

The above current densities are given in the Rational System of Units of Mr. Oliver Heaviside.

Here let

$a = dC/dz$, where

C = capacity of a vertical antenna (Rational System of Units) per unit of length. *See* Paper by the author, "Proc." I.R.E., December, 1918, on "The Vertical Grounded Antenna as a Generalised Bessel's Antenna." If equations (7) or (1) given therein are plotted it will be seen that except for less than 10 per cent. near the ground, a is substantially a constant.

k = the dielectric constant of the medium.

V = velocity of light.

a = radius of the antenna wire.

z = distance measured upward from the ground.

h = height of the antenna.

$p = 2\pi/T$.

t = time.

v_0 = maximum impressed E.M.F. at top of vertical antenna.

λ = wave length.

r = distance from antenna axis.

$2\pi N$ = Eccles' constant. Really $N = \sqrt{M^2-1}$, where M is obtained from the relation $\lambda = M \cdot 4h$. It will be seen that M is very nearly equal to unity. Strictly speaking M, and therefore N, should be derived from the consideration of the antenna as a Bessel's antenna.

I_0 = maximum impressed current at base of vertical antenna. The ratio $v_0/I_0 = \Omega = \sqrt{\frac{L}{C}}$ is the *apparent resistance* of the antenna, and

L = effective induction coefficient per unit of length of the vertical antenna, with

μ = as the permeability of the medium.

The z components of the current density will be given below. Comparing the two formulæ above with the Eccles formula

$$I \equiv r^{-1/2}\varepsilon^{-0\cdot002r},$$

given in his "Wireless Telegraphy and Telephony," page 153 (second edition), we see the correspondance is remarkable. The radius a of the antenna wire in the exponent can be neglected. Its introduction was necessary in solving the differential equations. However, the more important formulæ are these giving the vertical components of dielectric current density. These are for heights less than the antenna height h

$$i_z = \frac{1}{2r}\left(1 - 4\pi N \cdot \frac{r}{\lambda}\right)\frac{2a}{\pi V\mu\sqrt{a}} \cdot \cos\left(\frac{\pi z}{2h}\right) \cdot \cos pt \cdot \frac{v_0 h}{\lambda\sqrt{r}} \cdot \varepsilon^{-\frac{2\pi N}{\lambda}(r-a)}$$

(voltaic radiation)

$$i_z = \frac{1}{2r}\left(1 - 4\pi N \cdot \frac{r}{\lambda}\right)\frac{1}{2\pi\sqrt{a}} \cdot \cos\left(\frac{\pi z}{2h}\right) \cdot \sin pt \cdot \frac{I_0}{\sqrt{r}} \cdot \varepsilon^{-\frac{2\pi N(r-a)}{\lambda}}$$

(galvanic radiation).

The coefficient $\left(1 - 4\pi N\frac{r}{\lambda}\right)$ suggests rather strongly the type of correction factor suggested by Dr. Cohen cited above, since it actually involves the wave length. The complete mathematical derivations for the above formulæ, as well as those for heights greater than the antenna height, are to appear in the Proc. I.R.E. The complete solution throws much light on the problem of the horizontal antenna, for the solution of the latter can be made to depend on that of the former. Work on the effect of the rotundity of the earth is already under way. It will be found that the above separation of effects into voltaic and galvanic is extremely simplifying. Needless to say, the only mathematical method of attack worthy of the name is that due to Oliver Heaviside. The method of Cauchy would lead to analytical difficulties of insuperable complexity.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Notes on Magnetism for the Use of Students of Electrical Engineering." By C. G. Lamb, M.A. (London: Cambridge University Press.) Pp. viii.+94. 5s. net.

"A Plain Guide to Investment and Finance." Part I., Hints to Investors; Part II., An Exposition on Finance. By T. E. Young, B.A. (London: Macdonald & Evans.) Pp. xii.+324. 7s. 6d. net. Third Edition.

Mr. J. A. Robertson on the Electricity (Supply) Bill.*

(Concluded from p. 602.)

The technical problem of electricity supply will turn on the merits of local generating stations situated near the centre of their loads, as compared with supply from one large station on a site suitable for economical generation but distant by comparison from the loads. It is a fact that at the present time engineers are more divided amongst themselves as to the policy on this point than they were a few years ago. It is contended that the increased cost of super-station construction, which has risen from £7 or £8 per kilowatt of plant installed to £20 or £22, with a corresponding increase in the cost of transmission lines, has turned the scale in favour of local generation. On the other hand, it is true that coal and labour costs have increased in almost the same proportion, but it is claimed that the saving from super-station generation in these items does not neutralise the increased capital charges on super-station construction. It is impossible of course, to apply any general rule to individual cases, and the factors vary so much that any estimate on general lines is apt to be misleading.

It may be admitted at once that in the case of a local station, equipped with fairly modern plant at the prices obtaining prior to 1917, with natural condensing facilities sufficient to deal with the present load, and able to operate economically sets of 3,000 kw. or 5,000 kw. capacity, it is extremely difficult to make out a case for supply from a super-station, say, 8 or 10 miles distant. There are a number of such stations in the Lancashire area, which can show working costs that compare favourably with many of the larger stations now in operation. On commercial grounds there appears to be no good reason for closing down these stations at present in favour of a bulk supply. In preparing a scheme for a whole district, the question must, however, be looked at from a broader point of view, regard being had not to present conditions, but to the conditions which may exist 7 or 10 years hence. The fact is that we are faced in these industrial districts with very much greater demands for electricity than we have been accustomed to in the past. All the evidence goes to show that the enormous increase during the war will be more than maintained, and it is the general experience that in the change over from war conditions—which naturally meant a slowing down—we have already regained the position of November, 1918, and that further demands are constantly being made. It is not too much to estimate that within the next five years the present output will be at least doubled, and, if the national scheme fulfils expectations, still greater increases may be looked for.

We have to consider then whether local these stations on restricted sites, with limited condensing facilities, will be able to meet all future demands for electricity in their areas, because if the continuance of the stations involves new expenditure on plant, the relative advantage of pre-war prices disappears. The erection of a new station, other than a super-station, in the industrial areas, is unthinkable unless under most exceptional conditions. In a census taken by the Lancashire and Cheshire Inter-connection Committee, the fuel consumption varied from 2·2 lb. to 8·5 lb. per unit. In the case of the group referred to, it is probable that in three-fourths of the stations, a bulk supply from a super-station favourably situated, would show an advantage, while in the other two or three stations a case could be made out for local generation. If, however, a new super-station is required for the district, it may be good policy to close down the two or three efficient stations in addition to the eight or nine inefficient stations, to increase the load-factor on the super-station, and so improve the supply to the whole district. The two or three efficient stations in the group would be interconnected and could be retained for standby or peak load purposes up to the limit of their economical capacity.

After all, the supply of electricity cannot be considered by itself alone. It is essentially bound up with questions of transport, housing, industrial reconstruction, and the conservation of fuel. The electrification of railways, which has been held up during the war, is certain to develop enormously in the near future. Under the new conditions, it is hardly likely that the mistake of constructing separate generating stations for railway supplies will be repeated. The load-factor of railway supplies must be combined with the load-factor of industrial supplies to get the best results. Under these conditions the fuel saving by railway electrification has been estimated at 50 to 60 per cent. It is of the greatest importance that the two supplies should be combined, and the question of centralised generation versus local stations may in many cases be determined by this factor alone.

Another question that cannot be overlooked is the tendency for cities and towns to spread out in order to find improved housing accommodation for the workers. The industrial conditions of last century, when lack of transport led to the concentration of a large population in the industrial areas, is not likely to be perpetuated in the future. As the towns spread out, many industries will follow. There is even now a tendency to remove some classes of factories from the city to the urban or district areas. My point is that the tendency will be for the demand to spread out over a large area, and the advantage of the local station to-day through its proximity to the load may be a diminishing factor in the future.

There remains the still greater, I believe, the deciding, factor of fuel conservation. A cheap and abundant supply of power cannot be considered apart from this question. In passing, reference must be made to the repeated claims made by the gas authorities on behalf of coal carbonisation as a means to effect fuel economy. On this question, power station engineers have, I believe, an open mind. The urgent and primary need is for a supply of cheap power, and if this object can be more economically achieved by a process of carbonisation, it will be welcomed by the electricity supply industry. The combination of coal carbonisation with the production of power is a question on which further information is urgently required. The Fuel Research Committee has been considering the matter for some years, but up to the present we are without any practical proposition which would justify the combination of coal carbonisation and power production on a large scale for immediate requirements. So far as we know, the production of gas for firing boilers presents no advantage in thermal efficiency, apart from the production of by-products, the chief of these being ammonia sulphate. Over and over again experiments have been made which appeared to show favourable results, but there the matter ended. The powers of the Electricity Commissioners (as extended in Committee) will enable them to conduct experiments on the utilisation of fuel, and it is probable that some of the new stations to be erected will employ to a limited extent carbonisation plant, with the object of gaining information and experience. In the meantime it appears certain that under the new power schemes, the great bulk of power production will be obtained from stations with coal-fired boilers and turbine-driven generators, showing a boiler house efficiency of 80 to 85 per cent., and an overall thermal efficiency of 18 to 20 per cent.

The question is, what amount of fuel saving is possible by transferring the generation of electricity from a number of small and medium-sized stations to a few large stations on favourable sites laid out to secure the highest possible efficiency? Some useful information is available from the Coal Mines Department who have summarised the monthly returns of power station fuel consumptions in the United Kingdom for the years 1918 and 1919. The summary includes returns from 438 electricity undertakings having an output of 4,745,000,000 units, and a total fuel consumption of 7,356,000 tons, including 31,000 tons of coke. The stations are grouped in four classes, viz.: (*a*) Stations having an output of over 50 million units per annum; (*b*) Stations having an output of between 15 million and 50 million units per annum; (*c*) Stations having an output of between 3 million and 15 million units per annum; and (*d*) Stations having an output under 3 million units per annum. The average fuel consumption of all the stations was 3·47 lb. per unit generated for the year ended March, 1919. In group (*a*) the lowest fuel consumption of any station was 1·8 lb. per unit, representing a thermal efficiency of 18 per cent., the average being 2·76 lb. per unit, and the highest for any station, 3·95 lb. per unit. In group (*b*) the lowest fuel consumption of any station was 2·19 lb. per unit, representing a thermal efficiency of 14 per cent., the average being 3·39 lb. per unit, and the highest, 6·75 lb. per unit. In group (*c*) the lowest fuel consumption of any station was 2·61 lb. per unit, representing a thermal efficiency of 11·2 per cent., the average being 4·34 lb. per unit, and the highest 11·47 lb. per unit. In group (*d*) the small stations, the lowest fuel consumption was 3·72 lb. per unit, representing a thermal efficiency of 7·2 per cent., the average being 6·95 lb., and the highest 63·25 lb. per unit. This latter figure is probably a freak figure from a small station operating under abnormal conditions. Now, if the whole of the energy produced by the 438 stations had been generated as economically as it was at the station with the lowest consumption in group (*a*), *i.e.*, with 18 per cent. thermal efficiency, the resultant saving would have been fully 3½ million tons, or 47 per cent. of the total consumption. If allowance is made for those stations in group (d) generating 3 million units or under, which are so situated that they could not be included in a centralised scheme, we still have a possible saving of 3 million tons per annum which, if capitalised at the present price of coal on a 20 years' basis, would amount to no less than £90,000,000. This saving is calculated on the present output of electricity. Taking into account the certain growth in output, which cannot be estimated at less than double the present output five years hence, the saving of our capital resources will be correspondingly greater. The estimate of saving is based on a thermal efficiency of 18 per cent., a figure which has already been attained, and it is probable that an efficiency of even 20 per cent. may be reached in the near future. It is not sufficient, therefore, for the local station engineer to show that a case can be made out for continuance on commercial grounds. The question must be looked at from a much broader point of view. It is quite easy to show that the value of the coal wasted at a local station amounts to less than the capital charges, and the losses on a transmission system, but the broader view will take into account that transmission systems consist chiefly of copper and lead, or copper and steel, materials with an indefinitely long life and considerable residual value. The wastage of coal, on the other hand, can never be recovered, and in wasting it we destroy at once the nation's capital and our greatest industrial asset.

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* Abstract of an Address to the North-Western Centre of the Institution of Electrical Engineers.

The outlook for the electrical industry as a whole was never more promising than it is to-day. The rapid development during the war, the application of electricity to many industrial purposes, such as steel smelting and chemical processes, which were only in the speculative stage a few years ago, have established the future of the industry on a thoroughly sound basis. The manufacturers of electrical plant and apparatus have an unrivalled opportunity. The whole world is waiting for their productions. The problem of the moment is to increase production, so as to meet the needs of our own markets in the first place, and at the same time to re-establish our export trade, to enable us to pay off the heavy indebtedness arising from the war. The combination of manufacturing interests which has recently taken place, may do much to assist rapid production by organisation and allocation of the work amongst the factories which they control. If they can assure also that the combination of manufacturing interests will not destroy the stimulus to individual effort, that standardisation to ensure mass production, does not mean the rejection of new ideas, and that the benefits from reduced manufacturing costs will be shared by the purchaser, then the new conditions will be welcomed by the general body of the public. There is no public body in the country to-day which wishes to place their contracts in any country but their own. The old conditions under which the price of British plant for public power stations was fixed in Berlin, Zurich or the United States, have gone for a long time, and it will be the manufacturers' own fault if they ever come back, but if the purchaser is to lose the protection afforded by foreign competition, he must have some assurance that the prices charged are fair and reasonable, having regard to industrial conditions in this country, and that the plant he is purchasing will be at least equal in design and performance to the best that can be obtained abroad.

Much of the labour unrest in pre-war days was due to the absence of machinery for adjusting and settling differences before they became acute. We have that machinery now in the form of Whitley Councils and a National Industrial Council for the electricity supply industry, presided over by our Senior Vice-President, Ald. Walker, has been at work for some time past. The first District Council for the same industry has been set up in the North-Western Centre. We have also to consider a scheme of specialised training for our technical staffs. At present a man who is qualified in one direction rarely possesses the all-round training necessary to secure a responsible position in a power station or on a transmission system. A sub-committee of this Centre has been recently formed with the object of bringing together the technical college authorities, manufacturers and power station engineers, with a view to providing a specialised training—technical and practical—for the young engineers intending to follow power station work. The Distric Boards and the supply authorities must remember, however, that if the right kind of men are to be attracted, the salaries paid must be adequate f r the training they have received, and the responsibilities they have to undertake. The vital need of to-day of the electrical industry is co-operation between all the various sections and interests. If supply authorities, engineers, manufacturers, technical staffs and labour will realise that the wisest form of self-interest is to work for the welfare of the whole body, the electrical industry will be able to take advantage of the greatest opportunity in its history, and to assist in re-constructing the industry of this great Empire, which never needed the best work of all her sons so much as she does to-day.

Heating and Cooking Notes.

HEATING AND COOKING PROGRESS IN U.S.A.

Enamel Baking Ovens in a Typewriter Factory.—Interesting information is given in a paper read before the American Electrochemical Society, Chicago, by Mr. G. M. Clark, in which a description is given of electric ovens employed for baking the enamel finish on typewriters at the factory of the Royal Typewriter Company of Hartford, Conn.

The advantage of demonstrative heat control and automatic time control are made full use of both on the score of labour saving and safety. The ovens have a capacity of approximately 315 cubic feet and are loaded to 27 kw., the elements being mounted at the base of the oven. Special care is given to the provision of suitable ventilation to carry off inflammable fumes rising from the heated enamel, and the elements are run at a comparatively low temperature. The process of obtaining the solid type of enamelling characteristic to typewriters is a somewhat complicated one, as the coating of enamel has to be thick and to a certain extent elastic to withstand the liability of chipping in wear. For this reason the enamel employed contains a percentage of rubber, and in the States is termed "Rubber Japan." In coating wooden parts, such as spacer bars, it was found that five coats of rubber japan were required to give a satisfactory finish. The first four bakes being run at an even temperature of 250° F. for a period of five hours per baking, and for the fifth bake the temperature was increased to 275° F. The baking of metal parts such as ribbon spools, base plates, etc., is a rather more difficult matter. The parts are first dipped in a metal japan for five hours at 350° F. Next they are sprayed with a baking japan and put through a third baking process, the temperature this time being 400° F., and the period five hours.

The parts then go through a final rubbing down process, which is done by hand with hard felt and powered pumice, leaving a hard dull finish. They are next sprayed with a blackbaking rubber japan and baked for five hours at 400° F.

Electric baking ovens have been employed for this process for over five years, and have proved themselves to be more economical, easier to operate, and to yield less waste. The saving on running cost alone was approximately 20 per cent. without allowing for the saving in spoiled parts, which was obtained with electric baking, due to the ease and certainty of temperature control. The use of ovens for other enamelling processes such as cycles, steel office furniture, etc., certainly seems to be a field worthy of investigation in this country. The load factor can at least be as good as, if not better than, that offered by the power demand of many factories.

Electric Heating for Riveting. Two American concerns have developed methods of heating rivets electrically. The American Car and Foundry Company employ a method whereby the rivet itself forms a short circuit connection across the secondary of a transformer. A spring device holding the rivet in the desired position across the ends of the transformer whilst the operator holds the rivet with a pair of tongs and brings the spring holding device into operation by means of a footlever. The consumption of electrical energy is about 20 units per 100 lb. of rivets, and the time taken to heat the rivet naturally varies with the size of the rivet.

In the other type of heater, employed by the Electric Furnace Company a granulated carbon block forms the short-circuiting device across the transformed secondary, and in turn radiates heat to the rivets. The consumption of electrical energy for this type is about 18 units per 100 lb. of rivets.

Developing the Cooking Load in a Small City.—Mr. F. C. Dant, the Superintendent of the Belvit Municipal Electric Supply Department, Belvit, Kansas, U.S.A., contributes to the "Electrical Review" of N.Y. some interesting figures regarding progress made by a summer campaign for electric cooking. The population of the town is only 3,750, and the capacity of the generating plant 270 kw. The activity of the supply department is centred on propaganda work only in favour of electric lighting, cooking and power: appliances being obtainable through local dealers, and are not sold by the supply authority. As soon as the supply department finds a likely prospect the local dealers are advised, and in their turn they help to convert the prospective consumer

Last spring, before the summer campaign commenced, 36 cookers were connected to the mains, and at the end of the campaign this figure had been increased to 73. The charge for electricity is based on a sliding scale, one meter only being employed for both lighting and cooking. Twelve cents (at nominal exchange rate approximately fivepence) per unit is charged for the first three units consumed per room, per month, and four cents per unit for all further units used in that month. A minimum charge of one and a half dollars is enforced when the amount of energy consumed does not reach this figure. During May, June and July the total units sold were 85,301, of 54·3 per cent. were for lighting only, 19·8 per cent. for power only, and 25·9 per cent. for cooking and lighting on the above-mentioned system The most striking factor of the report is the fact that the diversity factor of the cooking load was such that in nearly all cases the transformers which were installed for lighting only were found to be large enough to carry the cooking load as well. Four cookers could be carried on a 5 k.v.a. transformer.

Coal in this district during the summer months sold for 9·50 dollars to 11 dollars per ton.

"Sunco" Electric Fires.

Our heartiest congratulations to the Sun Electrical Company, Ltd., 118-120, Charing Cross-road, London W.C. 2, upon their new design of electric fire and also upon their undoubted courage in standardising and making these in large quantities. The fires would have been put on the market much earlier but war conditions have prevented manufacture on a commercial scale. The element has, however, been severely tested over a period of four years, its weak points have been eliminated and we understand the company now offer it with every confidence. A standard 500 watt unit bar has been adopted for the element, and these bars can be grouped in any desired number from two upwards. The fire bar is of refractory material, is slightly convex, and is provided with three deep grooves in which the heating element wound in a spiral form is embedded. The element is in one length, and provision is made to grade down the temperature from that of the spiralled portion to that of the terminal. This is an important feature because trouble is most likely to arise at the connecting points between element and terminal. The element is worked at a temperature which gives a good proportion of radiant heat, thereby ensuring a light and cheerful appearance. From an examination of the processes of making up these fire bars the manufacturers have done their utmost to reduce as much as possible the chances of failure, both electrically and mechanically. The fire bars are carefully supported in the frame, and the internal connections which are made with tinned copper wire are substantial and unlikely to be affected by heat. the design of the supporting frame has been entrusted to an artist, and the results are particularly pleasing; the illustrations will help to emphasise this. From the point of view of appearance the fire should be a good seller. Our illustrations show one, two and four-bar fires, and the frames in each case are executed in best quality cast iron. In the case of the two-bar fire a neat adaptation of the tumbler switch with an extension lever projecting beyond the frame has been introduced. The fires put in an appearance at a time when there should be a brisk demand. Undoubtedly, there is a large market not only at home but overseas. At a later date the Company is introducing larger sizes, fitted with six bars. The "Sunco" fires are manufactured at the Company's works in Neal Street, London, W.C., and provision is being made for turning out very large quantities. There are at present difficulties in the delivery of castings owing to the moulders' strike, but it is hoped that these will soon be removed.

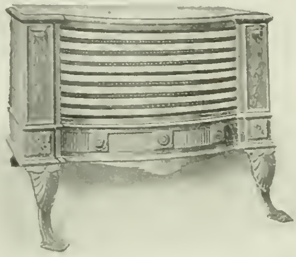

Fig. 1.—Two Bar "Sunco" Fire

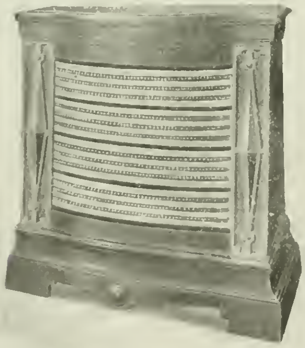

Fig. 2.—Four Bar "Sunco" Fires.

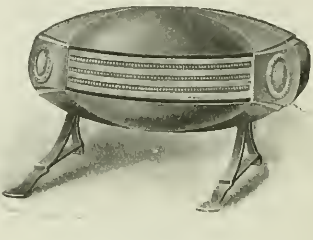

Fig. 3.—Single Bar "Sunco" Fire.

Swanpool Garden Suburb.

One of the most interesting of the housing schemes, whereby it is hoped to relieve the lack of accommodation which is being felt in all parts of the country at the present time, is the Swanpool Garden Suburb, near Lincoln, some of the houses in which have not only recently been finished but are now occupied. These houses are, indeed, probably the first in any of the Government housing schemes to be inhabited. In connection with all these schemes a question which is, of course, of vital interest to electrical enginneers is what arrangements are being made for the provision of artificial lighting and for the supply of fuel for cooking and heating purposes. We are glad to see that at Swanpool, at any rate, the right lines are being followed in this respect. The suburb itself is, of course, only in its infancy; but, though it will probably take from eight to ten years to complete, the work is being carried out with considerable forethought, and the ultimate aim is to make the suburb self-contained in every way. For instance, it will have its own power station, the primary use of which will, of course, be to supply electric power for lighting, heating and cooking. We understand that it is hoped that all the lighting and cooking will be done by electricity, and that electric power will also be employed for driving the machinery in certain factories which it is proposed to build on the eastern side of the estate. In case it should be thought that the amenities of the suburb will suffer through the establishment of these factories, it may be pointed out that they will all be devoted to clean trades, and will as far as possible provide employment for women who are now out of occupation. Waste steam from the power station will be used for heating the cottages, which will thus be served on the central heating plan, and until this scheme is ready temporary heating plant has been installed.

In considering the question of the supply of electricity for heating and cooking at Swanpool, it has been estimated that to use electricity for this purpose and for lighting, together with a central hot water supply, and the provision of steam for heating, will cost the tenants of the Swanpool cottages less than half what they would have to pay if they had to purchase coal and gas in the usual way; and, in any event, the total consumption of fuel for the whole estate will be much reduced by this centralisation. Every effort is being made to render the houses on the estate both artistic and habitable and each will have a pleasing view and will not look directly at a neighbour, either front or back. They will contain a parlour, living room, three bedrooms as well as a scullery and the usual domestic offices.

We hope that as Swanpool is among the first of the housing schemes, so it will also serve as an example to others. The work seems to have been done on the right lines, and every advantage is being taken of modern equipment and improvements. In this respect great credit is due to the architects, Messrs. Thompson, Hennell & James, under whose personal direction the work is being carried out.

Illuminating Engineering Society.

The opening meeting of the Illuminating Engineering Society for the present session was held at the house of the Royal Society of Arts on Tuesday, November 25th, the president (Mr. A. P. Trotter) presiding. In accordance with the practice of the Society this meeting was devoted to a short address by the president, to the presentation of reports of progress and to various exhibits illustrating recent developments in lighting.

Lambert and Photometry.

In a brief address on the above subject, Mr. A. P. Trotter gave an account of some of Lambert's early work on photometry, illustrating his remarks by quotations from the latter's "Photometria," published in 1760. Considering the early period at which this work was produced, it showed a good grasp of photometric principles, a number of "primary notions" being stated, and various laws, such as the inverse square law and the well-known "cosine law," associated with his name. It is rather curious that, although Lambert understood these ideas so clearly, he says little on the question of measuring apparatus, though he seems to have expressed the desire that a photometer should be "excogitated." It is not quite certain whether Lambert did or did not actually invent an apparatus for measuring light. Mr. Trotter is inclined to think not, and suggests that Bouguer was the first man to produce a photometric instrument; his device, indeed, is substantially similar to that used by the Metropolitan Gas Referees to-day.

Recent Progress in Illumination.

Following the president's address Mr. Leon Gaster presented a few notes on events during the vacation, alluding particularly to the various committees formed by the Society to study such matters as eye strain in cinemas, railway lighting and progress in lamps and lighting appliances. The hope was expressed that in the near future definite requirements for adequate lighting will be introduced into the Factory Acts in this country, seeing that in five of the United States' legislative codes now exist. The moment seemed opportune for common action by the chief European countries on this matter. No difficulties seem to have been experienced in carrying out the codes in the United States, but special educational measures for the benefit of inspectors and others have been found desirable. The Illuminating Engineering Society recently formed in Japan appears to be making good progress. Mr. Gaster also referred to the resump- of work by the National Illumination Committee, and in conclusion expressed the hope that students would make use of the new arrangements provided to enable them to join the society.

Following Mr. Gaster's report, Lieut.-Col. F. A. Cortez-Leigh, chief electrical engineer of the London & North-Western Railway, gave a brief account of the work of the Joint Committee on Railway Lighting, under his chairmanship. It was hoped that the Committee would receive the co-operation of the leading railways in carrying out tests of illumination and establishing some general principles of railway lighting.

The Position of the Metal Filament Lamp and Fittings Industry.

A report on the above subject, prepared by the Committee on Progress in Lamps and Lighting Appliances, was presented by Mr. J. W. Elliott. The report explained the nature of the difficulties which had hampered the production of lamps and fittings. There are now adequate supplies of tungsten wire for filament, and plants for making argon gas (used in the bulbs of some gas-filled lamps) are also available. One great difficulty has been the production of English-made bulbs in adequate quantities, and it is hoped that further information on this point will be presented by the Committee later. A feature during the last 12 months has been the introduction of smaller sizes of gas-filled lamps. Here, again, a deficiency in fittings for use with such lamps has been a difficulty. It is hoped, however, that these various troubles will be overcome in the near future. A set of curves illustrating the demands for lamps of various candle-powers during the war period was submitted by Mr. Elliott. These illustrated in a striking manner the rapid development in the use of lamps of the gas-filled type. Finally, Mr. Elliott exhibited a type of gas-filled lamp having an opal glass bulb which yielded a very evenly diffused light, and compared favourably with the high intrinsic brilliancy of the naked filament.

The Sheringham "Daylight" Lamp.

Dr. L. C. Martin, of the technical optics department of the Imperial College of Science, then exhibited a form of lamp for correcting the colour of light from artificial sources so as to secure a close resemblance to daylight. The device is due primarily to Mr. G. Sheringham, the well-known artist, and is essentially of "indirect" type. The lower half of the lamp utilised (for example, a gas-filled incandescent lamp) is covered by an opaque shield, and the light is reflected on to a dome-shaped surface above the lamp, which is covered with a chessboard pattern in various colours. Spectro-photometric tests have shown that by the judicious selection of these coloured patches (mainly green and blue) a reflected light which closely resembles daylight is obtained. Dr. Martin showed the effect of two such sources on a number of coloured silks and ribbons, and suggested that the device would be useful for many varieties of work in which accurate colour-matching is essential.

An Exhibit of "Pointolite" Lamps.

Mr. P. Freedman, of the Ediswan laboratory, gave an account the "pointolite" type since the lamp was first shown before the Society in 1915. New features include improved methods of manufacturing the ionisers, by the aid of which the arc is struck between tungsten electrodes and an improved method of attaching large tungsten globules to stalks of moderate size, which has enabled lamps of much higher candle-power to be made. Lamps of 500 c.p. and 1,000 c.p. were shown at the meeting, and in the later stages of the discussion a larger lamp of 4,000 c.p., which has just been completed at the works, arrived. Such lamps work at about 0·42 watts per candle-power, and have a life of about 250 hours. It is hoped, however, by various devices to increase the life considerably. Among the measures adopted for this purpose is a small glass cup mounted at the pip of the lamp (burned pip upwards), which creates a closed cycle of convection currents, and prevents the deposition of tungsten on the sides of the bulb. Special forms of lamps suitable for pyrometric work, &c., were also shown, and it was stated that, when equipped with a quartz glass bulb, it also serves as a useful source of ultra-violet light.

A New Form of Illumination Photometer.

Mr. Haydn T. Harrison exhibited a new form of illumination photometer which has several interesting features. A feature of this is that the observer sees an illuminated scale within the instrument, and does not have to read figures on its exterior (often inconvenient in view of the low illuminations prevailing). In one form shown this scale of graded brightness is seen reflected in a movable mirror, which has a small aperture scratched on it, in pointer form. The observer looks through this aperture at the illuminated surface to be studied, and balances its brightness by tilting the mirror against some part of the illuminated scale. This method renders it possible to secure a very fine line of division between the photometric surfaces, rendering the balance very sensitive.

New Electric Clock at Waterloo Station.

For some reason or another, the suburban traffic on the London & South-Western Railway has not lately been distinguished for its punctuality. Doubtless, as some set off to this, the authorities have provided a new electric clock, so that, at any rate, passengers may see how late they are, and decide as quickly as possible whether it is a case for tube or taxi. As our illustration shows, the clock is hung from the girders in the centre of the station, its weight being about 2 tons. It consists of four dials, each of 6 ft. diameter, and, to the astonishment of many, the space between these dials is vacant. The "works," indeed, consist of "Synchronome" electrical impulse dial movements, which are fitted behind the centres of each dial in a small metal box only 5 in. square. There are already more than 100 clocks in Waterloo Station operated on this system from one master clock, so that there is plenty of good example even if it is not always followed.

View of the New "Synchronome" Clock at Waterloo Station.

The Electrician.
FRIDAY. DECEMBER 5th, 1919.
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Progress in Illumination.

The interesting data submitted at the first meeting of the Illuminating Engineering Society for the present session, held on November 25th, may be taken as affording a guide to the present position in matters of illumination. Similarly the report on progress presented at the recent Convention of the American Illuminating Engineering Society enables us to judge fairly well the trend of development in this country and in the United States. The war period has naturally been unfavourable to new developments in lamps and fixtures. Manufacturers in both countries have been chiefly occupied in meeting demands for standard articles and have had little leisure to experiment, except for special war purposes. In this country a further check on development was imposed by the lighting restrictions, first as a measure of protection against hostile aircraft, and subsequently in the interests of economy. America suffered less in this respect, although even there the coal shortage led to the establishment of "lightless nights."

During the war the Illuminating Engineering Society was occupied with special war researches, and yet contrived to keep its ordinary machinery intact and foster the main principles of illumination. With the removal of lighting restrictions the need for the study of illumination is certainly greater than ever, and we are glad to see that the Illuminating Engineering Society has lost no time in attacking several problems that call for solution. A characteristic feature of the Society's methods is the carrying on of work through the medium of joint committees. Thus the assistance of physiologists, oculists and others has been enlisted in dealing with conditions in cinema theatres, and railway engineers are co-operating on a committee to deal with railway lighting. This procedure is well devised to secure efficient and permanent results, and has the additional advantage of bringing new circles of experts in touch with work on illumination. Meantime the report of the Society's Committee on Progress in Lamps and Lighting Appliances emphasises the difficulties under which makers of lamps and lighting appliances have been working during the war. These difficulties, in a less severe form, still exist. Judging from the appearances of shop windows at the present time, one would assume that the progress in the supply of lamps has temporarily outstripped the supply of efficient reflectors, shades, &c. The neglect to shade these bright gas-filled lamps, which is such a regrettable feature of much of the present lighting, is, as we have already pointed out, doubtless often due to pure ignorance or lack of thought; but in some cases it does admittedly arise from difficulty in securing proper shading appliances. We welcome the assurance of manufacturers that they are doing their best to make good these deficiencies and that it will not be long before they are met.

So far as radical departures in illuminants are concerned it would seem that the world has not produced any very striking developments during the past five years—at any rate nothing so marked as the introduction of the gas-filled lamp. In the immediate future we may anticipate extensions rather than radical developments. Gas-filled lamps of lower candle-power and consumption will become usual, and it is possible that, at the other end of the scale, we shall see lamps of exceptionally high candle-power for outside work. There should also be openings for special forms of lamps and fittings. The higher candle-power tungsten arc ("Pointolite") lamps exhibited before the Illuminating Engineering Society may be mentioned as an interesting instance of such specialities. This type of lamp, indeed, affords one of the few instances of genuine novelties introduced during the war. An arc maintained between tungsten electrodes in a hermetically-sealed glass vessel has promising possibilities for projection work. The 100 c.p. type, introduced in 1915, has found special applications during the war and the 4,000 c.p. type now announced may prove to have useful possibilities for cinema work. Another interesting novelty exhibited was the Sheringham "daylight" lamp, based on the reflection of light from a specially designed colour screen. Other forms of lamps, using special transmission screens, have been devised for colour-matching purposes in the past, but the attempt to use indirect methods is an interesting departure. It is somewhat surprising that hitherto comparatively little practical use has been made of these methods of producing "artificial daylight."

Generally speaking, we think it is true to say that progress in the art of applying light in the service of mankind has hardly kept pace with the advance in its production. We recognise that very great progress has been made during the past ten years, largely through the efforts of the Illuminating Engineering Society. But there is still much leeway to be made up. It has recently been estimated that the average American family spends to-day about the same amount on light as a hundred years ago, namely, about $24 a year, but for this sum they receive twenty times as much light. We imagine that a somewhat similar conclusion might be drawn in this country. Could it be truly said any correspondingly marked advance has been made in methods of using the greater amount of light available? The most hopeful method of educating the public to the proper use of light appears to be through the agency of authorities and bodies concerned with particular applications. The work of the Departmental Committee on Lighting in Factories and Workshops has doubtless had a considerable influence on industrial lighting; when, as we hope shortly, this work is consummated by the introduction of definite requirements of good lighting into the Factory Acts the influence will, of course, become more potent still, and will probably be followed by concerted action by the other chief countries in Europe. Similarly we hope that public authorities will respond to the suggestion that the time has come when street lighting should be conducted on a more scientific and uniform basis. The growing recognition of the intimate relation between adequate illumination and health, safety and efficiency ought soon to lead to considerable advances in these respects.

Reviews.

Principles of Radiotelegraphy. By C. M. Jansky, B.S. (London: Hill Publishing Company.) Pp. ix.×242. 8s. 9d. net.

It is a curious feature of the many text-books on wireless telegraphy published during the last few years that with the exposition of the principles and practice of wireless—a new subject calling for the writing of new books—is generally included much of the ordinary elementary theory of electricity, over-lengthy in a book nominally devoted to the special branch, but not thorough or good enough to replace the existing text-books on elementary electricity wherein the same matter is already better set forth.

The present volume, hailing from an American university, is no exception. The author, indeed, seems to perceive a certain possible incongruity between the title on the cover and the matter within; for he explains in the preface that "since radiotelegraphy is an electromagnetic phenomenon, and electric and magnetic apparatus is employed in the generation and detection of electromagnetic waves, a goodly portion of this book is devoted to a discussion of electromagnetic theory and apparatus, for without an understanding of these the student cannot understand the principles of the operation of radiotelegraphic apparatus." In fact, nearly half the book is devoted to such general teaching.

Some elementary characteristically wireless topics, such as the mode of rectification by a crystal detector or thermionic tube—the first lesson for the student, one would think, when he turns to reception—are almost neglected; and what is given about the detector is wrong. It is a serious error, fatal to an understanding of receiver problems, to believe of the crystal detector simply that it acts as a non-return valve "changing the oscillating current to a uni-directional intermittent current"; and of the thermionic tube that there is rectification because the anode current "cannot go below 0." An explanation, too, of how a buzzer is made to excite an oscillatory circuit seems wanted, particularly as in the earlier parts of the book it is implied that a spark gap in an oscillatory circuit is the one method of producing a condenser discharge. Two buzzer circuits are illustrated, but neither is explained; and we can see no reason why one of them should work. These are examples of points which one would like to find more adequately treated in a book on wireless, even at the expense of cutting out some of the matter familiar in electrical textbooks before ever books on wireless telegraphy were thought of.

It is not brought out in the text that the whole of the treatment of alternating currents refers only to the steady state, and can not therefore be applied the transient phenomena in wireless. In one place, where the application of an alternating E.M.F. across a condenser and inductance in parallel is dealt with, the thoughtful student will wonder how, if "the current in the supply wires is zero," the energy growing in the resonant circuit ever gets there.

The author expressly restricts the use of mathematics—but only the teacher or student of genius can afford to dispense with the aids of mathematics—and one can imagine the "reader unable to follow the mathematical demonstrations" even that are given, duly awed by the occasional statement that "by higher mathematics it can be shown . . ." In the absence of this higher mathematics, however, a good feature is the frequent inclusion of simple numerical examples worked out from the formulæ quoted.

After Chapter VI. on "Elementary Alternating Currents," there is a short one on "Oscillatory Circuits." Chapter VIII., entitled "Radio Circuits," is introduced by some definitions of terms which seem a little arbitrary and unusual. "A radio circuit may be defined as an oscillatory circuit capable of producing electromagnetic waves. These circuits are quite numerous, but in general they may be classed under two heads (*a*) simple, (*b*) coupled. Simple radio circuits are of two types, series and parallel." In the chapter on triodes, nothing seems to be gained by ordaining that the filament circuit "is called the A circuit," the plate the B circuit, and the grid the C circuit. These circuits are referred to by these letters thereafter, but the reader has always to translate back to filament, plate and grid. Names should never be multiplied unnecessarily in this day of overtaxed memories. Gausses, maxwells and gilberts are used with the unnecessary result, as it seems to us, of multiplying terms whose signification one can never remember. And the abampere, abohm, &c.; are they currency in the U.S.A., or introduced by the author? An abampere is one "absolute electromagnetic unit" of current (wherein absolute seems to signify C.G.S.).

In the later portions of the book, two chapters entitled "Practical Transmitting Appliances and Methods" and "Practical Receiving Appliances and Methods," provide a good but very sketchy survey of some modern methods. The Alexanderson and Goldschmidt alternators are briefly described, the principle of the latter being clearly explained. A good deal of attention, proportionately, is paid to the Poulsen arc: but we are not told the function of the hydrogen and the magnetic field except that the latter "keeps the arc steady." Neither the Marconi spark continuous wave system, nor the Telefunken frequency-changing system, is mentioned. Some space is given to Tikker, tone-wheel and heterodyne reception; but the first is unsatisfactorily treated as a simple interrupter, which it cannot be in the absence of a separate rectifier; and although a rectifier is shown in the heterodyne diagram, its function, as so often, is not noticed.

The final chapter, on "Vacuum Tubes and their Use in Radiotelegraphy," is satisfactory as far as it goes. The quantitative theory is not touched upon; and practical information is of the scantiest; for example, there seems to be no indication of the values of anode potential used in receiving triodes. The diagram illustrating anode rectification does not agree with the text, which itself is mistaken as already pointed out. On the other hand, the more important case of rectification with a partially insulated grid is correctly and clearly explained. Wireless telephony is barely mentioned. "If used for telephony, the high-frequency waves are modulated by some suitable means," undescribed.

There are several misprints, but the book is attractively printed and the diagrams are very clear. It is the first we remember to have seen in which no mention of the magnetic detector is made. L. B. Turner.

In the Side Shows. By Capt. Wedgwood Benn, D.S.O., D.F.C., M.P. (London: Hodder & Stoughton.) Pp. xii.+310. Price 12s. net.

The sub-title of this book is "Observations by a Flier on Five Fronts." But it is really a good deal more than this, as a short summary of the contents will show. In October, 1914, Capt. Benn joined the Middlesex Yeomanry, with whom, after the usual straining at the leash, and false starts, he proceeded first to Egypt and then to Suvla Bay, where he remained until sickness caused his transfer to Malta, with a voyage to England as a convalescent imminently foreshadowed. Capt. Benn managed, however, to arrange, or should we say to "wangle," his transfer to the Royal Naval Air Service as an observer. In this service which, in 1916, was nobody's child, he was engaged in reconnaissance work over the country from Aleppo to Beersheba, on anti-submarine work in co-operation with the French Fleet in the Eastern Mediterranean and in operations in the Red Sea against the Turkish forces near Aden. His next service was reconnaissance work from Port Said over the Syrian and Arabian coasts, combined with an air campaign against the Bagdad Railway, and an interlude with the French naval troops off the island of Castelorzio. Capt. Benn subsequently commanded a mixed force of French and English, not to mention the mighty Stickell, on the island itself, and his account of his welding of his somewhat incongruous following into a homogeneous whole is one of the not least interesting parts of the book, whether considered as a character study or as mere narrative. These episodes were followed by a return to England where the author obtained his "wings," and by further active service on the Adriatic barrage and on the Piave front.

It would perhaps be thought that all these activities with the hard work, the dangers and the many hairbreadth escapes that they involved, would have been enough for one man. But Capt. Benn, while performing his duties as an airman, never forgot the fact that as a Member of Parliament he owed the duty to himself, and to the nation, of keeping himself informed of the political developments both in outlying parts of the Empire and in foreign countries. One of his leave periods was occupied in a study of problems of administration in Egypt and the Sudan. On his many journeys in Italy and elsewhere he took the opportunity of gaining impressions of the feelings towards England, and he has much that is pertinent to say of the organisation of our military forces as viewed from within. His experiences therefore in his years of active service as a Member of Parliament must have been as invaluable as they were to him as a man. His remarks on the army system are pregnant with the seeds of reform which all of us who have suffered similarly hope will soon come to fruition, while what he says about the relation of science to art in the study of aeronautics is worthy of the closest attention.

It would be possible to write much more about this fascinating book, but the space at our disposal is limited. It only remains to say that we have read many war books, but none have held us as this one did. We did not, indeed, read it at a sitting (that would have meant skipping), but it remained "in cut," so to speak, until we had perused the last page. There is, we think, only one thing which Capt. Benn omits to tell us, and that is his opinion as to the true value of "side shows" and whether that value was overrated or underrated by people at home.

How the Progress Department Assists.

V.—The Shop Workers.

By W. J. HISCOX.

It is, unfortunately, true that new innovations are viewed with suspicion and distrust by the vast majority of the shop workers, and this particularly applies to the introduction of new methods of organisation. The shop worker sees here an attempt on the part of the management to economise at his expense, and he displays active hostility as a consequence. It may be said at once that his distrust has not always been without cause, for, in many shops in the past, systems and methods have been rushed through, and no secret made of the fact that they were for the purpose of putting the worker into his proper place.

Such, however, is not the case to-day so far as reputable firms are concerned, for the introduction of scientific management into the factory is as much to the advantage of the worker as to the advantage of the management. Many labour leaders will say otherwise, but practical experience in many factories under varied conditions has convinced the writer (who is a *worker*) that scientific management creates a better feeling in the factory (the result of more satisfactory conditions) and that the shop worker directly benefits.

One of the results of scientific management is the establishment of the Progress Department, and as in many factories this department comes into direct touch with the shop workers, its efficiency is a matter of some import to them. It is a department which is watched by them with some interest, and, although in some quarters adverse criticism is levelled at the efforts of the department, it cannot be gainsaid that it has a tremendous influence, and its apparent failure at times to accomplish all that is demanded of it is not proof of its antagonism to the worker, but rather the reverse.

The Progress Department is born in confusion, and bred in suspicion and distrust. It is created for the purpose of bringing order out of chaos, and under such circumstances its responsibilities are great. No one who has not worked in a progress department can understand or appreciate the difficulties with which it has to contend, not the least of which is the prejudice of the shop workers.

In spite of his professed talk of brotherhood, the average mechanic despises the clerk—as a clerk. He considers that he has no place in the factory, except perhaps in the pay office, and he resents anything by way of instruction emanating from a mere clerk. It is this attitude on the part of the operator which too often has an adverse effect upon the efficiency of an administrative department, for he is hypercritical, and magnifies out of all proportion every little move which does not secure his favour.

The Progress Department, controlling the actual shop organisation, has the power to greatly assist the operator, and the fact that under its direction orders are issued to the shops in a systematic manner (instead of the haphazard methods previously employed) is one way in which the operator benefits. In this way the operator knows exactly what he has to do, when the work in connection with the same will be completed, and what his next job will be. He is thus able to look ahead, compute with some degree of accuracy what his week's earnings will be, and know in advance the demands that are likely to be made upon him.

The operator is reassured by the knowledge that an adequate supply of material is always available, and that this will be brought to him instead of it being necessary to fetch it himself. It may be said that in the old days his piece-work price was high enough to cover any reasonable waiting time; but in a great many instances that reasonable time was considerably increased, and in the long run the operator suffered.

But it is, perhaps, in the fitting and erecting shops that the shop workers appreciate the activities of the progress man, for without him many of the workers would be hard put to to obtain a full week's work. That this is recognised by the fitters may be gauged by the fact that in many shops it was the custom for the fitters to give a monetary reward to the progress man in the department whenever a "big draw" materialised. This was, perhaps, a reprehensible practice; but it did at any rate show that the fitter recognised who was primarily responsible for the "big draw."

There is plenty of evidence to show that the assistance by a progress man or chaser in a certain department is very material; but this really cannot be compared with the assistance rendered by the Progress Department as a whole—that is, by organisation. The department chaser can (and does) hustle through a belated part, and gladdens the heart of the fitter by presenting it to him just in time to allow him to complete his operation and thus ensure payment this week; but the chaser would have an impossible task were the whole of the details comprising that unit dealt with in the same way. There is more joy in the heart of the fitter over the arrival of one belated piece than over the ninety and nine pieces which came through to time, and which as a consequence caused no anxiety.

The organisation of the Progress Department, which arranges for the parts to come through to the fitting shop in sufficient volume to ensure economical erection, is not regarded by the fitter at its true valuation. He is concerned with a certain job, and he naturally expects to find the whole of the details to hand when he requires them. He is not concerned with the troubles and difficulties with which the progress man has to contend, although he would do well to remember that if the progress man were to adopt his own attitude in the face of these troubles, and say "I can't worry about it; it isn't my fault," his chances of getting his requirements to time would be somewhat diminished. It is, of course, the progress man's duty to get over these troubles; but, as a great proportion of these troubles are directly due to lack of co-operation in the factory, it will be understood that there are times when the progress man is in despair, and asks himself "Is it worth while?"

It is the aim of the Progress Department to assist the shop worker, consistent with its duty to the company. The department is out for output, and to get what it desires it does everything in its power to facilitate the progress of work through the shops. It impresses upon the Purchasing Department the importance of prompt deliveries of outside supplies, and regulates delivery of material from the store in such a way as to prevent one department being favoured at the expense of the other. It presses the foundry for castings, and the smiths' shop for forgings, and it progresses the details through the machine shop in the correct sequence, so that, as far as practicable, complete sets of parts are available for the fitters.

The machine-shop operator sometimes has a point against the Progress Department on the score of changing work on a machine whilst further supplies of the part for which the machine is set are still in evidence. In other words, a machine is set for boring frames, and an order is issued for 50. When this quantity has been completed, an order for 50 end shields is issued, although it is known that a further batch of, say, 150 frames is available. The machine operator does not understand this, but the fitter does. One of the strongest points in the progress organisation is that it gets through the things that matter. It is concerned, not so much with mass machining, but with output—from the factory; and that in this instance means completed units. The machine shop, assured of adequate material, but left to its own devices with regard to production, may produce in the aggregate a huge volume of work, to the immediate advantage of the operators. If, as would be bound to occur, however, this huge volume of work did not constitute a complete set for erection purposes, what would be the position of the fitters, and (what is more to the point) what would be the ultimate position of the machine operators when it was discovered that, notwithstanding the fact that thousands of pounds had been paid out in wages, not a single completed unit had left the factory?

The machine operator will do well to ponder over this, and he will recognise that, in insisting upon work being machined in sets (provided that an economical working quantity is allowed) the progress-man is really acting in the interest of the firm, *and also in the interest of the operator.* The Progress Department studies the requirements of the customer, and acts in such a manner as to ensure that his requirements in respect to delivery are met. If the customer is satisfied, he will come again; if he is not satisfied, he will go elsewhere, and when this latter is the case it is worse for the firm and also the operator.

It is often argued that one cannot serve two masters, and it may be pointed out that that is precisely what it is claimed the Progress Department can do. The present writer, however, cannot see it in this light, for he doesn't recognise that there are two masters to be served. In the modern factory no one can stand alone, for each is dependent upon the other. The factory may be likened to the human form, the head directing the movements of the arms and the legs whilst the heart, composed of common purpose and common sense, controls the whole. And this factory (in the human form) works for one master—the consumer or customer. So does the Progress Department assist the whole factory, from the works manager to the junior apprentice.

The Electromagnetic Theory of Relativity.

This question is still giving rise to a great deal of interest in scientific circles, and, in accordance with a special request, Dr. Albert Einstein considered certain aspects of the subject in an article published in a recent issue of "The Times." We give a summary of these remarks below.

There are several kinds of theory in physics. Most of them are constructive; but, in addition to this most weighty group, there is another group consisting of theories of principle. These employ the analytic, not the synthetic, method.

The theory of relativity is a theory of principle, and is like a house with two separate storeys, the special relativity theory and the general theory of relativity. The special relativity theory is the application of the following proposition to any natural process: "Every law of nature which holds good with respect to a co-ordinate system, K, must also hold good for any other system, K', provided that K and K' are in uniform movement of translation. The second principle on which the special relativity theory rests is that of the constancy of the velocity of light in a vacuum. Physicists owe their confidence in this proposition to the Maxwell-Lorentz theory of electro-dynamics.

These two principles have received strong experimental confirmation, but do not seem to be logically compatible. The special relativity theories achieved their logical reconciliation by making a change in the doctrine of the physical laws of space and time. It became evident that a statement of the coincidence of two events could have a meaning only in connection with a system of co-ordinates. It also became evident that the inertia of a material system must depend on its energy content; hence the conception that inert mass was nothing but latent energy. The doctrine of the conservation of mass lost its independence and became merged in the doctrine of conservation of energy. The special relativity theory had consequences which reached beyond itself. Must the independence of physical laws with regard to a system of co-ordinates be limited to systems of co-ordinates in uniform movement of translation with regard to one another? What has Nature to do with these co-ordinate systems and with their motions? Although it may be necessary for our descriptions of Nature to employ systems of co-ordinates that we have selected arbitrarily, the choice should not be limited in any way so far as their state of motion is concerned. (General theory of relativity.) The application of this general theory to relativity was found to be in conflict with a well-known experiment, according to which it appeared that the weight and inertia of a body depended on the same constants (identity of inert and heavy masses). Consider the case of a system of co-ordinates which is conceived as being in stable rotation relative to a system of inertia in the Newtonian sense. The forces which, relatively to this system, are centrifugal, must, in the Newtonian sense, be attributed to inertia. But these centrifugal forces are, like gravitation, proportional to the mass of the bodies. Is it not, then, possible to regard the system of co-ordinates as at rest, and the centrifugal forces as gravitational? The interpretation seemed obvious, but classical mechanics forbade it.

This slight sketch indicates how a generalised theory of relativity must include the laws of gravitation, and actual pursuit of the conception has justified the hope. But the way was harder than was expected, because it contradicted Euclidian geometry. In other words, the laws according to which material bodies are arranged in space do not exactly agree with the laws of space prescribed by the Euclidian geometry of solids. This is what is meant by the phrase "a warp in space." The fundamental concepts "straight," "plane," &c., accordingly lose their exact meaning in physics. In the generalised theory of relativity, the doctrine of space and time, kinematics is no longer one of the absolute foundations of general physics. The geometrical states of bodies and the rates of clocks depend in the first place on their gravitational fields, which, again, are produced by the material systems concerned.

Thus the new theory of gravitation diverges widely from that of Newton with respect to its basal principle. But in practical application the two agree so closely that it has been difficult to find cases in which the actual differences could be subjected to observation. As yet only the following have been suggested:—

(1) The distortion of the oval orbits of planets round the sun (confirmed in the case of the planet Mercury). (2) The deviation of light rays in a gravitational field (confirmed by the English Solar Eclipse Expedition). (3) The shifting of spectral lines towards the red end of the spectrum in the case of light coming to us from stars of appreciable mass (not yet confirmed). The great attraction of the theory is its logical consistency. If any deduction from it should prove untenable it must be given up. A modification of it seems impossible without destruction of the whole. No one must think that Newton's great creation can be overthrown in any real sense by this or by any other theory. His clear and wide ideas will for ever retain their significance as the foundation on which our modern conceptions of physics have been built.

Local Authorities and Mains Laying.

Public utility companies, such as those supplying electricity, gas and water, will find much to interest them in the proposals which are now being put forward in regard to the consolidation and amendment of the highway law under the Ministry of Transport. As legislation is promised on this matter, it may be well to call attention to what is in the minds of the various county surveyors and engineers throughout the country in regard to the conditions which should attach to the laying of supply mains in public roads, this matter having received some attention at the Roads Transport Congress organised by the County Councils Association in connection with the Road and Transport Exhibition at the Agricultural Hall, London.

In a Paper read before the Congress on the 22nd ult., Mr. H. Hampton Copnall, Clerk to the Notts County Council, sketched out the draft of a proposed Bill for consolidating and amending the highway law as it now stands. In this he proposes to give full control over electricity, gas and water mains to the highway authority, who should also have full control of the subsequent reinstatement of the road, and have the option either to do the work itself or to require the undertakers to do the work and carry out the reasonable directions and requirements of the highway authority. Where the undertakers do the work themselves, they should be required to maintain the surface which they disturb for twelve months after the final reinstatement.

During the discussion it was pointed out that gas and water mains were at present controlled by an Act of Parliament passed in 1847. Mr. Drylands, county surveyor of Surrey, contended that public utility companies should be compelled to restore the surface of the roads which they disturb to a condition to carry the traffic, no matter what that might mean in expense to the companies, even if it meant laying the mains in concrete. Mr. Martin, of Salford, suggested that there should be standardised positions for the various classes of mains under the roadways, so that damage would not be done to the roads, as was often the case now, in trying to find where a particular main was. If it were recognised that particular mains would be placed in a particular position they could easily be found when required.

Another matter bearing on the question of mains under highways is the possibility of building roads on a different form of construction from that generally adopted at present. Great attention is being paid to the construction of concrete and reinforced concrete roads, many thousands of miles of which exist in the United States and other parts of the world. Though at the moment it may be said that there are differences of opinion between county surveyors on this matter from the general traffic point of view, experiments have been and are being carried out by the Road Board, and it is evident that if this class of construction is adopted it is not intended that the roads should be continually broken up for laying mains. The view appears to be that special tunnels will have to be constructed for carrying mains. In any case public utility companies should watch this proposed legislation.

Correspondence.

AN ATTEMPT AT CONSTRUCTIVE CRITICISM.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : Your leader of November 21st is of particular interest at the present time. The Electrician "desires to join the ranks of those who can suggest a policy which will lead to an improvement," *i.e.*, a lessening of the "disabilities under which the electrical engineering profession is suffering."

To do this you suggest :—(*a*) Controversial papers as distinguished from "elaboration of fundamentals." (*b*) That the Council should be made to understand that the views of electrical engineers should be crystallised by the Institution of Electrical Engineers, and constantly used to force the Government to give electrical engineers the same protection as the medical and legal professions, and the same status.

To deal with (*b*) first :—The power of the Council to represent the profession depends upon the members *first and last*. If it is their desire that the Council should act continuously, vigorously and powerfully for them as a whole, it is their obvious and simple duty to nominate candidates they consider fit for the purpose, and to vote on all Council elections. If they do not exercise their voting powers, they have not the slightest right to criticise the Council which results from their apathy, nor to utter the "peevish question—What good is the Institution to me ?"

My position as a member of the present Council precludes me from considering whether it is a body representative of a vast and necessary profession, that is, representative in such a completeness and strength that its will would be imposed on, or its advice taken by, the Government or any lesser outside body. The Council is, for such matters as you mention, the arrow-head of the profession, but the members themselves are the smiths who fashion it.

Despite my disabilities I will call attention to its great activities in the last two or three years, for which Mr. Wordingham in particular deserves the greatest credit. It has been called upon by the Government for advice, technical assistance, witnesses, &c., many times during the war, clearly recognising the position of the Council as the head of the profession, and it is hoped that this will not be forgotten by the Government when the Institution of Electrical Engineers asks for a higher status in the immediate future.

As for (*a*) controversial papers : I think, with respect, you are wrong. If a subject is naturally controversial, as, for instance, papers on traction are, then the controversial discussion is healthy and does good. But controversy is not good in itself, and the majority of papers are of necessity of such a nature that the discussion is questioning and informative, rather than the kind associated with the old nights of A.C. *versus* D.C.

The Informal Meetings have been established largely to supply the opportunity for real discussion, and their success may perhaps be taken by you as meeting this recommendation —I am, &c., J. Sayers.

Derby, Dec. 1.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : In your leading article in The Electrician of Nov. 21 you suggest that the presence of such a large proportion of students at the opening meeting of the Institution of Electrical Engineers was due as much to curiosity as to a desire for knowledge. We think that this statement casts an unjustifiable aspersion on the attitude of the great majority of student members, and we are convinced that their attendance at the ordinary meetings of the Institution shows a distinct desire for knowledge on their part, and that they appreciate very highly the privilege of being allowed to attend such meetings.

Since, moreover, you point out that the aristocracy of the profession must in future be drawn from that great middle class, whose absence from the meeting you deplore, is it not a little short-sighted on your part to ignore the fact that in the slightly more remote future that aristocracy will be drawn from the present members of the Students' Section ?—We are, &c.,

C. E. Webb,
F. R. Housden, } Students, I.E.E.
Godfrey H. Fletcher,

London, Nov. 24.

[We hope that the present generation of students will be as constant in their attendance when they become Associate Members as they are now.—*Ed. E.*]

CALCULATING GROWTH OF CURRENT IN AN INDUCTANCE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : Referring to the abstract of the article by Dr. C. Hering on this subject which appeared on p. 312 of your issue of September 19, 1919, I would point out that the method given is very interesting, but that often a still easier way may be followed. Let us draw a curve

$$I=\frac{E}{R}\left(1-e^{\frac{Rt}{L}}\right) \quad . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

for mean values of the E, R, L which will be used in most cases. This curve, calculated as exactly as possible, may then be used for all other values of E, R, L merely by changing the scales of the ordinates and abscissæ.

If for (1) each unit of length represents N amperes, we have for

$$I'=\frac{E'}{R'}\left(1-e^{\frac{R't}{L'}}\right) \quad . \; . \; . \; . \; . \; . \quad (2)$$

$$\frac{\frac{E'}{R'}}{\frac{E}{R}}\,N=k\,.\,\frac{E'}{R'}$$

amperes per unit of length, k being equal to

$$\frac{N\,.\,R}{E}.$$

Further, if for (1) each unit of length represents M seconds, this will be for (2)

$$\frac{\frac{R}{L}}{\frac{R'}{L'}}\,M=k'\,.\,\frac{L'}{R'}$$

seconds, k' being equal to $\frac{MR}{L}$.

It will, therefore, be possible to obtain with great precision, from the standard curve, any value of I' corresponding to a given value of t and vice-versa. This would only be possible with Dr. Hering's method if a great number of values were given for n. It seems, moreover, in general easier to work with a curve than with a table.—I am, &c.,

S. Van Mierlo, Engineer A.I.Lg., A.I.M.

Antwerp, Nov. 7.

Mercury Vapour Rectifiers for Glasgow.

The question of using mercury vapour rectifiers for transforming extra-high-tension current into continuous current has recently been arousing considerable interest, and as is well known, Messrs. Brown, Boveri & Company have been working on the development of this apparatus to make the mercury vapour rectifier a practical proposition for ordinary working conditions. The Electricity Committee of the Glasgow Corporation having had the possibilities of the mercury vapour rectifier brought to their notice, decided to send one of their members, and their chief electrical engineer, Mr. W. W. Lackie, to Switzerland to investigate the matter on the spot. Accordingly, Bailie Sadler and Mr. Lackie proceeded to Baden on the 15th October, and they have now submitted their report to the Electricity Committee of the Glasgow Corporation.

After explaining the nature and function of converting plant as at present installed in the sub-stations of the Glasgow system, the report goes on to point out that these converters are large pieces of running machinery weighing several tons; they require constant attendance and lubrication; and they suffer depreciation as the result of wear and tear. The mercury vapour transformer performs the same function as existing converting plant, but it is a stationary piece of apparatus. Current at 6,500 volts alternating current is led to a static transformer and transformed to 400 volts alternating current, and by means of the rectifier this low-tension alternating current is transformed to continuous current. The rectifier consists of a steel cylinder, from which the air has been pumped, so as to maintain a vacuum inside the cylinder. While the apparatus is in commission the inside of the cylinder is full of mercury vapour generated from a mercury bath by means of a mercury arc, and it is the valve action of the mercury arc only allowing the current passing through it to flow in one direction which effects the transformation of the energy from alternating to continuous current. This transforming property of the mercury arc has been known for some years, but prior to the developments effected by Messrs. Brown, Boveri & Company, the apparatus was only made for small powers and the cylinder was made of glass. The chief item of interest in the Brown, Boveri apparatus is the steel cylinder with mercury air-tight joints throughout to maintain the vacuum.

The Glasgow deputation saw rectifiers of this type in course of construction at Messrs. Brown, Boveri's works suitable for the Glasgow voltage, the units having a capacity 170, 330 and 660 H.P. respectively. The report testifies to the excellence of the workmanship; and rectifiers dismantled after being in use for several years showed no sign of depreciation. Installations were inspected at Schliren, Berne, Le Locle and Orbe, with units varying from 170 H.P. to 330 H.P., and in connection with all the installations seen, assurances were given, we understand, that the performance of the rectifiers was entirely satisfactory. The principal points noticed with regard to the apparatus were: (1) Its silence in operation—a feature likely to be of great benefit in sub-stations erected in residential areas. (2) Small space occupied and relative lightness in weight. The relative weight is shown by the following figures:—

H.P.	Rectifier.	Rotary.
170	1 ton	4½ tons
330	1¾ tons	6¾ tons
660	1½ tons	9 tons

(3) The minimum of attendance necessary. (4) Absence of running machinery and the advantages accruing therefrom. (5) Rapid starting up and shutting down.

The City of Paris are, we learn, contemplating a considerable installation of this equipment, and a list of 60 installations carried out during the past five years was supplied, representing a total of 100 cylinders and an aggregate capacity of 25,000 H.P. Although the current price of the new device is not much less than existing converting apparatus of the older type, the report concludes with a recommendation that owing to the incidental economies and the other advantages of the rectifier, a quotation should be obtained by the Glasgow Corporation for an experimental installation of four cylinders each of 330 H.P. This recommendation has been passed on by the Electricity Committee to the Corporation for approval.

According to "The Engineer" two 25,000 kw. American Westinghouse steam turbine sets are being erected at OSAKA (Japan) for the Osaka Electric Light Company, and when installed the company will have the largest steam-driven electricity works in the Far East, and will have a capacity of over 100,000 H.P. The station is in an extensive industrial district, and energy is supplied for light and power to street railways, steel works, shipbuilders, copper refining plants, paper mills, electro-chemical works, and other industries.

British Science and Key Industries Exhibition, Glasgow.

Following hard on the heels of the very successful Housing and Health Exhibition promoted by the Corporation of Glasgow, another exhibition devoted to British Science and Key Industries was opened under the auspices of the same authority in the Kelvin Hall of Industries on November 17th. The objects of this exhibition are three fold; to show the vital importance to "key" industries of science and scientific research; to emphasise the danger to this country of permitting vital industries and scientific secrets involved in them to pass out of our hands into those of other countries: and to show how during these trying years of war how these important industries have been recovered, and in some instances created by the skill, courage and patriotism of British scientists and workers. In order to achieve these laudable objects a very strong advisory committee representing Science and Industry was brought together. This committee included university representatives such as Profs. J. D. Cormack, C. H. Desch and Magnus Maclean; shipbuilders such as Sir Wm. Beardmore and Sir Archd. Denny; engineers such as Messrs. W. W. Lackie, M. B. Field and Sam Mavor and many others prominent in all branches of industry in the West of Scotland. The result of this work has been to bring together one of the finest exhibitions of scientific developments ever seen in this country.

The exhibition was formally opened on November 17th by Sir Charles A. Parsons, who, in a short speech, touched on the debt engineering and scientific progress owed to Glasgow and the West of Scotland generally, mentioning especially the names of James Watt, Lord Kelvin and Dr. Barr.

Turning to the exhibits in detail, *Messrs. Kelvin, Bottomley & Beard, Ltd.*, Glasgow, on their stand in Avenue A, besides showing their navigational instruments, such as standard compasses, sounding machines and electrical measuring instruments, ammeters, voltmeters, etc., are making a special exhibit of pneumercator tank gauge and pneumercator draught indicator, of which apparatus they are the sole manufacturers for Great Britain and the European Continent. This is an apparatus of distinct scientific interest, which can be used to record the level of any liquid in any tank or reservoir, also the fore and aft draught of ships. The principle involved is a very simple one. A sort of diving bell is placed in the tank whose contents are to be recorded, and from the top of this diving bell an air pipe is led to a multiple way control cock. This cock is connected to the gauge, which usually consists of a mercury column, and to a hand-operated air pump. To obtain a reading at any time the control cock is turned so as to connect the air pipe leading to the diving bell or "balance chamber" with the air pump. A few strokes of this pump expels any liquid which may have found its way into the chamber and re-establishes the balance or datum line on which the gauge has been graduated. Then on turning the control cock so as to connect the air pipe from the balance chamber to the mercury gauge the air pressure inside the balance chamber is balanced by the mercury column. It is easily seen that either volume or weight of liquid can be measured in this way. The application of this apparatus to marine uses gives a simple method of weighing the cargo taken on board or discharged at any time. The draught fore and aft is taken on two adjacent gauges coupled by link gear to an indicating pointer giving the average draught. From data supplied by the shipbuilder the scale over which the pointer moves is graduated in tons, and thus a continuous record of change in dead weight is obtainable.

Glasgow Corporation Electricity Department have a large stand on which is exhibited a large variety of electrical apparatus for heating, cooking and ironing, vacuum cleaners, sewing machines, motors, etc.

Messrs. G. & J. Weir, Ltd., have an exhibit of Monel metal for which they hold the sole U.K. rights. Monel metal has a composition of 67 per cent. nickel, 28 per cent. copper and about 5 per cent. of other metals. It contains no tin, zinc or antimony, and has this peculiarity that it is made as an alloy from the ore without separating the constitutional metals. Hence it is known as a "natural alloy." It is stated to be as strong as steel and incorrodible as nickel, and is shown both in its raw stages as pig, billet and bar as well as in finished machined articles.

Messrs. Siemens Brothers & Company have a representative exhibit of their activities. Among the most interesting of these are a ship's standard wireless telegraph station installed exactly as it would be on board ship. There is also an automatic telephone exchange comprising a 30 to 50 line switchboard operating on a system similar to that which has been installed at Grimsby and Stockport. This is shown in operation. Among the other exhibits are mining telephones and loud-speaking telephones for ship work, together with various devices for the protection of telephone and telegraph circuits against atmospheric and very high-potential discharges. Military telegraph apparatus and automatic telegraph apparatus of various kinds are also to be found. Two forms of pyrometer are shown, one of these is a thermo-electric pyrometer of the platinum—platinum-rodium type, and the other is of the thermo-electric type for measuring the temperature of superheated steam. The chief characteristic of this latter instrument lies in the fact that it indicates the most abrupt changes of temperature. An apparatus for indicating automatically the presence of chlorine is also shown, together with electric helm indicators, revolution indicators, torsion meters, navigation light indicators and signalling apparatus for use in mines. Searchlight projectors, switchgear, fans, motors, lamps, cables, primary batteries and other electrical accessories also find a place.

The London Electric Firm show a number of searchlight projectors for commercial purposes, including a simple "pilot house" projector, which can be trained and elevated by only one lever.

Messrs. Reyrolle & Company have a representative exhibit of high tension switchgear as supplied to various corporations, including Glasgow. This is of the armoured type so well known as associated with this firm.

Messrs. Brook, Hirst & Company, Ltd. (Chester), *Erskine, Heap & Company, Ltd.* (Manchester), and *Electric Control, Ltd.* (Glasgow), have a combined exhibit on a stand controlled by their Scottish agents, Linwood & Company. A large variety of motor starting and operating panels, switchgear and instruments are on view.

On the stand of the *Mining Institute of Scotland* a portion of the exhibit has been arranged to illustrate a working place in a coal mine, showing a section of a coal section with an electric coal cutter in action. It has been well got up to show the timbering and general arrangement of the average coal mine, and is a source of attraction and information to many who have no idea as to the underground condition in our mining areas. Here also are shown various types of miners' safety lamps, including electric lamps. Also the "Magnet" safety lamp relighter made by the Park Royal Engineering Works, Ltd., London, for underground use. This relighter is actuated by a hand-driven magneto placed in the base of a cylindrical column, has no batteries or high tension coils to go out of order, and is extremely simple in operation.

The Clay Cross Company, Ltd., are showing an audible and visual mine signalling apparatus. This seems to be a well-designed combination of audible signals mechanically given with electrical visual signal, which remains until the engine has actually started to move.

Messrs. Vickers are distinguished by having the largest individual stand in the exhibition. Here all the Vickers activities are shown in a series of exhibits too numerous to mention, save that they range from battleships to children's toys and dolls; from Vickers-Petter oil engines to sewing machine motors; from airships to magnetos, electrical switchgear, instruments and electrical accessories are the contribution to this heterogeneous collection of the Metropolitan-Vickers Company. The stand is a source of attraction to every visitor, and gives some idea of the immense ramifications of the Vickers interests.

Messrs. Mavor & Coulson show various types of electrical coal cutters, both bar and chain. Also their flame-proof mining switchboards and their Ironclad Switchgear for industrial purposes.

The Edison Swan Electric Company are making a special display of their "Pointolite" lamps, showing their use for lantern illumination, stage flood lighting, etc. There is also an interesting exhibit of glass work; molybdenum, showing the various stages from ore to finished metal; platinum substitute to replace the more expensive metal for leading-in wires. They also exhibit the usual run of electrical apparatus, such as lamps, switches, radiators, etc.

At the recent meeting of the North of England branch of the Association of Mining Electrical Engineers, the president (Mr. Geo. Raw) said the 1911 Coal Mines Act rightly required that surveyors and deputies should hold certificates of competency, but why it excused the engineer (mechanical and electrical) was not easy to understand. The colliery engineer had a highly technical staff under his charge, and he was morally responsible for the safety of the miners in the shafts; also he had the safety and maintenance of the plant and steam boilers under his care. The present promiscuous system was grossly unfair to the great numbers of colliery engineers and it was inexcusable in these days of steam and electrical efficiency to have collieries burning 20 tons of saleable coal out of every 100 tons drawn on their boiler fires. Yet such a state of affairs existed at many collieries. The mining industry had a great deal of leeway to make up in improving the efficiency of the engineering equipment of the collieries. The nation's precarious economic position could be restored if efficient plant and appliances were introduced and used with the same energy as American industry exhibited after the Civil War.

Private Bill Legislation.

Notice has been given by the following local authorities, companies, &c., of intention to promote in the ensuing session Bills and Orders to confer various powers in regard to electricity supply and traction undertakings:—

Provisional Electric Lighting Orders.

Applications for orders are being made by *Huddersfield Corporation* (extension of electricity area to Urban districts of Kirkheaton, Kirkburton, Lepton and Melham), *Havant, Risca, Bedwas and Machen, and Mynyddislwyn Urban Councils, South Wales Electrical Power Distribution Company* (for Abersychan, for Saint Mellons and for Panteg) and *Mr. Wm. Herbert* (for Ammanford and District).

Electricity Supply Bills.

Gelligaer Urban Council: To supply on hire electric wiring and fittings and to exempt same from distress, to make by-laws in regard to wires and fittings, to provide and maintain showrooms, to promote and hold exhibitions and to exhibit electrical appliances, machinery or fittings, and to promote the use of electricity by advertisement or otherwise, to empower the Council to refuse supply to persons in debt and to cut off supply used contrary to terms of agreement, to provide for payment of a minimum charge for stand-by supply, &c.; also to provide and run motor omnibuses within and beyond district.

Tredegar Urban Council: To generate and supply electrical energy, to lay mains in private streets, to supply electric fittings and apparatus, to exempt same from distraint, to fix charges for stand-by supply, &c.

A Bill seeks power to constitute and incorporate a Joint Board for the generation and supply of electrical energy in the Urban Districts of *Nantyglo* and *Blaina* and *Brynmawr* and to confer powers to supply electrical energy, to apply for provisional orders, &c.

North Metropolitan Electric Power Supply Company: To raise additional capital, &c., to break up roads in parishes of Aldenham, Hyde and Cuddington and the Urban District of Willesden, to erect electric lines, to authorise supply of energy beyond existing limits, to acquire other undertakings, &c.

Edmundson's Electricity Corporation, Urban Electric Supply Company, Twickenham and *Teddington Electric Supply Company, Penzance* and *District Electric Supply Company, Ramsgate* and *District Electric Supply Company, Ilfracombe Electric Light and Power Company*, and *Camborne Electric Supply Company:* To increase prices charged for electricity, to repeal and amend their existing Acts and Orders, &c.

A Bill is being promoted to incorporate the *Dartmoor and District Hydro-Electric Supply Company* for the construction of hydro-electric works, to lay mains and cables for the transmission of electrical energy and water, to lay electric mains above ground and to erect standards, &c.

In the Bill of the *South Wales Electrical Power Distribution Company* power is sought to issue further prior lien debenture stock and other capital, for further capital powers, &c.

Sunderland Corporation: Authority to purchase undertaking of local gas company and additional powers for electricity undertaking.

Traction Bills and Orders.

Gravesend and Northfleet Electric Tramways, Ltd., Middleton Electric Traction Company, and *Airdrie and Coatbridge Tramways Company:* To increase the fares and charges for passengers and goods, &c.

Peterborough Electric Traction Company: To increase the authorised fares and charges.

Warrington Corporation: Powers to construct additional tramways, further borrowing powers, &c.

Middlesex County Council: To construct tramways in Edgware-road, to work or lease tramways to Metropolitan Electric Tramways, Ltd., to enter into agreements for supply of electrical power, to provide and run omnibuses, &c.

Newcastle-upon-Tyne Corporation: To construct tramways and tramroads in Northumberland and Durham, to authorise additional powers in regard to tramway undertaking of Corporation, to acquire systems of Tyneside Tramways and Tramroads Company, to compel motor omnibus undertakers to contribute to cost of reconstruction and maintenance of roads, to enter into agreements for the supply of electric energy, to use trailer cars, to provide and run motor omnibuses, to supply electrical energy within and beyond city area to consumers abutting upon tramway routes, &c.

Pontypridd Urban Council: To construct additional tramways, &c.

Stoke-on-Trent Corporation: To acquire undertakings of Potteries Electric Traction and of the North Staffordshire Tramways Companies, to run omnibuses within and beyond borough, &c.

Nottingham Corporation: To construct additional tramways and tramroads, to extend time for construction of various lines, to run motor omnibuses outside city, &c.

In the *Erith* Improvements Bill the Urban Council (inter alia) seek authority to acquire and work the tramways authorised by the Erith Tramways Act, 1864, and to provide and run motor omnibuses within and without the district.

Southampton Corporation: To construct additional tramways, to run motor omnibuses beyond borough boundary, &c.

Wolverhampton Corporation: To provide and work motor omnibuses within and beyond the borough, further tramway and omnibus powers, &c.

Wallasey Corporation: To run motor omnibuses within and beyond the borough, to increase tramway fares, &c.

London County Council: To construct a number of new tramway lines and to reconstruct existing tramways (Particulars of these lines have already appeared in our columns) to provide and run motor omnibuses, and for further powers in regard to their tramway undertaking.

Rhondda Urban Council: To extend time for purchase of lands for completion of tramways authorised by their Act of 1915, to amend or cancel agreements with Rhondda Tramways Company, to establish service of motor omnibuses, &c.

Sheffield Corporation: To construct new tramways, to lay tramways on separate track, further powers as to motor omnibuses, to increase tramway fares on special occasions, &c.

In the Bill of the *Great Northern Railway* power is sought to use electrical energy or gas beyond the limits of undertakers supplying same.

The *Tyneside Tramways and Tramroads Company:* To amend existing powers, to increase borrowing powers, to increase tolls and charges, to provide and run motor omnibuses, &c.

Hastings Tramways Company: To use the overhead system on all their lines and to amend their Acts of 1900, 1903 and 1905.

Wrexham and District Transport Company: To amend Company's existing Acts and Orders and to increase tolls and charges, to alter provisions as to workmen's cars, &c.

In the Bill for the incorporation of the *Derwent Valley, Calver and Bakewell Railway Company* power is sought to work the railways by electrical energy and to enter into agreements as to the supply of electricity, &c.

London United Tramways, Ltd.: To increase fares and charges and to amend provisions as to stages, workmen's fares, &c.

In the Bill promoted by the *London Electric, Metropolitan District, City and Sauth London and Central London Railway Companies* authority is sought to increase and alter fares and charges, to amend existing Acts, &c.

Central London and Metropolitan Railway Companies: To construct new railways and works, to acquire running powers for the Central Company over the Kensington and Richmond branch of the L. & S.W. Railway, to enlarge Aldgate East Station, &c.

Metropolitan Electric Tramways, Ltd.: To increase fares and charges; further powers as to construction and use of junctions and junction lines; to extend time for construction of tramways and trolley vehicle lines, to use trailers and coupled cars, &c.

Application is being made to the Light Railway Commissioners by the *Yorkshire (Woollen District) Electric Tramways, Ltd.*, for an Order to amend the Spen Valley and Morley Light Railway Orders, to increase the fares and charges for passengers, parcels, animals, goods and minerals.

Southend Corporation is applying for a Light Railway Order to authorise the construction of additional light railways.

Brighton Corporation desires to obtain a Light Railway Order to construct two additional light railways.

South Metropolitan Electric Tramways and Lighting Company: To increase fares and charges, to use trailer and coupled cars, &c.

Joint Electricity Supply and Traction Bills.

Coventry Corporation: To construct additional tramways, to provide and work motor omnibuses beyond city, to acquire land for generating station; further powers in regard to electricity undertakings, &c.

Edinburgh Corporation: To extend boundaries of city and apply electric supply powers, &c., to added area; to construct tramways, &c.

Halifax Corporation: To construct new tramways in Halifax, Elland and Hebden Bridge, &c., to carry minerals and goods on the Corporation tramways, to alter gauge of existing lines, to extend area of electricity supply, to supply electricity in bulk, to take transfers of electricity undertakings, &c.

Salford Corporation: Additional powers in connection with their tramway and omnibus undertakings, including construction of 18 additional lengths of line, the laying of electric lines in private streets, and other powers in connection with the electricity undertaking.

Lowestoft Corporation: To use trolley vehicles and overhead electrical equipment for working same, to work motor omnibuses within the borough, and further provision as to tramways, trolley vehicles, omnibuses, electric supply, &c.

Manchester Corporation: Construction of additional tramways; to enter into agreement with Denton Urban Council, to establish a superannuation fund, to make further provisions in regard to loans for the Corporation's electricity undertaking, including the raising of capital for payment of interest during construction of works and the postponement of sinking fund payments, &c.

Portsmouth Corporation: To construct and work new tramways, to provide and run motor omnibuses, to extend area of electricity supply, further powers with reference to electricity undertaking, &c.

Dundee Corporation: To exempt wires and works of the electricity department and the tram rails of the tramways department from assessments, rates and charges, to make provision with regard to the reserve fund of the electricity department, to provide for through working between the Corporation tramways and the lines of the Dundee, Broughty Ferry and District Tramways Compnay, &c.

In the *Bristol Corporation* Bill authority is sought to construct and use new roads and tramroads, to repeal Kingswood Electric Lighting Order, to lay electric lines in Keynsham and Salford, and to acquire other electrical undertakings by agreement, &c.

Cardiff Corporation: To construct and work new tramways, to use trailer cars, to run motor omnibuses within and beyond borough boundary, to let electrical fittings on hire, to fix and repair lamps, motors, &c., to lay mains across, under or over lands, break up private roads, &c.

Huddersfield Corporation: To construct tramways and tramroads, to increase fares, to run omnibuses, for further provisions regarding the Corporation's electricity undertaking, &c.

In the *Blackpool Improvements Bill* power is sought to extend the borough area and to extend the electricity supply and other powers of the Corporation to added areas; to construct tramways and tramroads in the borough, Thornton and Fleetwood, to carry goods and minerals on the lines, &c.

St. Annes-on-the-Sea Urban Council: To acquire undertakings of Blackpool, St. Annes and Lytham Tramways Company, to vest portion of undertaking in Lytham Urban Council, with power to take a lease of the undertaking; to constitute a Joint Board for working; to construct new tramways, to run trailer cars, compulsory running powers over Blackpool Corporation tramways, further powers as to the generation and supply of electricity, &c.

Lytham Council: To acquire undertaking of Blackpool, St. Annes & Lytham Tramway Company; to enter into working agreements; to construct tramways in Lytham; compulsory running powers over Blackpool Corporation tramways; further powers for the generation and supply of electricity, &c.

In the Bill for the incorporation of the *Thames Ocean Wharf Railway Company*, power is sought to construct electricity generating stations and to work railway by electricity or steam, and to enter into agreements for the supply of electrical energy, &c.

Miscellaneous Bills.

The following local authorities seek powers to provide and work motor omnibuses within and outside their areas: *Bootle, Bridlington, Folkestone* and *Leigh Corporations* and the *Merthyr Tydvil* and *Risca Urban Councils.*

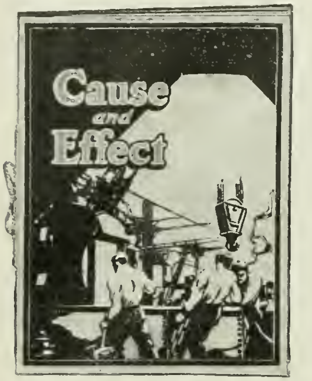
The Future of Industrial Power.

An interesting address on "Electricity Supply" was delivered at Batley last week by Mr. W. B. Woodhouse before a meeting of manufacturers, arranged by the Yorkshire Section of the Textile Institute.

Mr. Woodhouse said that while it was recognised that the extended use of machinery was of great importance in increasing the output of industry, the question of the methods of supplying power for that machinery were even more important than in the past. Unless those methods could be improved, industrial progress would be considerably retarded. In some way or other, the cost of electric power must be reduced, even though the cost of power may be only 5 per cent. of the selling price, as he took it it was the case in respect of textiles. There was a great need for increasing the output of coal, and with the further use of machinery and the goodwill of the miner he thought that might be accomplished. The collieries of this country consumed for power production 18 million tons of coal per year. That represented ¼ per cent. of the total amount of coal mined. Approximately, 2½ million horse-power was used by the collieries, of which at present half a million was electrical power. If the whole of the power were produced by large stations, the same amount of power could be supplied to the pits and a reduction of 12 million tons of coal achieved. Some 14 million tons of coal were consumed on the railways, which, if electrically worked, would consume less than one-half of that quantity; but there was the cost of overhead and other equipment to set off against the saving on coal. Factories and workshops used 53 million tons of coal, and the textile trade, he estimated, was responsible for 10 millions to create approximately two million horse-power. Therefore, the 12 million tons saved at the collieries would be more than enough to supply the coal used by the textile industry.

The use of large turbines and the importance of obtaining economy of capital supplied the reasons for the proposals to put down very large power stations. It had been found that the cost of producing 1 H.P. in a large station was less than half the cost as compared with a small station. The further advantages of large stations were that they could be equipped with labour-saving machinery, and allow of expert supervision of the processes. The disadvantages of the big station were recognised to be that if power were generated at one centre there would be the costs of distribution to meet. There was thus an economical limit to the size of a station: it should be determined by comparative density of the demand. In a district like the West Riding, the argument was in favour of reducing the number of stations. The only places where the power stations of the future should be put down were the sides of a river or near the seashore, so that an ample volume of water was available for condensing purposes. It seemed to be assumed that the electrical engineer was always an opponent of gas. On the contrary, they all looked forward to the time when, alongside the big power stations, there would be plant to extract by-products from coal. That would be in the national interest, and it would be done to-day only the process did not pay. A new method of treating coal for the generation of electricity must be discovered. The process used at gas works was primarily designed to produce gas, and, although good enough for its purpose, was not suited to the needs of the electrical engineer. Referring to the Electrical Supply Bill, he said the Electricity Commissioners would have to see that no power company was subjected to restrictions by local authorities and others without the interests of the large users of electricity being consulted. In the West Riding there were 25 electricity undertakings. Some of those were now working jointly, and that intercommunication showed that the various power authorities were moving in the right direction. It was hoped that the Elecrricity Commissioners would make them move more rapidly.

Factory and Workshop Lighting.



A greater output and an increased efficiency on the part of workers are the most urgent needs of the day, and good lighting is an important aid in attaining these desirable ends. It is true that manufacturers and employers are becoming alive to the importance of good lighting, but there is still much room for improvement in many factories and work-rooms. There can be no doubt that improper illumination is the biggest and most frequent cause of spoilage, waste, accidents, small production and high costs in industry. On the other hand good light, when properly applied, cuts down waste and spoilage, helps to avoid accidents, to lower costs and to increase the output. Thus good lighting might be said to be a good dividend paying investment by manufacturers. In this connection manufacturing and business houses will be interested in a beautifully printed pamphlet entitled: "Cause and Effect," which has been issued by the Benjamin Electric, Ltd., of Tariff-road, Tottenham, London, N.17, in which some typical lighting installations are shown. By the aid of correctly designed reflectors and fixtures the comfort, health and productivity of workmen are increased, and the interests of employers are enhanced by making labour efficient and profitable. The first view in the pamphlet shows a "safety first" installation by which all sharp shadows are eliminated, and the benches, machines, and everything in the shop are clearly shown without objectionable glare. A second installation shows a light of correct intensity and daylight for foundries, a third for the assembling shop, and there are others suitable for various kinds of workshops, sewing rooms, drawing tables, &c. In each case the installation is specially designed in order to provide for the special requirements of the work to be performed. The Benjamin Company, who are lighting experts and who have had a lengthy experience in the design and manufacture of reflectors and lighting fixtures, claim that by using the proper reflector and lamp to fit the conditions of each individual job, eye strain is reduced, the surroundings are made more cheerful, the work can be performed with less fatigue, order and neatness, as well as more effective superintendence and management increased, while there is approximately an increase of 12 per cent. in production, and 25 per cent. reduction in accidents.

Co-operative Housing Schemes.

Representatives of all the important organisations interested in the provision of working-class housing accommodation by means of public utility societies took part in a deputation which was received by Dr. Addison at the Ministry of Health. The deputation was organised by the Joint Housing Committee of the Federation of British Industries and the National Alliance of Employers and Employed, to point out to the Minister the impossibility of public utility societies undertaking building under the terms of the Act of 1919.

Sir ALGERNON FIRTH (a vice-president of the F.B.I. and chairman of the Joint Housing Committee) introduced the deputation, and submitted a statement reviewing the whole position. It was pointed out that the present rate of progress was not satisfactory, and that, despite announcements of the number of public utility societies who were content with the terms, few had proceeded with building. Many manufacturers were anxious to provide better living conditions for their employees by means of such societies, and there was evidence that groups of workpeople and co-operative societies would be willing to proceed if favourable terms were offered. At present there was no security that they would even get their money back if they put it into such a society, much less was there hope of any return upon it. One of the chief arguments for public utility societies was that the co-operative nature of these societies introduced a feeling of common interest between employers and their workpeople. If this object was to be achieved, it was essential that the tenants should be shareholders, and have a definite share in the management of a society. It was, however, impossible to secure co-operation if there were no dividends. The return on capital depended largely upon the rents which could be charged, and it was necessary that this point should be settled at once. The Joint Committee suggested that, if it were possible to ensure that private capital invested in public utility societies could be guaranteed some nominal return (say 4 per cent.) until such a time as rents were allowed to rise to their proper post-war economic level, it was probable that many would be willing to accept as a reasonable risk whatever might happen at the end of that period.

Capt. R. L. REISS, on behalf of the Garden Cities and Town Planning Association, said some 50 new societies had been registered by his Association this year, in addition to those existing before the war; but very few had found it possible to proceed. Numerous inquiries had been received, not only from employers, but also from workpeople and co-operative societies; but, in view of the unsatisfactory nature of the terms, his Association had felt bound to discourage these persons from forming societies. He protested against the rate of interest chargeable on loans to public utility societies being raised to 6 per cent., and explained that this would mean a 1s. per week increase in rents.

Mr. HENRY VIVIAN heartily approved of the proposals put forward by Sir Algernon Firth. He, however, desired to put forward an additional proposal—viz., that the State subsidy should be based on a grant of a definite sum per foot cube, and not on a percentage of the cost of building. Any other system would tend to increase costs.

Other speakers having made statements, Dr. ADDISON said he fully realised the difficulties of societies under present conditions, and promised to give sympathetic consideration to what had been said.

Coal for Electricity Works.

The following extracts from the Coal (Pit's Mouth) Prices Order and Direction of the 29th ult., which comes into force on Monday, will be of interest to our readers:—

Where coal is delivered to a gas or electricity undertaking the owners or secretary or manager may, when paying therefor, give a certificate either to the colliery owner or to the factor, dealer or merchant from whom they bought that a proportion of the said coal has been or will be used by them for making gas or electricity for domestic or household purposes and shall in that case be entitled to deduct 10s. per ton from the price in respect of such proportion. The proportion in respect of which such certificate may be given shall not exceed the proportion which the gas or electricity supplied by them for such purposes bears to their total output. Provided that the Controller may vary or prescribe the amount of coal in respect of which such deduction may be made as he in his absolute discretion thinks fit.

Every colliery owner and every factor, dealer or merchant and the owners of every gas or electricity undertaking shall, if and when required by the Controller, disclose to him any book kept by them containing entries in regard to coal bought or sold by them, and shall supply copies of any entries that the Controller may require verified in such manner as he may direct.

Coal shall be deemed to be bought or sold for domestic or household purposes only when it is bought or sold for the purpose of supply (either by re-sale or directly) customers under the provisions of the Household Fuel and Lighting Order, 1919, or any modification thereof.

Gas or electricity supplied for domestic or household purposes means gas or electricity supplied to any premises coming within, and for the purposes mentioned in, the said Order.

Whitley Councils.

A meeting of the District Council Electricity Supply (No. 6 Western Area) was held at Bristol on the 17th ult., Mr. H. Faraday Proctor in the chair. A sub-committee was appointed of four members on the employers' side and four on the employees' side to obtain information and to report to the Council on the consolidation of war advances and war bonuses into permanent rates of wages and on conditions of labour. A resolution was passed recommending the National Council for Electricity Supply to issue a notice to all electricity supply undertakings that the engineering award dated Nov. 5, 1919, of 5s. per week be paid, except in cases where it has been the practice to regulate the wages of the men concerned by other awards. A resolution was also passed recommending those undertakings which have not already done so to adopt the 47 and 48 hours working week.

On the 20th ult. the Northern tramway workers agreed to form a Joint Industrial Council, which has been elected as follows:—H. Graham (Newcastle), G. Ross (Sunderland), J. Bruce (Houghton-le-Spring), F. Derbyshire (Stockton), T. Foggin (Gateshead), C. Marchmant (Carlisle) and S. Newsome (Hartlepool). In case the membership of the Council is increased to ten, C. Dulton (Sunderland), W. Rushmere (Newcastle), and P. McNanan (Tyneside) were chosen as provisional members. Mr. J. Hind was appointed secretary to the Council.

Legal Intelligence.

Workmen's Compensation.

At the City of London Court, last week, the widow of a cable jointer, named Farrant, claimed £300 against the County of London Electric Supply Company, Ltd., as compensation for the death of her husband, who was killed in a switch room at the company's power station at Mitcham-lane. It was claimed that Farrant, who received a shock from an 11,000-volt cable, ought not to have gone into the switch room until he had ascertained that the power had been turned off, and that therefore the company was not liable.

Judgment was reserved.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 Specifications.

8,118 Hatfield & Hookham. Electrolytic meters. (31/3/14.)

1917 Specifications.

107,013 Guillou. Magnetos. (27/1/15.)
133,337 Western Electric Co. & Polinkowsky. (Western Electric Co. partly). Machine switching telephone systems. (17/12/17.)

1918 Specifications.

118,630 Remy Electric Co. Regulating devices for dynamo-electric machines. (10/7/17.)
118,631 Remy Electric Co. Regulating devices for dynamo-electric machines. (18/8/17.)
121,588 Chomier. Miners electric lamps. (17/12/17.)
127,229 Candlot. Apparatus for electromagnetically controlling jigging conveyors. (24/5/18.)
132,221 Alcock, Brander & Wagstaff. Electrical process for thawing carcases of frozen meat and the like. (5/9/18.)
133,338 Western Electric Co., Polinkowsky & Deakin. Semi-automatic telephone systems. (2/1/18.)
133 339 Berry. Electrical transformers for regulating or varying the voltage of the current supplied therefrom. (4/1/18.)

An arrangement wherein there is associated with tappings on a primary or secondary winding of a main transformer and a main regulating switch whereby the active length of the primary or secondary winding in circuit can be altered and the voltage of the secondary current correspondingly varied, an auto-transformer energised from the main transformer winding the voltage of which is to be regulated and a supplementary regulating switch, whereby the transformer can be utilised to still further vary the voltage of the secondary current supplied by the main transformer.

133,341 Western Electric Co. & Polinkowsky. Machine switching telephone systems (11/1/18.)

1919 Specifications.

123,096 Mollerhoj. Iron cores for electrc transformers, inductances and the like. (6/2/18.)
123,306 Soc. Electro Metallurgique Francaise. Electric furnaces. (11/2/18.)
132,224 Fagerlund. Electric switches. (6/9/18.)
133,081 Fessenden. Methods and apparatus for detecting low-frequency impulses. (21/5/17.)
133,083 Rogers & Lyon. Wireless signalling systems. (10/11/16.)

A wireless system for signalling by electro-magnetic waves, in which an antenna from the signal instrument is used. in which the antenna is placed on or under the surface of the earth or water, and in electrical contact therewith substantially throughout its entire length, thereby constituting a ground connection along such length and an additional grounded connection for said instrument.

133,092 B.T.-H. Co. (G.E. Co.) Electric furnaces. (9/2/18.)
133,099 Reid. Electrical furnaces. (13/3/18.)
115,839 Bosch Akt.-Ges. Double-current dynamo machines. (15/5/17.)
133,114 Palin. Apparatus for controlling electric circuits. (2/8/18.)
133,122 Hinrichsen. Combined push-button and automatic switch to be applied on electric flatirons. (19/9/18.)
133,135 Electrical Improvements, Ltd., & Beard. Electric reactance coils. (30/9/18.)
133,153 Tucker & Crabtree. Electric switches. (3/10/18.)
133,162 Ness. Electro-plating and electro-cleaning apparatus. (4/10/18.)
133,176 Brookes. Electric switch. (11/10/18.)
133,181 Edison Swan Electric Co. & Hiatt. Wireless telegraph valves. (14/10/18.)
133,187 B.T.-H. Co. & Wedmore. Protective devices for alternating electric current distribution systems. (17/10/18.)

Relates to a method of compensating for the lack of balance between the transformers, which consists in providing on the relays or tripping devices of the system, coils producing when excited by the current, forces tending to restrain the relays or tripping devices from operating, which forces are substantially proportional to the current in the feeder.

133,199 Robinson. Electrical switches. (31/10/18.)
133,200 Beaver, Richards & Claremont. Test sheath joint for electric cables. (31/10/18.)
133,220 Donovan & Donovan. Electric terminals suitable for switches and other electrical apparatus. (11/12/18.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

September 25, 1919.

23,576 Western Electric Co. Telephone, &c., transmission systems.
23,578 Chantler. Insulators for overhead wires, &c.
23,586 Ross. Electric fuses.
23,587 London. Electric heating apparatus.
23,590 Fuller & Gilbert. Holders for incandescent lamps.
23,599 Smith & Dorer. Electric lamp for vehicles.
23,613 B. T.-H. Co. G. E. Co.) Power transmission.
23,616 James. Variable limit switch for motors operating printing machinery.
23,623 James. (Submarine Signal & Co.) Electromagnetic oscillators.
23,629 Berwick & Sizaire. Ignition devices.
23,637 Pohle. Detecting use of incandescent lamps. (28/8/18, Germany.)
23,639 Hollister. Magneto-electric machines.
23,659 Tannahill. Ceiling, &c., roses.
23,663 Loring. Altering electrical conductivity of metals.

September 26, 1919.

23,675 Taylor. Obtaining currents of any frequency from three-phase systems of any frequency.
23,676 Taylor. Improving power factor of alternating current apparatus.
23,691 Metropolitan Vickers Electrical Co Steam turbines.
23,700 Taylor. Improving distribution on single-phase and two-phase systems.
23,701 Osborn. Spring motor for driving dynamos from windmill.
23,705 Pellery. Electric gas lighter and extinguisher.
23,722 de Becker. Incandescent lamps.
23,724 Taylor. Distribution in alternating current systems.
23,750 Mather & Platt & Hepburn. Bi-polar electrode electrolysers.
23,752 B. T.-H. Co. (G. E. Co.) High-frequency alternators.

September 27, 1919.

23,791 Sargent. Socket for electric light globes.
23,801 Brydon & Cusins. Wireless telegraphy and telephony, &c.

September 29, 1919.

23,845 Parsons. Electrically-operated diaphragm horns.
23,873 Berwick & Sizaire. Conduits for electric wires.
23,876 B. T.-H. Co. (G. E. Co.) Motor control systems.
23,891 Ruzicka. Detection of electrically conducting bodies.
23,906 Levy. Antiparasitic receiving and selecting system for telegraphy and telephony. (1/10/18, France.)

Commercial Topics.

Taxation of Road Vehicles.

The Ministry of Transport has formed a committee of 12 members, with Sir Henry Maybury as chairman, to consider and report upon various matters relating to road vehicles, including taxation, registration and licensing; design, construction and weight; speed limits, &c.

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Non-Ferrous Metal Stocks.

The Ministry of Munitions have the following stocks of non-ferrous materials (exclusive of old metal and scrap) in this country:—Copper, 18,492 tons; spelter (g.o.b.), 14,727 tons; spelter (refined), 11,563 tons; aluminium, 9,353 tons; soft pig lead, 64,832 tons; nickel, 2,100 tons; antimony regulus, 3,200 tons. A proportion of these stocks has, however, been sold to the trade for forward delivery.

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German Goods in Scandinavia.

It is reported that German competition for electrical contracts is becoming very keen in Sweden and Norway. Last month German firms secured a large order for machinery for factories in the North of Sweden, at a price half a million crowns lower than the lowest Swedish tender. Norway has also given orders to German manufacturers to the value of millions of crowns. Swedish factories previously had a very good market in Norway, but they are being ousted by Germans. Of the four large turbines at Raanaasfos power station in Norway three turbines have been ordered from Germany and one from Sweden.

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South African Electrical Supplies.

According to recent statistics, the value of the imports of electric materials, cable and wire into South Africa during 1918 was only £90,624, compared with £250,669 in 1913. The imports from the United Kingdom decreased in value from £170,293 in 1913 to £19,744 in 1918; but American imports increased from £4,977 to £32,026. A striking feature is the extraordinary position of Japanese imports in 1918. During that year the value of Japanese imports was £33,955, an amount greater than that of any other country, yet it was not until 1917 that Japanese manufacturers introduced their goods into the market, when the value of such imports amounted to only £142. In view of the inferior quality of Japanese supplies and the impossibility of relying upon goods being equal to sample, it is not thought likely that Japan will retain any permanent hold on the market.

* * * *

The South African Electrical Market.

The recent report of H.M. Trade Commissioner for South Africa (Mr. J. L. Wilson Goode) contains much that is of direct interest to electrical manufacturers and exporters. After referring to the increased competition of America and other countries, Mr. Goode gives a list of various public works which are projected. The Department of Posts and Telegraphs of the Union of South Africa is taking steps to extend and improve the telephone system. It is proposed to install at Johannesburg and at Cape Town automatic exchanges for 10,000 connections, and the provision of similar switchboards of a lesser capacity for use at other centres in the Union is under consideration. The Borough of Durban is negotiating for the acquisition of a site for a new power station, and new machinery is being installed at the old works. Maritzburg Corporation has under consideration the question of extensive additions to the electric generating plant which have been delayed owing to the war. The municipality of Mossel Bay is thinking of putting in electric lighting plant, but the projected scheme may be revised and extended.

The combined efforts of the local factories which have sprung into prominence, or into existence, since the commencement of the war have demonstrated the ability of South African manufacturers to meet the requirements of the mines in a way sufficient at least to maintain their operations to the extent of about 80 to 90 per cent. of their pre-war capacity; but the manufacture of special machinery, such as turbines, steam engines, pumps, &c., will in all probability be beyond the reach of the local manufacturing community for a number of years. In point of value, the imports into South Africa in 1913 were £765,986, of which the United Kingdom supplied goods to the value of £511,968, and the United States of America to the value of £161,191. German goods were valued at £73,939 and Danish goods at £11,273. In 1918 the total imports were valued at £569,448; the imports from the United Kingdom were valued at £292,123, but the imports of American machinery in 1918 were £271,730. The demand for all classes of mining machinery is very great, as is that for pumps used in connection with the mines. In this connection, attention is called to the advisability of introducing a British manufactured high-lift centrifugal pump for heads up to 2,000 ft. to 3,000 ft. The bulk of this business is in the hands of foreign manufacturers, notably a large firm of manufacturers in Switzerland.

Although the price of every class of electrical machinery rose beyond all expectations, the value of the imports in 1918 was only £126,323, compared with £451,280 in 1913, so that the actual quantity imported during 1918 was probably under 20 per cent. of the imports of 1913. The position of the United Kingdom was stronger in comparison in 1918 than in 1913, but it must be taken into consideration that, whereas in 1913 the imports from Germany were valued at £252,746, the imports in 1918 had discontinued. The imports from America in 1918 represented about half the total, whereas in 1913 they did not amount to 10 per cent. of the total. In many cases orders for electrical machinery were suspended during the period of the war, and Mr. Wilson-Goode is of opinion that a demand from the United Kingdom can now be looked for with confidence.

Electricity Supply.

Accrington Electricity Committee is purchasing a site in Henry-street, Church, for a sub-station.

Dover Corporation will extend its supply mains to the South Foreland Lighthouse, at a cost of £2,400.

Leicester Corporation has decided to purchase the Freeman's Meadow as a site for a new generating station.

A sum of £22,826 is to be expended upon electric supply extensions by Islington (London) Borough Council.

The Richmond (Yorks) Town Council has requested the Gas Committee to submit a report upon the question of electricity supply.

The Beccles Parish Church Council has decided to adopt electric lighting for the church.

It is proposed to increase the salary of the Nelson Borough Electrical Engineer and Tramway Manager by £50 a year.

The Scunthorpe and Frodingham Urban Council has instructed an electrical engineer to prepare an electric supply scheme.

Milnrow Urban Council has appointed a committee to consider the question of electricity supply for lighting and power in the district.

Manchester Corporation are recommended by the Electricity Committee to increase the charges for electric current as from Jan. 1 next.

Trowbridge Trades and Labour Council has passed a resolution urging the Urban Council to acquire the local electricity works. The right to purchase cannot, however, be exercised until 1932.

A Special Committee has been appointed by the Machynlleth Urban Council in order to report upon a proposal to utilise local water power in the generation of electrical energy for public and private lighting.

An inquiry was held at West Ham on Tuesday into the application of the Corporation for sanction to borrow £164,500 for extensions of the electricity undertaking.

Liverpool Corporation proposes to apply for sanction to borrow a further sum of £200,000 for additional generating plant, boilers, cooling towers, &c., in connection with the reconstruction of Lister-drive electric power station.

All previous records are being broken in the output at the Oldham Corporation Electricity Works. During the fortnight ending Nov. 19, the units generated were 749,879, against 553,292 for the corresponding period last year.

Owing to the present bad system of gas lighting at the Children's Home the Portsmouth Guardians have decided to introduce the electric light, and the Finance Committee has been asked to report upon the financial aspect of the question.

Ald. Wm. Bruce has resigned the chairmanship of the Sunderland Electricity Committee owing to continued ill health, and in his place Coun. R. J. Wilson, the vice-chairman, has been appointed chairman, with Coun. T. Speeding as vice-chairman.

Blackpool Electricity Committee has decided, on the suggestion of the electrical engineer (Mr. Chas. Furness) to apply for sanction to borrow £30,000 for new cables, &c., in order to be able to meet the increasing demands for electric current.

The Earl of Ellesmere is having additional electrical installations and renewals effected at collieries and workshops in the Worsley district. The Wigan Coal & Iron Company also contemplates putting down additional electrical plant and renewing existing plants at an early date.

The Urban Electric Supply Company has notified Grantham Corporation of its intention to increase meter rents by 1s. each per quarter, and to advance the price of current by contract by 2½d. per unit, plus the present percentage.

St. Pancras (London) Borough Council has adopted a recommendation of the Electricity and Public Lighting Committee to increase the charges for electricity. The new tariff will be as follows: Lighting, flat rate, 8d. per unit; power, 2d. per unit; heating supply, 2d. per unit (plus rental of meter, minimum charge 1s. 6d. per quarter).

Arrangements have been made by which the East Hetton and Trindon Grange Colliery Companies will light the streets and roads in East Hetton, Quarrington Hill, Cassop, South View and Kelloe by electricity, the companies to lay the cables and provide the plant for £800 per annum.

The Worcester Electricity Committee reports a brisk demand for electric power, and negotiations are proceeding for an additional 1½ million units per annum. It has also been decided to install an all-electric drive for pumping at the waterworks. For the first 300,000 units 1d. per unit will be paid, with a variable sum (based upon the labour and coal costs) per unit for the remainder.

The new Electrical Driven Winder which is in use at the Isabella pit of the Cowpen Coal Company, Blyth, was designed by the company's engineer, Mr. C. Hunter, and is capable of raising 150 tons per hour from a vertical depth of 900 ft. It is fitted with safety appliances which control the travel of the cage, and the most modern signalling apparatus has been provided. This is claimed to be the first electric winding engine used in Northumberland.

The accounts of Portsmouth electricity supply department for the year ended March 31 show revenue £60,103 (against £56,797 in previous year), working and general expenses £52,950 (£42,747), and gross profit £7,152 (£14,049), and, after providing for capital charges and income tax the net deficit was £12,824 (£8,118). Units generated were 4,125,780 and sold 3,097,704. Total maximum supply demanded was 2,200 kw.

In view of the heavy demand for electricity for power and lighting and to delay in the delivery of new plant Plymouth Electricity and Street Lighting Committee has asked power users to refrain as far as possible from using their motors between the hours of 3.45 p.m. and 5 p.m., and tradespeople to reduce their window and outside lights and to be as economical as possible in the consumption of electricity

An inquiry was held at Salford last week into the application of the Corporation for sanction to borrow £120,000 for electric pumping plant, screening chambers and detrition tanks at the sewage disposal works. The consulting engineer (Mr. James Diggle) stated that the electric pumps would effect a saving of between £50 and £60 a week on coal alone, and the Corporation intended to start on the work at the earliest possible moment.

Acting on the advice of the borough electrical engineer (Mr. C. H. Yeaman), Stoke-on-Trent Council has decided to apply for sanction to borrow £26,000 to enable him to carry out the necessary work for dispensing with the steam plant at the Burslem sub-station, and for the supply of cable, switchgear and plant to give further supply to the northern district. For switchgear room extension at the Stoke sub-works a sum of £4,000 is also to be borrowed, and as the capital expenditure has exceeded the loans sanctioned by £25,813, ait is proposed to borrow this sum together with £20,000 to cover prospective expenditure upon mains and services.

Nottingham manufacturers and traders are agitating for an increased supply of electrical energy for power and a deputation from the Notts & Derbyshire Traders' Association has waited upon the Electricity Committee in order to further the demand. Councillor J. Farr declared that more electricity was wanted quickly. It was urged that the Committee should get busy in an endeavour to bridge over the period between the present and the development of the Government scheme. Plant which should have been fixed by Sept. 30 was not likely to be ready until March, and would then not meet more than a normal year's demands.

Considerable extensions at the Warrington Corporation Electricity Works are foreshadowed. The works are unable to cope with the present demands. An interview has taken place between the local Electrical Contractors' Association and the Chairman of the Electricity Committee, in which the contractors put forward the difficulties they were having with regard to future customers, and it was agreed that prospective customers would be notified by the department as to the possibility of their being supplied on the completion of the extensions in hand. The committee will bring before the Council shortly a scheme of extensions estimated to cost at least £300,000), which will enable the undertaking to supply all demands.

A serious position has arisen in connection with the mills and works in Stalybridge, Mossley, Hyde and Dukinfield, which obtain their power from the Joint Board. Owing to the heavy load on the plant the mills will either have to reduce their working hours or reduce their consumption for a time. The Generating Station Committee met the large consumers (mostly cotton mills) and representatives of the trade unions last week, and it is expected that arrangements will be made whereby some portions of the mills or works will commence work at 6 a.m. and stop during the hours when the load is at its greatest. Orders for plant were placed early in the year, but the contractors for the boilers had not been able to carry out the work to time, and Councillor E. Bury states that the Board must proceed with the new station at Hartshead, because if the new plant on order had been erected it would scarcely meet the existing demands.

Owing to difficulties in connection with the supply of electricity for power at Bradford, the employers and representatives of trade unions connected with the textile trade have arranged a scheme for a change in the hours of the textile trade. Users of electric power are to be divided into two groups (group 1 being firms within a mile of the Town Hall, and group 2 being firms outside that radius) which shall work alternately 50½ hours one week and 45½ hours the next. Thus the ordinary number of hours per week (45) will still be maintained. The joint secretaries of the National Wool (and Allied) Textile Industrial Council (Mr. A. Shaw and Mr. G. H. Wood) and Mr. T. Roles (city electrical engineer) have drafted a circular to be sent to all firms concerned requesting them to be prepared to make the change on 24 hours' notice. The electricity department states that no change will be necessary until the termination of the moulders' strike. The alteration of hours will affect about 15,000 operatives, and will involve a reversion to earlier hours of commencing work. The present hours are from 7 a.m. to 5 p.m.

When the extensions which are at present being made to the Rotherham Corporation electricity works are completed the total capital outlay of the electricity department will exceed £1,000,000 and the capacity will be 100,000 h.p. The first instalment of the machinery at the new power station is ready for running, and the whole will be completed by about the middle of next year. The electrical engineer (Mr. E. Cross) states that the additional electrical power generated will probably be largely used for industrial purposes. He expects to generate a unit from every two pounds of coal. There is an era of prosperity dawning for Rotherham and the Don Valley, and electricity will be an important factor in the reconstruction and development of local industries. There are many vacant sites in Rotherham district and in the Don Valley which will, it is hoped, be taken up by manufacturers. Cheap power is a ruling factor in the consideration of a site for works and factories, and particularly in the heavy industrial trades it forms a heavy proportion of the total expenses. At present the Corporation are supplying electric power to a number of large works, but many more will take a supply when the extensions are completed.

Electric Traction.

Owing to pressure of business Ald. Russell Taylor has resigned the chairmanship of the Liverpool Tramways Committee.

Owing to increased wages and cost of material: the Birmingham & Midland Tramways Company intend to adopt a minimum fare of 1½d.

Sunderland Corporation tramcars will be run as usual on Christmas Day, but Burnley Tramways Committee will suspend the tramway service

A tramcar accident occurred at Burnley on Friday last. A car was proceeding towards Harle Syke along a steep incline in Briercliffe-road, when it began to slip backwards. The driver was apparently unable to prevent its backward career, and at a curve the car left the rails and overturned, resulting in injuries to four passengers.

It was reported at the meeting of Barrow Council on Monday that negotiations had been concluded between the Corporation and the British Electric Traction Company for the purchase of the local tramway system for £96,250. The lines will be taken over as from Jan. 1 next, and Mr. J. R. Groves, the present manager, will enter the service of the Corporation at £600 per annum.

The Special Tramways Committee of the Stoke-on-Trent Council recommend the Council to abandon the proposed purchase of the Potteries Electric Tramways Company's undertaking, and to promote a Bill for power to purchase and run motor omnibuses in the six federated towns of the Potteries and the adjoining districts. The Council recently decided to purchase the tramways at £737,000, the purchase money to be raised by loan and repayment extended over a period of 30 years.

The Stepney and St. Pancras Borough Councils have consented to the new tramway scheme of the London County Council so far as their boroughs are concerned, but Paddington and Westminster Councils as well as the City of London Corporation have decided to oppose.

An interesting discussion took place at the meeting of the London County Council on Tuesday upon a proposal "that no change be made in the principle, consistently followed by the Council since it began to operate tramways, of allocating to the account of the tramways a sum in respect of the cost of street widenings in cases in which the widenings are partly or entirely necessitated by tramway construction."

Sir John Benn moved an amendment which referred to the opinion expressed by the Council that inequitable differentiation in treatment existed between the Council tramways and other competitive forms of traction, and added: "The Council is not prepared to continue any longer to impose charges on its own tramway undertakings while effecting improvements for competing traffic free of all costs."

Mr. R. C. Norman, in the course of a somewhat illogical reply, said the sinking fund and interest for improvements were a comparatively small charge of £36,000 on the tramways in the last year, whereas two awards made with respect to tramway workers' wages had added £460,000 to the wages.

The amendment was defeated by 48 votes to 59.

Imperial and Foreign Notes.

The Mossell Bay (Cape Province) Town Council has decided to proceed with the electric supply scheme prepared by Mr. Charles G. Trevett, consulting engineer. The estimated cost is £30,000.

The classification of electric speed indicators or magneto-electric tachometers by the Japanese Customs Department has been revised. These goods are now subject to import duty of 20 per cent. ad val. under item 546 of the tariff.

The Bombay Municipal Council has passed a resolution urging that the Great Indian Peninsula and Bombay, Baroda & Central India Railways from Bombay to Kalyan and Virar respectively, should be electrified at an early date.

According to a Reuter telegram from Melbourne the Victoria Government has now decided to make an immediate start on the scheme for the development of the Morwell Brown coalfield in order to provide cheap electricity for Melbourne and other parts of the State The scheme involves an expenditure of three millions sterling.

It is proposed to adopt electric traction on the Dutch Railways between Rotterdam, the Hague, Amsterdam and Amersfoort.

The Commercial Cable Company has lodged a protest with the U.S.A. Government against the State-owned Cable laid across the Pacific, and states that on account of volcanic and other conditions the contemplated northern route by way of the Aleutian Islands would be an absolute failure.

It is announced that the French Government is urging the other allied Governments to create an International Commission for the purpose of distributing among the allies the supervision and management of the German Submarine Cables. After the Armistice France and Japan agreed that all war booty should be retained, but this view was not adhered to then by the United States, and a temporary agreement was reached under which the Emden–Vigo, the Monrovia–Lome and the Constantinople–Kustenji (Rumania) cables should be placed under British management; the Emden–Teneriffe, the Emden–Azores and Teneriffe–Pernambuco, the Emden–Brest and the Azores–New York cables reverting to the temporary direction of the French, and the Japanese controlling all the Far Eastern German cables. This situation obtains at present, but the French Peace Delegation is of opinion that the cables should be apportioned between the Allies, France retaining indefinitely those which she is now operating.

Miscellaneous.

At Manchester Assizes last week John Wm. Hewitt, formerly a cashier employed by the Manchester Corporation Tramways Department, was sentenced to three years' penal servitude for stealing money and falsifying accounts. The total defalcations, which began in April, 1916, amounted to about £5,000.

It is proposed to make Woolwich Arsenal a centre for building railway engines and rolling stock, so as to give employment to men in the district who are out of work. It is also reported that the manufacture of telephones and electric cables will be undertaken, and the necessary machinery for the equipment of the works has been ordered.

The Eastern Telegraph Company announces the following reduction of tariffs for telegrams over their system to places in British Africa:—Bathurst and Sierra Leone, 2s. 6d. per word; Accra, Lagos and Bonny, 3s.; Union of South Africa, Mauritius, Seychelles and Zanzibar, 2s.; British East Africa - Mombasa, 2s.; other places, 2s. 3d.; other places East Africa (formerly German East Africa), 2s. 3d.

The ballot of the Engineering Trade Unions on the amalgamation proposals shows 239,645 votes were cast in favour of the scheme and 42,665 against. The object of the scheme is to include in one union 500,000 workers, with funds amounting to nearly £3,500,000. Eight societies succeeded in securing the number of votes required to give force to the decision, but seven societies failed to do so.

The Minister of Munitions has revoked the certificates given at various dates by him under Sect 9 (1D) of the Munitions of War Amendment Act, 1916, that the supply of light, heat or power or the supply of tramway facilities (given by the electricity supply and tramway undertakings set out in schedules to the order) was important for the purpose of carrying on munition work.

Mr. H. E. Blain, manager of the Underground Railways, who read a Paper on the "Safety First" scheme at the recently Roads Transport Congress and Exhibition, Royal Agricultural Hall, Islington, stated that since 1916, when the London "Safety First" Council was formed, there had been a steady decrease in the number of accidents in the streets and on the railways. The movement had since spread to factories and workshops, and one firm had reduced its first aid costs from £1,300 to £600 as a result of the "safety first" measures it had taken. Another firm had reduced its accident payments by over £50,000 per annum.

Owing to the passing of the Industrial Courts Act, the Interim Court of Arbitration has now ceased to exist, and will be replaced by a standing arbitration tribunal called the Industrial Court. The Interim Court came into being on the passing of the Wages (Temporary Regulation) Act in November, 1918, and has made 930 awards, while they have advised the Minister of Labour on 50 occasions on matters relating to wages and conditions of employment. The experience gained both from the work of the Committee on Production and from the Interim Court gives ground for hoping that the permanent Industrial Court now established will meet a public need of the greatest importance.

The Postmaster-General has stated that the rates for ordinary telegrams are not remunerative and there is no prospect of their being reduced. The higher charge for Press telegrams (2s. 6d. per 75 words before 6 p.m. and 2s. 6d. per 100 words after 6 p.m. plus 8d. for each address after the first) were proposed by the Retrenchment Committee, not by the Post Office. The recommendation was not accepted by the Government, the lower scale of increased rates having been adopted in its place and embodied in the Telegraph Act, 1915. The Government decided to postpone the operation of those rates—which will come into effect on January 1—because it was thought undesirable to restrict the dissemination of news during the war. The amount by which the revenue from the lower Press rates will fall below the revenue anticipated from the higher rates was about £180,000 per annum.

One of the outstanding features at the "Ediswan" Works, Ponders End, is the happy relations and good feeling existing amongst the employees. This is fostered and engendered by the "Ediswan" Staff Association, and other organisations of a kindred nature at these extensive works. The Staff Association recently provided an admirable concert for the members and their friends, which was largely attended and much appreciated. The chairman of the association (Mr. J. Bacon) presided, and congratulated the Committee on the success of the concert. The artistes provided a most enjoyable programme.

On a recent evening Ediswan Cricket Club held its annual dinner and concert in the Staff Café, the chair and vice-chair being occupied respectively by Mr. J. Bacon and Dr. C. E. Hiatt. An excellent dinner was served. In a short speech the chairman traced the history of the club since its formation in 1907. The first secretary (Mr. T. S. Read) put the club on a firm basis; but in 1909 he was succeeded as secretary by Mr. E. Russell, and the club's success steadily improved from a financial and a playing point of view down to 1914. During the war the men had been playing a far sterner game. They had been able to resume play this year, and had had a most successful season. They had a playing membership of 34 and an honorary membership of 29. He presented the prizes as follows: Highest batting and bowling average 1st team, case of razors to Mr. Len Orme and Mr. S. Gilks respectively; second prize for bowling average, 1st team, silver medal, Mr. J. Fay; highest batting and bowling average, 2nd team, brief bag, to Mr. L. V. Cordell, and biscuit barrel to Mr. W. Cowley. Mr. E. Russell, hon. secretary, was presented with a set of gold cuff links and studs. An enjoyable musical programme was furnished, under the direction of Mr. E. S. Anderton.

Tenders Invited and Accepted.

Bournemouth Tramway Committee require tenders by noon Dec. 15 for the supply of 20 bogie electric tramcars. Specifications, etc., from the general manager.

Manchester Tramways Committee want tenders by 10 a.m. Dec. 9, for electric tramcar bodies and copper rail bands. Specifications from the general manager.

Wallasey Tramways Committee require tenders by Dec. 14 for supply of 350 tons of tram rails and 150 pairs of fishplates. Specifications from the borough engineer.

Sydney (N.S.W.) Electric Lighting Department require tenders by 3 p.m. Jan. 19 for supply of sub-station equipment (except power transformers) (contract 558). Specifications from the City Electrical Engineer.

The Dublin Port and Docks Board require tenders by the morning of Dec. 10 for 12 months' electrical supplies, castings, ironmongery, oils, &c. Forms from the Secretary, Westmoreland-street, Dublin.

The Clyde Navigation Trustees require tenders by Dec. 30 for electrically driven re-watering pumps for 1, 2, and 3 graving docks, Govan. Specifications from Messrs. Walter Bridges & Company, 3, Salters Hall-court, London, E.C. 4.

Londonderry Corporation invite tenders for the supply of two 500 kw. rotary converters, with transformers, e.h.t. cubicles, with switchgear, l.t. d.c. panels, connecting cables, &c. Specifications from Mr. R. V. Macrory, M.I.E.E., city electrical engineer, and tenders to Mr. F. H. Miller, town clerk, by Dec. 13.

New South Wales Government Railways and Tramways Department invite tenders for manufacture and delivery at Glebe Island, Sydney, of 70 3-phase induction motors for terminal wheat elevator. Specification from the office of the Electrical Engineer of the Department, 61, Hunter-street, Sydney, and tenders to the Chief Commissioner for Railways and Tramways, Philip-street, Sydney, by noon Jan. 14.

Stoke-on-Trent Corporation has accepted the tender of the Davenport Engineering Company for the supply and erection of two cooling towers, capable of dealing with 400,000 gallons of circulating water per hour, with mass concrete foundations and pond, for £9,576; and that of the New Conveyor Company for conveyor and elevator plant at the Central power house at £9,718 5s.

The following tenders were accepted by the British Government Departments during October:—*Ministry of Munitions.*—General Electric Company, rewinding, testing, &c., of turbo-alternator. *India Office.*—Peel-Connor Telephone Works, telephone apparatus; Elliott Bros., Baudot apparatus; F. Smith & Company, Shropshire Iron Company and T. Bolton & Sons, bronze wire; British Westinghouse Electric & Mfg. Company, cleats; Siemens Bros. & Company, cable; Taylor, Tunnicliff & Company, insulator cups; J. Stone & Company, dynamos; Lancashire Dynamo Company, motor engines, &c.; Veritys Ltd., fans, &c.; Bullers, Ltd., insulators; Newton & Wright, radioscopic stands; Creed & Company, transmitters. *Post Office.*—Western Electric Company, telephone exchange equipment extension, Dublin, protective apparatus and telephone apparatus; Phœnix Telephone & Electric Works, protective apparatus; Automatic Telephone Mfg. Company, Peel-Connor Telephone Mfg. Company and Siemens Bros. & Company, telephone apparatus; Connollys (Blackley) Ltd. and Siemans Bros. & Company, telegraph and telephone cable; Siemens Bros. & Company, Léclanche cells; India Rubber, Gutta Percha & Telegraph Works Company and Western Electric Company, coating brass bodies with ebonite; Phœnix Telephone & Electric Works and Siemens Bros. & Company, telephone cords; Bullers Ltd. and Taylor, Tunnicliff & Company, insulators; Bayliss, Jones & Bayliss, insulator spindles; Spartan Mfg. Company, cable suspenders; British Insulated & Helsby Cables, insulated bronze wire; T. Bolton & Sons, R. Johnson & Nephew, Shropshire Iron Company, F. Smith & Company, and Wilkes, Sons & Mapplebeck, copper wire. *Crown Agents for the Colonies.*—General Electric Company, electric fittings; British L. M. Ericsson Mfg. Company and Siemens Bros. & Company, telephones, &c.; Hooper's Telegraph & India Rubber Works, insulated wire; Marconi's Wireless Telegraph Company, wireless set. *Public Works* (Ireland).—Handley & Robinson, electrical works and supplies, Dublin district.

Appointments Vacant.

A senior lecturer and demonstrator in electrical engineering is required at Armstrong College, Newcastle-on-Tyne. Applications by Dec. 11.

A senior lecturer in physics is required at Portsmouth Municipal College. Salary £250-£10-£300, then by £25 each four years to £400. Applications to the Secretary.

A junior lecturer and demonstrator in physics is required at University College, Nottingham. Salary £200. Applications to Registrar by Dec. 8.

A lecturer in Physics is required at the University of Cape Town. Salary £350 to £450 with war bonus. Applications to the Secretary, Office of the High Commissioner for the Union of South Africa, 32, Victoria-street, S.W. 1, by Dec. 11.

A chief lecturer in electrical engineering (salary £300-£10-£450 per annum) and an assistant lecturer in physics (£250-£10-£350) are required at West Ham Municipal Technical Institute. Applications to the Principal, Romford-road, Stratford, E.15, by Dec. 15.

Applications are invited for the position of assistant in the electrical engineering department of the Sunderland Technical College. Commencing salary £250-£370, with annual increments of £15 to £400, and of £10 to £450. Applications to the chief education officer, Mr. Herbert Reed, by Dec. 17.

Business Items.

Messrs. Howarth Bros. have commenced business at 79, High-street, Bromley, as electric lighting and power engineers and contractors.

Messrs. T. J. Grainger & Company, electrical engineers, have removed to 31, Side, Newcastle-on-Tyne. Telephone, Central 3474.

Neville Wallace Gilbert and Trevor Watts White (trading as the Gilbert White Engineering Company), electrical and motor engineers, 33, King's-road, Hay Mills, Birmingham, have dissolved partnership.

The British Glass Industries, Ltd., is making rapid progress with its scheme of development. In addition to the acquisition of several well established glassworks, the company is proceeding with the extension of a modern glass factory in Canning Town.

In the sale by auction at the Laira Naval Store, Plymouth, on the 16th inst. there are miscellaneous assortment of engineers' tools, electrical appliances, miscellaneous stores, &c. Catalogues from the Auctioneers, Messrs. Woolland, Son & Manico, 5, Frankfort-street, Plymouth.

The partnership between Joseph Harton, Joseph Osbaldiston and Geo. H. McMillen (trading as The Shire Arc Welding Company), 31, Fear Hill-rise, Nottingham, has been dissolved. Debts to Messrs. Harton and McMillen, who continue the business as the Shire Arc Welding Company at the same address.

The Monometer Mfg. Company (1918), Ltd., engineers and furnace makers, have removed their works to Browning-street, Birmingham. Telephone number: Midland 553, but the telegraphic address remains "Monometer." The Monometer Company are also the proprietors of the Griffin Ironworks and Albion Foundries.

The Quasi Arc Company, Ltd., of 3, Laurence Pountney Hill, E.C. 4, has issued a pamphlet on the quasi-arc process of electric welding which has been approved for ships construction by Lloyd's Register of Shipping and the British Corporation for the Survey and Registry of Shipping. The pamphlet contains particulars of welded ship construction ascertained during the construction of the first vessel built entirely by electric welding.

In a leaflet issued by the Automatic & Electric Furnaces, Ltd., 28-3 Gray's Inn-road, W.C.1, particulars are given of the company's new electric radiation furnace, which is essentially an upright cylinder, in which the work is suspended, the heat being entirely conveyed to the work by uniform radiation from the cylinder wall. It is claimed that these furnaces give quick and uniform heating, and other advantages are cleanliness, absence of noise and fumes, certainty and simplicity of operation, and small heat losses. Bulletin No. 16, on the magnetic electrometer and its uses (Part III.) has also been issued by the company

Just before the war Messrs. J. H. Tucker & Company, of Birmingham, completed a new pattern 5-ampere flat type tumbler switch having both a quick "make" and a quick "break" action. Owing to the war the firm were prevented from bringing the switch to the notice of the electrical trade and offering it for general sale. Large quantities have, however, been used during the last four years by various Government Departments, and having now finished all Government contracts they are now offering the switch to the trade for general lighting purposes. Although possessing both a quick "make" and a quick "break" action it is identical in size and external appearance with the usual flat type tumbler switch possessing a quick "break" action only. The advantages of a switch possessing both a quick "make" and a quick "break" action are obvious, and it is put forward as representing probably the ideal type of switch for general domestic purposes. It is supplied in either polished brass finish or the usual fancy finishes.

We have received from Messrs. Credenda Conduits Company, Ltd., a copy of their new season's list of electric fires. Special attention is drawn to a new portable electric heater of very low loading (600 watts), which, being fitted with an adjustable copper reflector, enables the heat to be focused in any required direction. This heater can also be used for heating liquids, and is altogether a handy and useful form of heater for local use, and should have a large sale.

We have also received from the same source a booklet dealing with a new electric oven, which claims to be the most economical in use of current yet devised; the claims are based upon the fact that the heat insulation is as nearly perfect as is possible, and the door being provided with a spring and wedge contact precludes the possibility of any loss of heat in this most fruitful source of such loss. Copies of either booklet will be sent on request by Messrs. Credenda Conduits Company, Whitehouse-street, Aston, Birmingham.

The children of to-day are the buyers of to-morrow. Realising this fact, the B.T.-H. Company, as an item in their new season's Publicity Campaign, have issued a most attractive painting book, addressed primarily to children, but containing a moral for light users of all ages. The text of the booklet consists of a story describing in simple terms the mythological origin of the word "Mazda," which in ancient Persian means the "Supreme Light." A number of line drawings are employed to illustrate the progress and issue of the age-long combat between "Mazda"—the spirit of light—and the swart and malevolent "Angro," who personifies the darkness which has been finally routed by the "Mazda" half-watt lamp. These pictures afford an opportunity for the artist of tender years to exercise his embryo talent with crayon or brush. The paper used in the painting book has been specially selected to take water colours properly. Limited quantities of the booklet, entitled "The Meaning of Mazda" (L. 129), will be supplied overprinted with contractors' names and addresses, on application to the Company, 77, Upper Thames-street, London, E.C. 4.

Companies' Reports, &c.

The Globe Telegraph & Trust Company has declared a quarterly interim dividend on the ordinary shares of 2s. per share, tax free.

The accounts of the Montevideo Telephone Company, Ltd., for the year ended July 31, show a profit of £38,347, and including £8,427 brought forward, an available sum of £46,775. After writing off £10,000 for depreciation, and placing £16,954 to reserve, the directors recommend a final dividend of 3 per cent., leaving £8,963 to be carried forward.

The directors of the Western Telegraph Company, Ltd., have declared the first quarterly interim dividend of 3s. per share, tax free, for the year ending June 30, 1920, being at the rate of 6 per cent. per annum. The transfer books of the company will be closed from the 12th to the 19th inst. inclusive, and the dividend will be payable on the 20th inst.

The report of the West African Telegraph Company, Ltd., for the year 1918 last states that the revenue amounted to £67,528, from which is dedcuted £19,909 for ordinary expenses and £31,436 for expenditure relating to maintenance of cables, &c., leaving a balance of £16,182, to which is added £50 brought forward, making £16,232. The sum of £6,000 has been transferred to general reserve. An additional dividend of 2 per cent. was paid in May, bringing the total distribution for the year up to 4 per cent. (tax free), as in 1917, £90 being carried forward.

At the meeting of the Castner-Kellner Alkali Company, Ltd., last week, it was stated that for the year ended Sept. 30 last that the net profit, after allowing for amount required for maintaining the works and machinery is £190,655, and with £48,819 brought in the total is £239,474. Deducting debenture interest (£7,598) and interim dividend (£60,000) available balance is £171,876. The directors recommend placing £50,000 to depreciation reserve, and a final dividend of £7 per cent., making £13 per cent. for year, leaving £51,876 to be carried forward.

The Newcastle-on-Tyne Electric Supply Company, Ltd., is making an issue of 1,500,000 7½ per cent. cumulative preference shares of £1 each at par in order to meet expenditure on extensions and to repay temporary loans. New generating plant has been put down which, it is anticipated, will save at least £60,000 during 1920 and over £100,000 if the new plant were working for the full year. This estimated saving together with the saving of interest on bank loans to be repaid, will cover about four-fifths of the amount required for dividends on the present issue.

For the year ending June 30, 1919, the profit of the Cape Electric Tramways, Ltd., was £90,864 10s. 11d., and after providing for debenture interest and redemption of debentures, taking into account the balance from last year, and placing £12,000 to reserve, the balance is £35,766 14s. 7d. The directors recommend payment of a dividend of 5 per cent. on the ordinary share capital, leaving £11,205 12s. 7d. to be carried forward. During the year under 27,993,276 passengers were carried, giving a return of £301,791 16s. 6d., against 26,444,465 passengers, earning £264,137 18s. 6d. in 1917-18. Working expenditure has continued to rise owing to higher cost of supplies and materials, and to further increases in wages.

At an extraording meeting of Marconi's Wireless Telegraph Company, Ltd., last week the resolution passed on the 13th ult. for an increase in the capital was confirmed. Mr. Godfrey C. Issacs, who presided, referred to the Committee recently appointed to consider and report on a scheme of Imperial wireless communications in the light of modern wireless science and Imperial needs. When the requisite information was in the possession of the Cabinet, he understood they would then decide whether or not the stations would be erected for account of the State, or whether private enterprise would be licensed to erect them for their own account, or, as a possible third alternative, whether they would be erected by private enterprise conjointly with the State with State control. He hoped it was a step towards securing for the Empire a chain of wireless stations of the latest and best system. His company alone possessed for the British Empire all the efficient commercial wireless systems, besides having the sole right of all new patents and improvements in those systems.

Referring to the Post Office licences for wireless students, he understood that certain restrictions would necessarily be imposed in respect of transmission work, and thought that the Post Office would have to be satisfied as to the nature of the transmission work that any student was desirous of doing. The whole object of the facilities granted by the Post Office was to give the students the opportunities they required to develop their knowledge, understanding and learning of wireless telegraphy. He had not seen an announcement to the effect that the Post Office had invited students to use the Post Office installations for acquiring knowledge of wireless telegraphy. He felt quite certain that such an announcement had not been made, as it would be a practical impossibility for the Post Office to place their installations at the disposal of the students as their stations had other work to do.

We learn that at the recent statutory meeting of the Aladdin Renew Electric Lamp Corporation, Ltd., the chairman (Sir Harry Foster, J.P., D.L.) gave some particulars of the financial position and progress made by the company, which was formed to acquire the business of the Renew Electric Lamp Company, Ltd., including the world rights of the invention of Mr. F. Harrison and others for permitting the repair or renewal of a broken filament in an electric lamp bulb. It had been computed that in the United Kingdom alone more than 50,000,000 bulbs whose filament had gone were destroyed annually. The Renew Company clearly established the practical and commercial value of Mr. Harrison's various patented processes for effecting the salvage of lamp bulbs, and the present Company had secured the necessary capital for developing it on a sufficient scale to render a real service to consumers. The capacity of their Harrow-road works had been trebled by taking over the two adjoining buildings, and they hoped that a factory which had been fitted up in the centre of Birmingham with a capacity of over a million lamps per annum, would be running by the new year. They had been hung up in the delivery of appliances ordered many months ago from the manufacturers, owing to the unwillingness of labour to produce. He hoped they might not take too long to learn that a fair day's wage required a fair day's work, and that labour would never be able for long to take out of an industry what it did not put in. When their new works had been fully organised, they hoped to be able to cope with orders which at present they were obliged to refuse, and to extend their operations to Manchester, Bristol and Glasgow, The renewed lamps had been submitted to independent trials, side by side with new lamps, by Messrs. Kynochs, and at Faraday House School. Messrs. Kynochs tested eight renewed lamps against eight new lamps. Of the new lamps four failed to reach the guaranteed life of 1,000 hours, and the remaining four burned out—one in 1,031 hours, one in 1,309, one in 1,467 and one in 1,720 hours. Of the renewed lamps, one burned out in the cap within a few hours owing to some defect in the cap and not in the renewal process, and one after 553 hours. Of the remaining six, two burned out in 1,550 hours, one in 1,701, one in 1,890, one in 2,100 and one in 3,200 hours. The average life of the renewed lamp was, therefore, about 60 per cent. higher, and the consumption of current per candle-power was substantially less. The Faraday House comparative test of three renewed lamps for 1,000 hours against three new lamps of a well-known maker showed that the new lamps consumed, light for light, 24·8 per cent. more electricity. They owned patent rights all over the world, and those rights have been greatly extended in the few months of their existence by various improvements; they had secured the services as technical adviser of Mr. Harrison, the inventor, who had had over 30 years' practical experience of lamp manufacture. They had sold the rights for New Zealand for a sum in cash and a guaranteed minimum royalty, and they had granted options based on a cash payment and a royalty in respect of other countries, including France, Switzerland, India, Canada and Australia. The process of renewal was done by female labour and by piece work.

At the annual meeting of the Nitrogen Products and Carbide Company, Ltd., last week, the chairman, Major C. H. Campbell, dealt with the progress of the company and the proposed amalgamation with the Alby United Carbide Factories, Ltd. Substantial progress had already been made with the harnessing of the Aura water power, which, when fully developed, is capable of giving over 250,000 h.p. per annum. At Sundalena, where the great power station will be situated, they owned about 500 acres of good level land suitable for the construction of factories and housing accommodation. As time went on water-power was assuming greater and greater importance. With the ever-increasing cost of coal and labour the situation had completely changed. Their companies were in a very fortunate position. For instance, at present the Alby Company's works at Odda, Norway, were supplied to the extent of about 65,000 h.p. per annum. The Aura power had a total capacity of about 250,000 h.p., and Dettitoss, in Iceland, had a capacity of at least 400,000 h.p., as yet unharnessed. That made a total of over 700,000 h.p., and, from the point of view of coal-saving in England, it was interesting to note that the same power, generated from coal, would entail a consumption of at least 4,500,000 tons per annum. It was the intention of the company to concentrate its energies on the development in Norway of such processes as required no coal, or to so perfect the process that the coal required was cut down to a minimum. It was also intended to utilise their water-power for the treatment of minerals containing phosphorous for the production of a fertiliser. Their researches had shown that it was possible, with cheap power, to produce nitrate of soda without recourse to any imported raw material.

Within the past few years considerable progress had been made in the electrical smelting of iron ore. When it was considered that practically all the iron used in Great Britain was smelted by means of coal, or rather coke produced from coal, and that a large proportion of the raw ore was imported, thereby consuming more coal, it was evident that electrical smelting should be employed where such was economically possible. In the present state of the industry it was not possible, even with electrical smelting, to entirely dispense with the use of coal, but the portion used was much less than in the case of blast furnace practice with coke. In Norway there were large deposits of iron ore, which did not lend themselves readily to the ordinary process of blast furnace smelting, but which had been successfully treated by electrical methods. It was on such ores that their researches had been directed. They were also investigating the manufacture of cyanides and sodium cyanide. The directors had continued the extensive trials and tests referred to in the last annual report, with the object of ascertaining the most economical means of producing power from coal, and at the same time economising this national source of wealth. The directors examined various collieries, and had purchased the St. Helen's colliery and brickworks at Workington, in Cumberland.

The report and accounts were approved, and at an extraordinary meeting it was resolved to effect an amalgamation with Alby United Carbide Factories, Ltd., and that with a view thereto Nitrogen Products and Carbide Company, Ltd., be wound up voluntarily.

New Companies.

J. H. BROWN, LTD. (160,647)—Private company. Reg. Nov. 15, capital £3,000 in £1 shares, to take over the business of motor and electrical engineers carried on by J. H. Brown and D. G. Gaywood as J. H. Brown. First directors are J. H. Brown, D. G. Gaywood and R. Cleave. Reg. office: 1, Charlwood-street, Pimlico, S.W.

F. W. COOK & COMPANY (SOUTHAMPTON), LTD. (160,675)—Private company. Reg. Nov. 17, capital £10,000 in £1 shares, to take over the business of an electrical engineer, gas and hot water engineer, &c., carried on at Southampton as F. W. Cook & Company. First directors are F. W. Cook (permanent managing director and chairman), E. A. Smith, R. H. Burkett, F. B. While and W. Small. Reg. office: 23-4, Bargate-street, Southampton.

CO-OPERATING CONTRACTORS SYNDICATE, LTD. (160,221)—Private company. Reg. Nov. 1, capital £1,200 in 1,000 ordinary shares of £1 each and 4,000 deferred shares of 1s. Objects: To acquire concessions, rights or privileges for the construction, extension and operation of railways, tramways, harbours, docks and other public and private works, &c. Sec.: E. R. D. James. Reg. office: 45, Finsbury-pavement, E.C.2.

DERBY GARAGE, LTD. (160,101).—Private company. Reg. Oct. 29, capital £5,000 in £1 shares. Objects: to carry on the business of manufacturers of and dealers in automobiles, parts and accessories, automobile, electrical and general engineers, &c. First directors are A. J. Nicholls, W. H. Jones, T. Porter and R. F. Brownson. Secretary: W. H. Jones. Reg. office: York Garages, Railway Terrace, Derby.

DOWDING & MILLS, LTD. (160,837)—Private company. Reg. Nov. 21, capital £3,000 in £1 shares, to take over the business of manufacturing and mechanical engineers carried on as Dowding & Mills. First directors are W. H. P. Dowding, H. L. Mills, R. Lowe and E. B. Dinenage (all permanent). Reg. office: 193, Camp-hill, Bordesley, Birmingham.

NEWCASTLE TELEPHONE (NEW SERIES) COMPANY, LTD. (160,814)—Private company. Reg. Nov. 26, capital £1,000 in £1 shares, to carry on the business indicated by the title. First directors are F. T. Jackson (permanent managing director and chairman) and C. Cochran. Sec., F. T. Jackson. Reg. office: Rollingsworth Works, Martell-road, West Dulwich, S.E.

PIMM & BURROWS, LTD. (160,632)—Private company. Reg. Nov. 5, capital £1,000 in £1 shares, to carry on the business of consulting, mechanical, gas and electrical engineers, iron and brass founders, tool makers, &c., and to enter into an agreement with A. W. Pimm and L. Burrows. First directors are A. W. Pimm and L. Burrows. Reg. office: 36, Southwark Bridge-road, S.E.1.

SOUTH WALES & MONMOUTHSHIRE TELEPHONE (NEW SYSTEM) COMPANY, LTD. Private company. Nominal capital £1,000 in £1 shares. The objects are as indicated by the title. The first directors are F. T. Jackson (secretary) and C. Cochran. Reg. office: Hollingsworth Works, Martell-road, West Dulwich, S.E.

The following have also been registered, the particulars being similar to the above, viz.:—

BRISTOL & WEST OF ENGLAND TELEPHONE (NEW SYSTEM) COMPANY, LTD. (160,218).

LIVERPOOL TELEPHONE (NEW SYSTEM) COMPANY, LTD. (160,227).

SHEFFIELD TELEPHONE (NEW SYSTEM) COMPANY, LTD. (160,232).

Prices of Metals, Chemicals, &c.

Tuesday, Dec. 2.

		Price.	Inc.	Dec
Copper—				
Best selected.........	per ton	£105 0 0	—	£8 0 0
Electrolytic bars ...	,,	£107 0 0	—	£8 0 0
H.C. wire basis......	per lb.	1s. $2\frac{7}{16}$d.	—	$\frac{15}{16}$d.
Sheet	,,	1s. $3\frac{3}{4}$d.	—	$\frac{5}{16}$d.
Phosphor-bronze Wire—				
Phosphor bronze wire, basis	,,	1s. $6\frac{7}{16}$d.	—	$\frac{15}{16}$d.
Brass 60/40—				
Rod, basis	,,	0s. 11d	—	$\frac{7}{16}$d.
Sheet, basis	,,	1s. $2\frac{3}{8}$d.	—	$\frac{1}{4}$d.
Wire, basis	,,	1s. $2\frac{1}{4}$d.	—	$\frac{1}{4}$d.
Iron—				
Cleveland Warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	£32 10 0	—	—
Lead Pig—				
English	,,	39 0 0	£1 5 0	—
Foreign or colonial	,,	38 0 0	£1 0 0	—
Tin—Ingot	,,	£95 5 0	£6 5 0	—
Wire, basis	per lb.	0 3 $7\frac{1}{2}$	$\frac{1}{2}$d.	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £22 10s.

Sulphuric Acid (Pyritos, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40.

Boric Acid (Crystals).—Per ton, £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6d.

Shellac.—575s.-580s.

Rubber.—Para fine, 2s. $6\frac{1}{4}$d.; plantation 1st. latex 2s. $5\frac{1}{2}$d. lb

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W. T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From The Electrician, Dec. 2, 1882.]

Throwing Stones at Telegraph Posts.—At the Dewsbury (Yorks) West Riding Police Court the other day four boys, residing at Liversedge, paid 10s. each and costs, with the alternative of one month's imprisonment, as the price of a few minutes' stone practice at telegraph poles.

Gas Fired by Lightning.—During a thunderstorm on Friday week a curious occurrence took place at Bridge of Weir Station, Scotland. The lightning entered the signal cabin and ruptured a gaspipe, setting fire to the gas when liberated. The woodwork took fire, but the flames, being observed, were at once extinguished.

Electric Lighting in Manchester.—Messrs. G. & R. Dewhurst, one of the leading firms of Manchester, are lighting their warehouses with 12 Pilsen arc lights, 200 incandescent and some Joel semi-incandescent lamps. Messrs. Woodhouse & Rawson have been appointed by the Pilsen, Joel and General Company to carry out this work.

Professor Palmieri.—Very recently we announced, on the faith of a French contemporary, the death of Prof. Palmieri, of the Vesuvius Observatory. Since then we have seen his death recorded in several papers. Within the last few days, however, it has been stated, on the authority of Messrs. Negretti & Zambra, that the professor is in his usual health, and that in all probability the report of his death originated in the fact that his nephew died recently. We are very glad to record the fact that Prof. Palmieri is still with us, and hope he may have many more years of activity before him.

Swan Lamps and the Russian Government.—We have the best authority for stating that the following paragraph, published a day or two since in the "Daily Telegraph" money article, has no foundation in fact. The paragraph is as follows: "It is stated that the Swan United Electric Light Company have sold to the Russian Government for £100,000 in cash the exclusive right to use their invention throughout the empire, and to sell their lamps. There can be little doubt that the employment of the electric light in the larger cities and towns of Russia could be made a most lucrative State monopoly. The company's paid-up capital is £160,000 in 80,000 shares, the quotation of which to-day was $2\frac{1}{8}$, $\frac{3}{8}$."

Charing Cross Electric Railway.—Notice has been given of intention to apply for a Bill in the ensuing session empowering the construction of a railway from Cockspur-street, Charing Cross, near King Charles's statue, and joining the railway authorised by the "Charing Cross and Waterloo Electric Railway Act, 1882"; also another railway forming a junction with the above electric railway near Belvedere-crescent, and terminating in the parish of Christchurch, Southwark, S.E., near the Blackfriars-road; also other railways in continuation of the above, which will finally terminate close to the Royal Exchange in Cornhill, E.C. The Bill will also authorise the London & South-Western Railway Company to contribute towards the cost of constructing the above intended railways.

Electric Light at Birmingham.—The stand of Messrs. Tangye at the Birmingham Cattle and Poultry Show, which was held from Nov. 25 to 30, in Bingley Hall, was lighted by means of Edison lamps, some 60 or 70 of which were used. Two Edison dynamos, one 60 light and another 15 light, were driven by means of Messrs. Tangye's coupled gas engines of $2\frac{1}{2}$ h.p. In these engines there are two impulses at each revolution, and consequently steady working is obtained, this being, as everybody knows, of the utmost necessity in incandescent lighting. The lights were erected by Messrs. Smith & Chamberlain, of the Solar Works, Birmingham, who had obtained special permission from the Town Council to do so. This is, we believe, the first time that the the electric light has been shown in Birmingham.

A Peripatetic Paragraph.—Some time ago (*vide* Electrician. Vol. VI., p. 216, March 19, 1881) we published an illustration with short description of the longest span of wire in the world—viz., that over the River Kistnah, between Bezorah and Seetanagrum, in India, which is more than 6,000 ft. across. Our information and illustration were derived from private sources. Since that time we have come across our illustration and letterpress in various shapes and guises, sometimes the letterpress without the illustration, sometimes both together, but never with the source acknowledged. The whole is now reduced to a convenient little paragraph, which has helped several printers and sub-editors to fill up a column. Thus we have seen it in the "Journal" of the Franklin Institute, "Scientific American" (more than once), "Operator," "Journal of the Telegraph," "La Lumière Electrique," "L'Electricité," "L'Electricien," "Engineer," several provincial papers, &c. After this list we think we are justified in the use of the word "peripatetic."

Long Distance Telephoning.—A novel experiment is now in progress with a view to overcoming the difficulties attendant upon long distance talking. Between Boston and Worcester (U.S.A.) a line is being constructed of No. 4 gauge wire, which reduces the telephone distance between the two cities about one-half. This line, says the "Scientific American," will cost $10,000, whereas an ordinary line of No. 9 wire would cost only about $4,000. If the experiment is a success the line will be extended to Springfield, and similar lines will be built from Boston to Portland, Plymouth, N.H., and other distant points, enabling subscribers there to talk with Boston as readily as subscribers in Dowell, Salem, Lawrence and other neighbouring places. The ordinary telephone line, running straight across the country, costs from $100 to $150 per mile. The big wire is now completed between Boston and Hopkinton, a distance of 20 miles. Communication over the line on this 20-mile stretch is as distinct as in the city.

THE ELECTRICIAN

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Notes.

The Electricity (Supply) Bill.

THE strong opposition offered by the House of Lords on Monday, when the Electricity (Supply) Bill came on for adjourned debate on Second Reading, was probably a surprise to most of our readers. It is interesting to note that the bulk of the opposition centred on the question of finance. The feeling of the House was that it was eminently unwise at the moment to involve the public credit in any sums of magnitude, and that the nationalising tendency of the Bill as it now stands means ultimately a big draft on the public exchequer. It was argued that by discouraging private enterprise, and thus driving it out of the industry, quite unnecessary financial burdens were being transferred to the public. More than one suggestion was made in the direction of relegating the whole matter to a Select Committee. It is questionable, however, whether many of those whose thoughts turned in this direction had seriously considered how little is to be gained by this course. The chief matters that would engage the attention of a Select Committee would be the engineering basis of the scheme, and whether reorganisation and unification of supply were urgently needed. On this question, however, there is practical unanimity, and it has already been threshed out *ad nauseam*. The important matters of difference, and the ones which loomed largely in the controversy in the House of Lords, are those of administration and finance, and these are matters of too general interest to be amenable to determination by the methods of a Select Committee. As Mr. EMILE GARCKE has recently pointed out, the whole Bill has been badly muddled from the political point of view. We agree with him that it would have been much better to have followed the recommendations made by the Committee of the Institution of Electrical Engineers and to have confined its provisions to the appointment of Electricity Commissioners with full power to consider and deal with the complex, technical, administrative and financial problems involved in any scheme of electricity supply reform. In this way a gradual development in the establishment of administrative machinery for this purpose would have been realised. If it is thought that the Commissioners would thus have been given too much power, some provision could have been inserted making their decisions subject to review by a Government Department, or by some such body as the Light Railways Commissioners. As it is, the provisions of the Bill are much too detailed and an opportunity has, therefore, been given for all sorts of interests, many of them regrettably reactionary, to try their hand at amending it with the results which we have seen. Electricity supply from super-power stations is an ideal, but a great deal of useful preparatory work can, and must, be done before that ideal can be reached. This is work for experts, such as the Electricity Commissioners will be, and not for the legislature.

How Opposition Might be Met.

A GREAT deal of the opposition in the Lords might, perhaps, be met by restoring the balance between private and municipal interests. The former are at present suffering under a distinct sense of injustice owing to the purchase terms which have been inserted in the Bill. This could, at any rate, be counteracted by purchasing the companies' stations at a higher price and giving them an extended tenure, though the latter solution might delay "linking up." Another suggestion is to lease the undertakings of District Boards to existing undertaking companies, so as to retain and provide further capital for the large developments needed. This would help to reduce the necessarily large demand of expenditure from the public revenue, and do away with the scare of nationalisation. It is to be regretted that the Home Secretary gave way to pressure in the Commons and virtually converted the Bill to a municipalising measure. For it seems to be precisely this aspect of the Bill that finds such disfavour in the Lords, and has caused such widespread opposition. At the same time it must be pointed out that the avowed object of the Bill is the provision of electrical energy on a large scale, and that no private interests can be allowed to stand in the way of this object being carried out. We admit that there are many difficulties in the way and that much diplomacy will be required, but nevertheless we pin our faith to the Electricity Supply Commissioners.

Learned Societies and Finance.

Recent indications go to show that learned societies must be classed amongst the "new poor." At the present time most of them find their income little, if any, more than it was before the war, and in certain cases it has actually fallen, while the expenses, especially for printing and other work of that kind have risen to an extraordinary degree. It would seem that the present tendency of the wealth of the country to shift from one class to another has also had the consequence of making expenditure flow in other directions. Our landed proprietors and manufacturers, taking as their example the classical Maecenas, used to find it good to devote a portion of their wealth to the patronage of science or art with a result that certain activities in which there was no immediate possibility of profit were able to flourish both for the good of their protagonists particularly and the country generally. But lately that source of income has ceased, and we hope one of the changes brought about by the war will not be the cessation of what is called the endowment of research. It is almost an axiom that men who have scientific ideas are generally equally lacking in this world's goods and the same applies to scientific societies who, if they are to carry out the duties for which they are best equipped, must work under some scheme of patronage. An appeal of this kind should be particularly heard by those engaged in electrical engineering where theory and practice walk ever hand in hand, and we hope that those connected with our profession who are able to do so, and there are many, will help scientific research out of the pitfall into which it has fallen through no fault of its own.

The Endowment of Education.

The above lines had already been written when we received a notice from the Manchester College of Technology directing attention to an appeal which they are placing before the public for the sum of £150,000 to allow them to erect additional buildings, and for £500,000 for various other purposes connected with the University of Manchester. As is well known, the Manchester College of Technology is especially concerned with university education in subjects falling within the terms "applied science" and "technology." Before the war we used to be told how far behind Germany and the United States we were in this matter of technical education. It was pointed out that there was little or no recognition in this country of the way in which the scientifically trained engineer or technologist can assist the manufacturer, and that if we did not change our ways disaster would be the only result. These arguments are as cogent now as they were then, and we need hardly say we heartily welcome the desire of the educational authorities in Manchester to provide more accommodation for the highest type of education in applied science and technology, and we hope that their appeal for funds for this purpose will not fall on deaf ears With the end of the war has come a great desire on the part of our young men to increase their knowledge of scientific matters, and at the same time there is every need that science and technology should be applied to industry. The only thing wanting to bring about the combination of men and knowledge is money. In appeals such as these example is better than precept. We have already spoken of what has been done in America, a country which is happy in possessing rich men who appreciate the value of education. Among these was the late Mr. H. C. Frick, who has made the princely bequests of 15,000,000 dollars to Princeton University and of 5,000,000 dollars each to Harvard University and the Massachusetts Institute of Technology. Apart from these bequests Harvard University during the last three months has collected 12,000,000 dollars and the Massachusetts Institute of Technology 10,000,000 dollars for the extension of their work, and about half this sum is to be devoted to the endowment of applied science and technology. What we have said above about learned societies applies with even more force to educational institutions, and we hope that for every reason the needs of the Manchester College of Technology and of other educational institutions in this country will be generously provided for without delay.

The National Electric Light Association.—The Annua Convention of this Association will take place in Southern California from May 18 to 21, 1920.

Industrial League and Council.—The sixth lecture of the present series arranged by the Industrial League and Council will be held in the Council Chamber of the Guildhall, on Tuesday, December 16th. The chair will be taken at 2.30 p.m. by the Rt. Hon. Lord Parmoor, K.C.V.O., and an address on the "League of Nations" will be delivered by Sir George Paish. No tickets are necessary.

Women's Engineering Society.—This Society has been established in the interests of women engaged in the engineering and allied trades, to promote the training and employment of women in those trades, to secure their admission to schools of engineering, to give special attention to the future of women who have attained some degree of skill in this employment, and to work for their admission to the membership of all suitable engineering institutions. All women doing technical and mechanical work in Government or other engineering factories are invited to join the Society, whose offices are at 46, Dover-street, London, W.1.

London Electrical Engineers' Old Comrades' Association.—We are informed that preliminary steps have been taken towards the formation of an Old Comrades' Association of the London Electrical Engineers, R.E. (T.F.). A general meeting to inaugurate the Association will be held at Headquarters, 46, Regency-street, at 7 p.m., on Jan. 16, 1920. In the meantime Headquarters will be open to all old members of the corps on Friday evenings from 6 to 9.30 p.m. The Hon. Secretary of the Association is Company-Sgt.-Major E. R. Baxandall, to whom all communications should be addressed either at Headquarters or at 82, Shooters Hill Gardens, Eltham, London, S.E.9.

The Faraday Society.—The Annual General Meeting of the Faraday Society, will take place in the rooms of the Chemical Society Burlington House, London, W. 1, on Monday next at 7.50 p.m. The nominations for Officers and Council for the year 1919-1920 are as follows:—*President:* Sir Robert Hadfield, Bart., F.R.S. *Vice-Presidents:* Mr. W. R. Cooper, Prof. F. G. Donnan, F.R.S., Mr. E. Hatschek, Prof. A. W. Porter, F.R.S., and Mr. E. W. Rayner. *Treasurer:* Mr. R. L. Mond. *Council:* Dr. J. Allmand, Dr. H. Borns, Prof. C. H. Desch, Dr. J. A. Harker, O.B.E., F.R.S., Mr. Cosmo Johns, Mr. H. Moore, Prof. J. R. Partington, Dr. W. Rosenhain, F.R.S., Sir T. Kirke Rose and Dr. George Senter.

British Engineering Standards Association.—A Conference on Pipe Threads, under the ægis of the Association is to be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, to-day, at 2.30 p.m., under the presidency of Sir Arthur Duckham, K.C.B., President of the Society of British Gas Industries. The Association is inviting manufacturers and users to attend this Conference in order that they may have first hand information as to the exact situation at the present time. We are asked to state that any firms who wish, either to be represented or to have further information in regard to the matter, should at once communicate with the Secretary of the British Engineering Standards' Association, 28, Victoria-street, London, S.W.1.

Use of Motor Cars in Europe and America.—We notice that "Machinery" has been making an estimate of the number of motor cars used in the United States and in various European countries. The United States, as is well known, is far in advance of other countries, the remarkable figure of one motor car per 24 persons having recently been reached. In Canada, with one car per 50 persons, this figure is approached, and England comes next with one car per 200 persons. It is interesting to notice that France, Belgium, Holland, Switzerland and Germany only use about one car per 400 of population, while Austria-Hungary, with one car to each 2,650, is far behind. It would thus appear that the use of motor cars is not necessarily an indication of advanced industrialisation. Possibly it is rather a criterion of wealth per capita, and uniform distribution of wealth.

Visit of Technical Journalists to Slough.—By permission of Lord Inverforth, the Minister of Munitions, arrangements were recently made by the Circle of Scientific, Technical and Trade Journalists to visit the extensive motor repair works at Slough. Although the works are still incomplete the scale of operations is already very extensive, and there was much of interest to be seen. The primary object of the works is the systematic repair of the large number of cars and lorries in the Government service. Visitors were shown repairing operations in full swing in a series of shops, some of which occupy more than eight acres. A feature of interest is that the entire works is to be lighted and driven by electricity, generated at a special power house now in course of erection. At the time of the visit only one of the three 1,000 kw. turbo-alternator sets was in operation, but the other two are being completed in the near future. The general nature and planning of the workshops appears quite up-to-date, and the whole installation, when complete, should be a valuable one. It only remains to be said that everything was done for the comfort of the visitors, and we congratulate the Ministry on affording this opportunity to the technical Press to be kept *au fait* with arrangements which has been much criticised.

Obituary.

We regret to record the death of Mr. John Ardron, C.B., which took place at Stanmore on the 4th inst. Mr. Ardron was born at Queniborough in 1843, and entered the Post Office service in 1864. When the State took over the telegraphs in 1870 he assisted in carrying out the transfer of the undertakings of the telegraph companies and in the organisation of the new Government service. He became attached to the telegraph branch of the secretariat. and had to deal in an administrative capacity with a variety of questions affecting the improvement and development of the telegraph service. He became principal clerk in 1880, and was appointed assistant secretary (telegraphs) in 1897. He represented his department in various ways both at home and abroad, and was vice-president of the International Telegraph Conference held in London in 1903. He was an associate of the Institution of Electrical Engineers, and served on the Council in 1895. He was created C.B. in 1906, and at the end of that year he retired from the Post Office service.

Personal.

We understand that Mr. W. B. Woodhouse, engineer and manager of the Yorkshire Electric Power Company, is to be one of the electricity commissioners under the new Electricity Supply Bill.

Sir Richard Redmayne, chief inspector of mines, will resign his position at the end of the year, and will devote himself entirely to the work of the Imperial Mineral Resources Bureau, of which he is the chairman, and to the practice of his profession as a consulting mining engineer.

Mr. David James, manager of Swansea Improvements and Tramway Company, has been added to the local magisterial bench.

Arrangements for the Week.

FRIDAY, Dec. 12th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers to be read: "First Steps in the Experimental Analysis of a Galvanic Cell," by Prof. W. M. Coleman; "Radiation from a Perfectly Diffusing Circular Disc," by Mr. J. W. T. Walsh, M.A.; "A Comparative Method of Testing Thermionic Valves for Passing No Reverse current at High Voltages," by Dr. N. W. McLachlan; and "On Recording and Reproducing Sounds by Means of Light," by Dr. A. O. Rankine.

Society of Technical Engineers—Woolwich Branch.

7 p.m. At Royal Oak Hotel, New-road, Woolwich, London, S.E. Paper on "The Proper Position of the Engineer in Political and Industrial Circles," by Mr. E. C. de Segundo, A.M.Inst.C.E.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Paper on "A Walk through the Shops at Richborough," by Mr. R. L. Kirlew.

Electro-Harmonic Society.

8 p.m. At the Holborn Restaurant, London, W.C. Smoking Concert. Mr. H. E. Blain in the Chair.

SATURDAY, Dec. 13th.

Stoke-on-Trent Association of Engineers.

7 p.m. In the Council Chamber, Town Hall, Hanley, Stoke-on-Trent. Paper on "The Casting of Refractories for the Metallurgical and Engineering Trades," by Mr. B. T. Allen.

Birmingham and District Electric Club.

7 p.m. At the Grand Hotel, Colmore-row, Birmingham. Annual General Meeting.

MONDAY, Dec. 15th.

Batti-Wallah's Society.

1 p.m. Luncheon at the Holborn Restaurant, London, W.C. Sir Lynden Macassey will deliver an Address.

Institution of Electrical Engineers.

7 p.m. At the Chartered Institute of Patent Agents, Staple Inn Buildings, London, W.C. Informal Meeting. Discussion on "Some Reflections on Labour," to be opened by Mr. R. Rankin.

Institution of Electrical Engineers—North-Eastern Centre.

7.15 p.m. At Armstrong College, Newcastle. Lecture on "Electrical Developments at Christchurch, New Zealand," by Mr. J. Lythgoe.

Faraday Society.

7.50 p.m. At the Chemical Society's Rooms, Burlington House, London, W. 1. Annual General Meeting.

8 p.m. Ordinary Meeting. Papers to be read: "Electrolytic Iron Deposition," by Lieut. W. A. Macfadyen, M.C.; "The Measurement of Physical Properties at High Temperatures," by Mr. A. G. Tarrant, B.Sc.; "The Electrolytic Formation of Perchlorate from Chlorate," by Mr. J. G. Williams, B.Sc.; "On the Vapour Pressures of Binary Mixtures," by Prof. A. W. Porter, F.R.S.; "Some Relations between Solubilities of the Solutes and their Molecular Volumes," by Mr. S. Horiba; "An Accurate Method for the Determination of Vapour Pressure" and "Some Properties of Copper Ferro-cyanide," by Dr. E. J. Hartung; and "The Solution Theory of Steel and the Influence of Changes in Carbide Concentration on the Electrical Resistivity," by Prof. E. D. Campbell.

Royal Society of Arts.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Synthetic Drugs," by Dr. J. T. Hewitt, M.A., F.R.S. (Lecture 3.)

TUESDAY, Dec. 16th.

Institution of Civil Engineers.

5.30 p.m. At Great George-street, Westminster, London, S.W. Paper on "Precise Levelling," by Major E. O. Henrici, R.E.

Institution of Electrical Engineers.—North-Western Centre.

7 p.m. At the Engineers' Club, Manchester. Paper on "Scientific Works Management," by Capt. J. M. Scott-Maxwell..

Illuminating Engineering Society.

8 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Lecture on "The Art of Camouflage," by Captain W. A. Howells.

WEDNESDAY, Dec. 17th.

Institution of Electrical Engineers—Wireless Sectional Meeting.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "High-Frequency Resistance of Wires and Coils," by Prof. G. W. O. Howe, D.Sc.

Institution of Electrical Engineers—South Midland Centre.

7 p.m. At the University, Edmund-street, Birmingham. Paper on "Scientific Works Management," by Capt. J. M. Scott-Maxwell.

Liverpool Engineering Society.

8 p.m. At the Royal Institution, Colquitt-street, Liverpool. Paper on "Science and Art of Lubrication," by Mr. H. T. Newbigin.

THURSDAY, Dec. 18th.

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Electricity in Tin Mining," by Messrs. D. M. W. Hutchison and W. J. Wayte.

Institution of Electrical Engineers—Irish Centre.

7 p.m. At the Royal College of Science, Upper Merrion-street, Dublin. Paper on "Water Power," by Mr. T. C. Roberts.

FRIDAY, Dec. 19th.

Institution of Mechanical Engineers.

6 p.m. At Storey's Gate, St. James's Park, London, S.W. Paper on "Cutting Power of Lathe Turning Tools," by Mr. G. W. Burley.

Junior Institution of Engineers.

7.30 p.m. At the Royal United Service Institution, Whitehall, London, S.W. Presidential Address, "The Influence of the War on Engineering,'" by Sir E. H. Tennyson D'Eyncourt, K.C.B.

Society of Technical Engineers.

7.30 p.m. At the Memorial Hall, Albert-square, Manchester. Address on "The Value and Purposes of Organisation," by Mr. E. Murray Wrong.

Cargo Handling at Ports.

With Special Reference to the Modern Development of Electrical Appliances.

By BRYSSON CUNNINGHAM, D.Sc., F.R.S.E., M.Inst.C.E.

Summary.—The article commences by emphasising the necessity for eliminating delay in quayside discharging operations. Early appliances are alluded to, and the inception of the hydraulic crane, due to the late Lord Armstrong, is described. This type has been followed by the electric crane, which is now rapidly superseding it. Various special features and requirements of an electric quay crane are enumerated. Alternative methods of ship discharge are noticed, and some consideration is given to cargoes of a homogeneous character, such as grain and coal. The article concludes by pointing out the interdependence of a number of factors in determining the accessibility of ports, and by urging the importance of the question of transport from the docks.

THERE is scarcely any problem of to day which presents features of such vital interest and importance to the members of an island community like Great Britain, as that which concerns the rapid and uninterrupted transit of merchandise from an overseas origin to an inland destination. In the case of perishable foodstuffs, the necessity is so evident and imperative as to call for no proof or demonstration. The most casual observer at the docks and harbour wharfs cannot fail to be aware of the large and numerous cargoes of frozen meat, rabbits, eggs, butter and dairy produce, apples, bananas and other fruit, which are daily received from foreign shores, and of the huge consignments of fish which are brought in from distant fishing grounds by each returning fleet of trawlers. Even where the liability to detriment and decay is not actually a consideration, it is obvious that any detention or delay in the supply of raw material to manufactory or workshop, cannot fail to be inimical to the interests of trade, and a hindrance to commercial development. Where keen competition causes prices to be cut to a minimum, a rapid turnover is the only means of achieving a reasonable profit, and any large amount of useful material locked up in idleness, implies a corresponding loss in capital charges, besides rent and cost of storage.

We need not labour the point. It is only necessary to mention it as a reminder of the immense importance attaching to an ample provision of cargo-handling facilities at the quayside, and as an explanation of the remarkable strides which have been made of late years in the development of mechanical contrivances for expediting the transfer of goods from ship to shore, and thence by road or rail to their immediate destination. The rivalry of ports for mercantile supremacy has caused the utmost activity to prevail on the part of harbour and dock authorities, in order to cope with the growing and insistent requirements of modern commerce in this respect.

In contrast with the leisurely procedure of our forefathers, the almost bewildering rapidity of quayside operations at the present day, combined with the array of mechanical contrivances engaged therein, marks a revolution as fundamental in its way as the advent of the aeroplane or the evolution of the turbine. It is difficult to realise that so essential and universal an appliance as the quay crane had its inception merely a century back, and then was devised in a form so crude and primitive as to bear as much resemblance to its latest prototype as an arquebus or crossbow to the modern rifle. So far as records can be traced, the first sketch, or design, for a quay crane appeared about the year 1821, and it consisted merely of a jib and drum, or barrel, with multiplying gear, worked by hand. What success the crane met with at the outset can only be a matter of surmise, but there is evidences of the extension of manual appliances of this kind, because, when the London Docks were opened a year or two later, there were installed at the dock side some hoisting appliances of the treadmill type. The lifting rope was wound on the crane barrel by the action of a number of men climbing the rungs of a rotary circular frame. These appliances were actually still in existence (though, of course, long out of use) until a few years ago, when the last was dismantled at the Eastern quay of the London (Western) Dock.

Whatever may have been the reception of the quay crane in its primitive form, there was certainly opened out for it a wonderful vista of possibilities when the late Lord Armstrong (then a commoner, practising as a solicitor in Newcastle) conceived the idea of applying water under pressure as the motive power, instead of the slow and cumbrous manual, or pedal, exercise. This was about the year 1840. In a Paper subsequently contributed to the Institution of Civil Engineers (Vol. LXX.) he tells us how it occurred to him that "when water is lifted by a pumping engine, it becomes the recipient of the power exerted in raising it, and if the same water be used as a motive power in its descent to its original level, it renders back the power conferred upon it by the engine, and thus becomes the medium through which the power of the pumping engine may be transmitted to a distance and distributed in large or small quantities, as occasion may require." He imagined a small steam engine in the vicinity of St. Katharine Dock, continuously employed in pumping water from the Thames into a large cistern placed on the top of one of the lofty warehouses round the dock, and thus used as motive power for hoisting goods out of ships. The idea did not materialise, however, until the year 1846, when the first hydraulic quay crane was erected for actual use on Newcastle Quay. The water supply came from the town water company's main, and the machine was capable of lifting 5 tons. With a pardonable degree of pride, the inventor relates how the great dock engineer, Jesse Hartley, of Liverpool, a man famous in his day and generation, was pressed to inspect the crane, though sceptical as to its capabilities. He visited the site without notice and incognito. The operator, "who went by the name of 'Hydraulic Jack,' and who had acquired great dexterity in the management of the machine, being put on his mettle by Mr. Hartley's incredulous observations, proceeded to show its action by daring treatment of a hogshead of sugar. He began by running it up with great velocity to the head of the jib, and then letting it rapidly descend, but by gradually reducing its speed as it neared the ground, he stopped it softly before it quite touched the pavement. He next swung it round to the opposite side of the circle, continuing to lift and lower with great rapidity while the jib was in motion—and, in short, he exhibited the machine to such advantage that Mr. Hartley's prejudices were vanquished." Thereupon that gentleman waited upon Mr. Armstrong, as the inventor then was, laconically announced himself and his intention of recommending the type of crane for adoption at the Albert Dock, Liverpool.

The application of hydraulic power to the quay crane was an event of outstanding importance, and the machine held the field without a rival until the close of the century. Since that date it has fought a losing battle with the electric crane, which is now gradually, but surely, superseding it for general quayside purposes. The defeat in no way detracts from the merits of the older machine, which has done splendid work in its day. The writer knows of hydraulic quay cranes still in use after upwards of 40 years of continuous and strenuous service—a wonderful record of useful work. The rigid necessity, however, for economy of power consumption, of which the hydraulic crane is oftentimes prodigal, has occasioned the gradual supersession of water under pressure by a motor capable of proportioning its expenditure of energy to the load lifted. An hydraulic crane is not economically employed otherwise than in lifting loads of its maximum capacity—this means a rigid uniformity of load, and in quayside work such an ideal condition rarely obtains. Loads are perforce variable, according to the nature of the material, its bulk and the rate of handling. In order to provide adequate power for dealing with heavy material, the maximum capacity of most quay cranes is generally in the neighbourhood of

30-35 cwts., but the majority of parcels from a ship's hold do not come up to a moiety of this weight. Unless fitted with concentric rams, which are complex, heavy and cumbersome, an hydraulic crane exerts the same amount of power and consumes the same quantity of water whether lifting 15 cwts. or 30 cwts. In this respect it is at a decided disadvantage with the electric crane, in which the output in power is directly proportional to the load lifted. Spread over a large number of operations and continued for an indefinite period of time, the ratio of useful work performed by the hydraulic crane falls considerably below the record of the electric crane. Nothing, however, can detract from the steady reliability and control of the hydraulic machine, and it still holds an unassailable position as a source of slow-moving constant power, such as is necessary in the case of heavy lifts of uniform calibre and in actuating dock gates, swing bridges, coal tips and other massive appliances. The provision of a double lifting capacity by means of an additional internal ram has already been mentioned, but it is not in vogue to any great extent. Hydraulic power also maintains its utility in regard to quay capstans, where the rotating crank shaft and piston replace the direct-acting ram.

The electric quay crane first made its appearance about the year 1892, when it was introduced at Hamburg and other German ports in the Baltic. Although the innovation speedily proved a success and was promptly copied at other Continental ports, some time elapsed before it found a footing in this country. Southampton was the first British port to make the experiment. Since the commencement of the twentieth century the adoption of electric cranes has gradually spread from place to place, so that now there are very few ports—certainly none of the first rank—which are not equipped with an installation of electrical quay cranes.

Under the variable conditions prevailing in connection with dock and quayside work, continuous current has proved the most satisfactory form of power. Alternating current is not so suitable for direct application to machines, such as cranes, which are called upon to overcome the inertia of heavy bodies in a series of starts and stops, and although the supply is often generated as a high pressure alternating current, transformers and rotary converters are introduced to effect a change in the character and voltage. Thus current may be generated as a polyphase alternating high pressure current up to, say, 10,000 volts, but supplied at the quayside as continuous current at 450 to 500 volts. The most convenient means of transmission is the conduit system with a continuous groove, or a cable with plug connections at intervals. Standards and overhead wires would constitute a serious obstruction and entanglement amid an environment of masts and spars. The underground groove is sometimes troublesome and needs to be well and substantially designed, otherwise it may be difficult to ensure efficient contact.

The motors of quayside cranes are preferably either series wound or compound wound. Shunt wound motors are not generally suitable, or, at any rate, not so well adapted for starting against a heavy torque, as the series wound motor. When supplied with current at constant pressure, however, the shunt wound motor will run at nearly constant speed under a varying load. The compound motor combines both advantages in a lesser degree. It is a type of motor which is fitted to cranes in which the motor is allowed to run continuously. Generally speaking, for the intermittent action of a quay crane, the series wound motor is the most suitable owing to its speed chacteristic varying with light or heavy loads, but many motors for cranes are compound wound.

The environment in which a quay crane works and the nature of its functions are such as to differentiate its design in many important respects from that of other classes of crane. In order that the jib may clear the lofty sides of modern vessels when riding light, the crane structure has necessarily to tower to a considerable height, often 50 to 60 ft. above quay level. This inevitably makes the stability of the crane a difficult problem, particularly as the load and counterbalance are so near the summit. The writer is acquainted with an accident in which, from this cause, a crane overturned and fell across a dock shed. A further cause of instability is the necessity for placing the driver, with the actuating gear, in a cabin at such a height that he can supervise the whole cycle of each operation. It is true that an attempt has been made to render this elevation of position unnecessary by the introduction of a system of distance control, the driver with a keyboard, having flexible connections, taking his position on the vessel itself, overlooking the hatchway which is being worked. But this does not enable him readily to follow the movements of the load when clear of the hatchway, and, for this and other reasons, the system, though tried, has not, so far as the writer is aware, met with any great degree of success or encouragement.

Then the revolution of the jib is a difficult matter to achieve without accident amid the complexities of ship's stays and yard arms. Wherever practicable rectilinear movement is desirable, and this involves a luffing movement of the jib, with the consequent provision of some form of compensation gear in order to cause the load to travel horizontally; otherwise, there would be an unremunerative expenditure of energy due to the rise of load during the inward movement of the jib. There are several devices by which horizontal movement of the load can be secured and they have been adopted with greater or less success. One of them is outlined in Fig. 1.

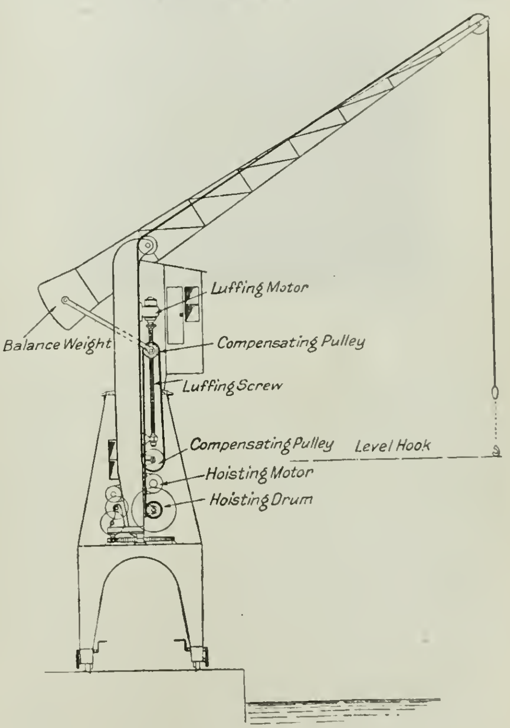

Fig. 1.—Musker-Davison Electric Luffing Quay Crane.

A very objectionable use to which quay cranes are put (the practice is unfortunately prevalent) is that of "breaking-out" cargo. This means that the crane rope is employed for dragging and pulling bales or packages between decks, more or less wedged in compact masses, until they are freed sufficiently for separation into individual parcels. Not only does this place an unknown and oftentimes excessive pull on the rope, but it also causes the tension to lie along a line very far out of the vertical, and so throws a stress on the crane jib and framework which they were not designed to withstand. Cases have occurred in which cranes have been tilted over by this means, and only saved from complete overturn by the support afforded by a vessel's bulwark. It is a very pernicious and dangerous practice, and should altogether be discountenanced. Unfortunately, stevedores and others engaged in ship discharging operations are apt to lose sight of the risks run in this way in an endeavour to facilitate matters from their own point of view. Moreover, men are often put in charge of cranes who, having little or no technical knowledge, are unable to appreciate the dangerous character of the action. It illustrates a point which has to be borne in mind in connection with quay crane design, since the temptation to put a crane to this illicit use is considerable.

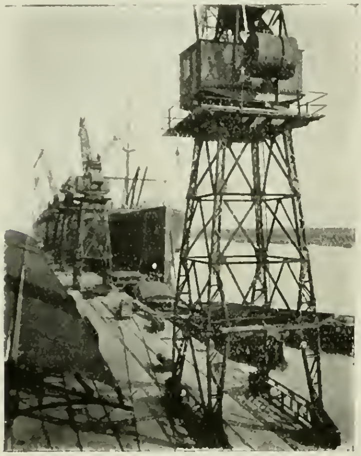

Fig. 2.—Base of Babcock & Wilcox Electric Luffing Quay Cranes.

The under-carriages or pedestal of quay cranes are constructed generally to a gauge wide enough to admit of a line of sidings for railway rolling stock passing underneath. The cranes are then styled Portal cranes, and if the quay be insufficiently wide to admit of a second line for the back leg of the crane, the latter may be carried by a rail running along the wall of the shed or other structure, in which case the crane is distinguished as a Semi-Portal Crane. Where there are no sidings required, the crane base may be plated in, but it is usual, in any case, to design an arched pedestal in order to provide a passage for trollies and foot traffic. The front rail of the crane track should lie as near the quay edge as possible, consistent with the location of bollards and mooring posts and the leads of ships' moorings. Every foot within the quay line adds to the length of the jib to a corresponding extent in order to obtain the necessary radius or outreach.

At Liverpool where the quay margin is too narrow to receive a crane base, a specially designed crane is much in evidence. This runs entirely on the roof of the quay shed, the outer rail lying along the eaves of the building and the inner rail along the ridge-piece. Naturally the shed structure has to be strengthened accordingly, and the crane is handicapped by the additional 8 ft. or so of outreach which is required in the jib.

The Port of London Authority have recently installed a large number of electric quay cranes at the Albert and Victoria and Tilbury Docks, which will serve as a typical example of the class (*see* Figs. 2 and 3). They are 56 in number and were supplied to the specification of the Chief Engineer to the Port Authority by Messrs. Babcock & Wilcox. The maximum lifting capacity is 3 tons, but the lower power gear for a 30 cwts. lift is more commonly in operation. Each crane is actuated by three separate motors, all compound wound and running at 600 revolutions per minute. The first of 15 B.H.P. is for lifting; the second of 7 B.H.P. is for slewing and the third of 3 B.H.P. is for luffing. The speed of lifting full load (3 tons) is 150 ft. per minute, and for half load (30 cwts.) it is 300 ft. per minute. Slewing can take place at an average rate of a complete revolution in 60 seconds, under conditions in which the crane is carrying full load on the hook against a wind pressure of 15 lbs. per sq. ft. The luffing speed is 4 ft. per second, and the jibs luff inward from a maximum radius of 60 ft. to a minimum of 20 ft. during which the load travels in a level line by means of a compensation action contained within the jib structure. By reducing the load the outreach may be increased by another 5 ft. The total lift at 60 ft., radius is 105 ft., 35 ft. of this below quay level in the holds of vessels and 70 ft. above quay level. The cranes are carried on framed pedestal bases running on a rail track the gauge of which is 13 ft. 6 in., allowing for the passage beneath the cranes of rolling stock with a maximum width of 9 ft., and a height of 13 ft. to the crown of roof.

The motors were specified to be capable of carrying a momentary overload of 100 per cent. without undue sparking, and the rise in temperature after 30 minutes' running at the specified voltage was not to exceed 70°F. above the surrounding atmosphere. Current is taken from mains in a conduit below the quay surface with a continuous grooved aperture so that connection may be made at any desired point. The current is direct and the voltage 480 transformed from two phase alternating current generated at 6,000 volts pressure. Travel along the quay is actuated by hand, there being no motor provided for this movement. Double purchase gear is fitted to two wheels so that, in the unloaded condition, the crane can be moved along the quay at the rate of 10 ft. per minute by four men. In this connection it may be mentioned that, in certain cases, non travelling cranes can be propelled by an independent trolley fitted with its own motor, but, where change of position is infrequent, the method of hand-travelling is found to suffice.

But while the use of the quay crane is perhaps the most striking feature of loading and unloading operations carried on in British, and for that matter in most Continental ports, it is by no means the only appliance available for the purpose even in connection with general goods. The ships' own winches come in very largely for a share of the work. They are very frequently employed for raising goods to the deck level, then handing them over to be dealt with by the crane. But ofttimes unaided, or with the assistance of a slide, or of a pulley attached to pole, mast or shed structure ashore they are able to deposit their loads directly on the quay. This method is often preferred even in situations where quay cranes are available. At Antwerp, for instance, one line of steamships consistently employs the winch to the exclusion of the cranes with which the quay is amply equipped. At New York along

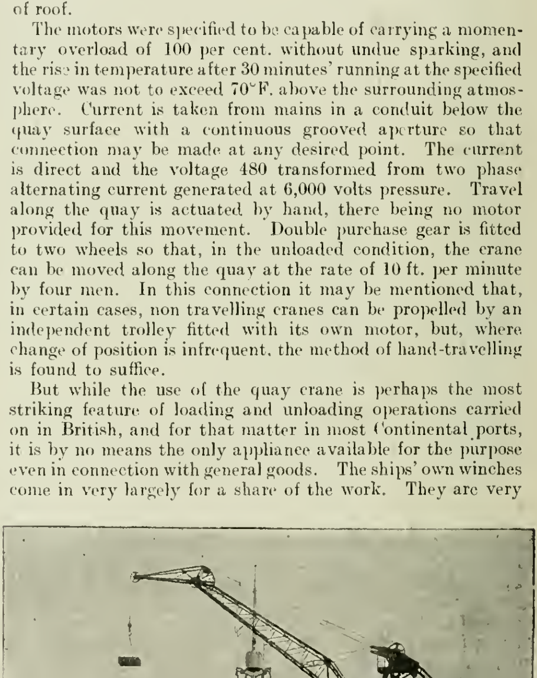

Fig. 3.—Babcock & Wilcox Electric Luffing Quay Cranes.

the more modern piers or wharfs will be found a series of what are termed "cargo hoists"; these are only pulley blocks attached at convenient points to a structural bridge or girder rail running along the frontage of the pier at a certain level above the eaves of the shed roof. The sheds in question, like those at Liverpool, are within a few feet of the water line, and the quays, therefore, have but a narrow width. By rigging a block directly over the door of the shed by which entry is to be effected, and with the assistance of a similar block on one of the ship's masts commanding the hatchway which is being worked, it is found that discharge can be effected in a most expeditious manner, so that the practice has become quite general. In fact, as a broad statement, it may be said that quay cranes are not used in New York. The method of operating the cargo boats is quite simple. The end of a line, or rope, run from a winch, either on the ship's deck or on the pier, through the block over the hatchway, is fastened to the end of another line which is similarly run from a shore winch through the block on the cargo hoist. The hook for the attachment of the load is placed at the junction of the two lines and has a range of action between the two pulleys. Assuming discharge to be taking place, the pier line is allowed to hang free while the lift is made by the ship line. When the hatchway is cleared by the load, the pier line comes into action, and the ship line is slackened to allow of the load being swung out on to the pier deck. The method has the advantage of simplicity and effective control. The load is entirely under the direct action of the respective lines at the point of lifting and at the point of deposit, and there is no swinging or luffing of jibs to be performed. This, at any rate, is the American point of view, and the system certainly finds great acceptance on the Altantic seaboard of the United States. The pier winches used are portable, either steam or electrically driven, of the double drum type with "nigger heads" at each end, enabling two loads to be dealt with simultaneously. The power lies generally between 18 and 35 H.P., and loads varying from 300 lbs. to 2,000 lbs. are dealt with at the rate of from 20 to 40 cycles per hour.

In Europe, if the ship's winch be employed, it is more generally used without any shore auxiliary at all, or merely in conjunction with a slide. The line passes from the winch over a pulley at the end of a derrick boom, attached to the foot of the ship's mast, and of sufficient radius, when swung, to land the load on the quay, or to deposit it at the top of a slide, whence it passes by gravitation downwards into the shed. The slide, of course, is only available when there is sufficient difference in level between the ship's deck and the quay to give the necessary incline. This commonly obtains and the gradients are in fact sometimes so steep as to require a check on the speed of descent.

At some ports (notably London, where the proportion amounts to from 70 to 80 per cent. of the whole) a large quantity of cargo is passed overside into barges and lighters for conveyance to some riverside warehouse, or by canal to some inland wharf. Under such circumstances, discharge by ship's winch or whip is a convenient means of handling lifts in an opposite sense to that for goods loaded on the quay. To enable cranes to deal with this class of work, they have to be fitted with jibs of very considerable radius exceeding the beam of the vessel, and sometimes attaining to 60 or 70 ft. or even more. This exemplifies the importance of compensation gear for the luffing movement in crane design where outreach is an essential consideration.

The difficulty of dealing mechanically with a long horizontal run for the load, especially where it is continued for some distance ashore, can be met by means of the conveyor, which is largely in use for the shipment and unshipment of goods, miscellaneous perhaps in character, but fairly uniform in respect of size and bulk. It is a common feature, of course, in warehouses and factories; at the quayside it is commonly found in conjunction with an elevator for the purpose of raising the goods direct from the ship's hold. The combined apparatus in its simplest form consists of a portable framework laid across and resting on the vessel's sides and coamings, or it may be supported by the extended jib of an overhead gantry running along the quay, or, again, it may be carried by a fixed cantilever projecting outward from a warehouse, shed or other convenient structure.

The Donald ship elevator conveyor, which is a well-known example of the principle in all three forms, was described at length in an article which appeared in the issue for December, 1917 ("The Present Day Handling of our Foodstuffs by Machinery"). There is no occasion to repeat the information therein contained. Another development of the conveyor principle, in which gravity takes the place of mechanical or electrical power, is the gravity runway, which was described in an article in the issue of January 10th last ("The Gravity Roller Runway"). Both these appliances, the conveyor and the runway, as well as others of the same type, viz., the telpher and the transporter, are by no means confined to the quayside. Their application is wide and general, and their utility has been abundantly proved in various directions. In dealing with ship's cargoes, however, they are to some extent placed at a disadvantage in certain cases on account of the conditions being peculiar and unsuitable. For instance, the Harbour Engineer of New York, in a recent report on the Mechanical Equipment of New York Harbour, states that the telpher, despite its undoubted advantages, where there is free scope and an absence of restrictions, has, in several cases, been abandoned by shipping firms in favour of the winch and whip used in conjunction with the hand-truck.* The principal field of service of the telpher lies in connection with cargoes where a single commodity has to be handled in bulk and in fairly uniform packages, without much sorting.

A similar stricture has been made on the use of the electric storage battery truck for all but long runs, with large consignments of similar packages of small bulk. The difficulties of sorting out the various lots appears to be the main objection, and hand-trucks are stated to be relied on, chiefly, for short runs. This is frankly regretted on account of the costliness of manual traction. "Motor trucks and travelling platforms have been applied and have been successful to some extent, but they do not wholly solve the problem of economical freight-handling about the pier or between the pier and the back lands."

There are numerous other devices for dealing with goods in transit, such as escalators, shoots, pilers, etc., but as they are not unique features of quayside work it would be out of place to consider them here. The subject of the mechanical handling of merchandise is extremely wide, and limits of space preclude any excursion beyond the field immediately under review.

From a discussion of the appliances in use for dealing with goods of a miscellanous character, it is an easy and appropriate transition to those special installations which deal with material in bulk and all of one kind, viz., grain, ore, coal, oil, timber and the like. Arrangements are usually made to receive consignments of this kind at berths especially reserved for them, as in the majority of cases they are not suited to proximity with other goods. But, in order not to traverse ground already covered in the columns of this journal, it must be mentioned that grain handling was dealt with in an article on "The Pneumatic Handling of Cereals" in January last, and coal handling in an article on "Coal Handling at Ports," which appeared in the same manner. The subjects, however, constitute so essential a feature of port equipment that it is impossible to pass them over without brief notice.

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* Mr. Staniford's remarks deserve attention; they are as follows: "Telepherage, or overhead conveyance, has been tried on a few piers in this country, but, so far, has not proven successful in its present form. This may be due to improper design or it may be that the principle is unsuited to the chacter of the business done on the pier. It is recognised that it is very difficult to design any form of overhead conveyance which will be sufficiently elastic to meet the requirements of general commerce, but if a form of overhead conveyance can be designed which will be thoroughly elastic as well as not over-complicated—that will receive freight from any point on a pier and transport it in one movement to any other point on that pier or to any building adjacent on the upland and to any floor on that building, it would seem that this would go a long way towards cutting out the hand-trucking, which, as before stated, is the principal item of expense. ("Report on the Mechanical Equipment of New York Harbour," Dec. 19, 1912.)

The development of facilities for dealing with cargoes of grain has been very marked during the last quarter of a century. At all large seaports are to be found granaries and silos of considerable capacity, situated so as to receive consignments direct from the ship's hold. Quite recently the King George Dock at Hull has been equipped with an installation of 40,000 tons capacity, while a few years a granary of over 30,000 tons capacity was erected at the Meadowside Quay, Glasgow. There are others of note at Liverpool, Manchester, Immingham, Avonmouth and elsewhere in this country and on the Continent and in the United States.

There are two rival methods of handling grain in bulk, one by the bucket elevator and the second by pneumatic, or suction, apparatus. The former is generally cheaper, and until recently, the advantage in this respect was very much on its side; but within the last few years there has been a marked reduction in the consumption of power and, correspondingly, in the working cost of the pneumatic apparatus. This is attributable to the introduction of the turbine exhauster. Apart from the question of power, the preponderating considerations are in favour of the pneumatic apparatus. It is flexible and portable. The intake can be led to any part of a ship's interior, and there is an entire absence of shovelling, or ploughing, the grain by hand, such as is unavoidable in the case of the bucket apparatus for perhaps 70 or 80 per cent. of the entire cargo. No impediment is produced by the rising freeboard of a lightening vessel, which is sufficient in some cases to arrest the use of the bucket elevator, nor is the depth of the hold material. The air current, which forms the essential feature of the pneumatic apparatus, discharges a double duty, in that it not only sucks up the grain, but it also aspirates, or aerates, it, thus improving its condition especially on its arrival after a prolonged voyage, when it may be in a heated condition. The dust nuisance is absent from the pneumatic method, whereas, with the bucket elevator, the hold becomes almost unendurable at times to the unfortunate individuals whose duty it is to trim the grain to the elevator boot. Carried into suspension by the powerful aspiration, the difficulty is to get the dust to settle again, and the finer particles have to be collected in an auxiliary chamber, called the cyclone separator. It is a curious reflection on modern methods of treatment that the dust so easily extracted from the grain at this stage of its progress has to be carefully collected and incorporated in the parcel before the latter is handed over to the consignee—otherwise, it would not be according to sample! At a later stage the dust has again to be separated from the grain. The only pertinent criticism which has been made against the pneumatic appliance is that the surface friction of the pipes tended to injure the more delicate class of grain, such as malting barley. But this contention, however, justified in the past, has no real foundation now, in view of improvements which have been effected of late years in the piping and jointing, and, in any case, it is difficult to see how the abrasive action of the buckets, in the bucket apparatus, can escape similar criticism. Finally, when it comes to dealing with a number of individual parcels of grain, conveyed in layers in a vessel, with nothing to separate the parcels but a waterproof sheet, the pneumatic apparatus is the only satisfactory and expeditious method.

The available capacity of the intake is usually in the neighbourhood of 100 tons per hour per machine. This is the general practice at the London Docks, but at King George Dock, Hull, it is 150 tons, and at the Meadowside Granary, Glasgow, 250 tons. In the last named installation there are two quayside machines of the capacity stated, each with 166 buckets of 0·65 cu. ft. volume set at 12 in. pitch. These raise the grain to the conveyor gallery at the top of the building for delivery on to bands running longitudinally, by which it is conveyed to any of the silo bins or of the storage floors. There is also an auxiliary elevator of 100 tons per hour capacity for weighing and loading out or for turning overheated grain. The ship elevator motors are of the totally enclosed type with dust-proof bearings, shunt wound, and of 40 B.H.P., running at 500 revolutions per minute, the system of supply being 500 volts direct current.

A floating turbo-elevator at London in the service of the Port Authority has a rated capacity of 60 tons per hour, but has maintained an average of 65 tons per hour over a lengthy period and has achieved the record of 129 tons of wheat in a single hour. The air is exhausted from the receiving chamber or canister by a turbo exhauster coupled by gearing to a 200 H.P. four cylinder oil engine run on ordinary crude petroleum. Various auxiliary machinery is driven electrically from current generated on board, and the motors for controlling the slewing luffing and telescoping of the suction pipes are placed on the crane post and controlled from a cabin attached to it.

Exports of coal and other fragmentary or granulated minerals can be dealt with either by the belt conveyor, the crane, or the hoist and tip. Imports are generally handled by the transporter or the crane with grab bucket. As the conditions prevailing at various ports are diverse in a number of respects, it is difficult to assign pre-eminence to any of these systems. For export work, the crane and hoist and tip are more generally used than the conveyor shoot, though there does not appear to be any fundamental reason why this last should not establish itself as a successful competitor. Installations have been tried at Hull and Durban with results that are certainly encouraging, and possibly, when more experience has been gained, the method will recommend itself for further exploitation. Belts are capable of dealing with 500 to 600 tons per hour, or even more; hydraulic tips from 600 to 800 tons and cranes from 300 to 400 tons—these are merely typical instances of actual installations, dependent on the requirements of the locality.

The loading of coal is as much dependent—more dependent in fact—on the trimming of the material in the field, than it is upon the speed of the apparatus for loading. Grab buckets are rated at much lower speeds, and can only be counted upon generally to the extent of 50 to 80 tons per hour, but, in certain cases, a performance of 150 tons has been attained.

The handling of oil in bulk by pumping direct from ship's tank through mains to storage tank is an operation which hardly calls for any particular discussion in connection with the subject of this article. There is no special feature which distinguishes it from the same operation when carried on elsewhere. The same remark applies to timber storage at the docks, for stacking which it is customary to rely mainly upon manual labour, often with the use of the steam crane, of 3 or 5 tons power. Attempts have been made to deal with cargoes of deals and other light scantlings, by means of the runway and band conveyor, but, although in some cases one or other of these methods is quite possible, yet, in the generality of cases, there is always the difficulty of sorting to be reckoned with, and this, of course, is the fundamental obstacle in regard to the rapid handling of miscellaneous goods at the port of arrival. Were cargoes always homogeneous in character—consisting of units of uniform size and weight and all consigned to a single firm—the application of mechanical handling to the entirety of quayside operations would be within the bounds of practicability. But the ideal is unattainable in view of the inherent dissimilarity in kind and the variation in ownership. Still, in spite of this drawback, the extent to which mechanical appliances have superseded manual handling is surprisingly remarkable, and demonstrates the ingenuity of the human mind when applied to the solution of problems of considerable intricacy. Nor can it be said that the limit of efficiency and application has yet been reached. There is much scope for further improvement before perfection can legitimately be claimed. This is true without implying any adverse comment or reflection upon the standard of excellence which has already been attained. Weighing the conditions which prevailed a generation ago and comparing the elaborate equipment of power and mechanism which is now at the disposal of shipowner, merchant and stevedore, one cannot in justice refrain from acknowledging that the progress already made is wonderful and constitutes an excellent augury of greater and more striking advances in the future.

But, while admitting all this and emphasising the supreme importance of rapidity of execution in regard to ship-discharging operations, one must not lose sight of the fact that there are other considerations to be taken into account and other factors to be weighed before any satisfactory solution of the transport problem can be arrived at. The process of unshipment is only one of several stages in the whole journey from producer to consumer and from manufacturer to mart. Each must receive an equal share of attention in order to eliminate its defects and improve its capabilities. It is useless to construct great liners of tremendous engine power to shorten the distance between ports by a few hours, if such vessels are held up by an adverse conditions of tide on arrival. It is idle to expend large sums of money in deepening approach channels and improving fairways at the entrances to harbours, in order to provide ready ingress and egress, if the goods conveyed are to be detained for hours, and even days, on the quay before being forwarded to their destinations. Congested quays and overcrowded transit sheds are as great an evil in their way as an undredged sandbar or a slow vessel. Very often the cause of delay lies not in lack of appliances for handling goods, nor in organisation or methods of unshipment. These may be well-nigh perfect in their way, and yet the goods themselves may be caught in a deadlock from which it is difficult to extricate them. This may be due to an inadequate provision of means of conveyance away from the docks—whether by rail, road or river. It is unfortunately the case in many of our older ports, where the docks lie in populous areas, that it has been impossible to provide anything like satisfactory avenues of approach and departure, or sufficient connection with the great trunk lines of traffic. Like Topsy in "Uncle Tom's Cabin," the docks have "simply growed"; often in promiscuous and unsatisfactory situations, admitting of little or no development. A glance at the plans of the docks of some of our leading ports is sufficient to show how cramped and irregular some of them are in outline and arrangement, and how difficult it is to improve them. Modern conditions have overtaken them in their mature age, and they have no scope of adaptation. It is a most regrettable state of affairs, and, if not rectified, the trade of such ports is bound to suffer, and ultimately possibly to disappear. Still, there is no reason to despair. The improvement which has been made in regard to cargo-handling appliances and the degree of success which has been attained in other directions, leads us to believe that a means will surely be found for ameliorating the conditions of transport from the quayside onwards. Necessity is said to be the mother of invention, and as to the existence of the necessity there can be no measure of doubt.

Labour and Labour-saving Devices.

By G. F. ZIMMER, A.M.Inst.C.E.

Summary.—In this article the author after dwelling at some length on the labour trouble and the inclination of the masters to adopt the machine, as a consequence, emphasises the economy of labour-saving devices from the present-day standpoint. The reader is assisted in his choice of a conveyor for specific purposes by diagrams, charts and tables. The author advocates continuity of process, the employment of more scientific methods, including the routing of the raw materials and the objects in course of manufacture, through industrial establishments along the shortest possible paths, thereby reducing the number and length of conveyors necessary, and in conclusion he lays stress on the need for better organisation generally.

"A man of wisdom with gentle handling can bring in frame
That by currishness no twenty can tame."
William Forrest (1558).

INTRODUCTORY.

THE Biblical injunction, "Open thy mouth wide and I will fill it," being more congenial to the toiler of to-day than St. Paul's emphatic words, "If any would not work neither should he eat," he follows it implicitly, and ignores the other.

He has an inflated idea of his value, clamours constantly for higher wages and lets loose the strike fiend amongst our industries, regardless of whether higher wages are deserved or otherwise. It becomes more and more evident that the worker of to-day is out to do as little as possible for as much as possible. He prefers to use brute force rather than logic, bringing pressure to bear by numbers upon individuals who employ him and with a quite unjustified exhibition of venom, seeks, with true Prussian tyranny, to impose the will of one section of the community upon all others. Such a course, if allowed to go on unchecked by the Government or by the intervention of labour-saving devices, will drive out of the country the industries by which we live; we hope, however, that both masters and men will see the handwriting of warning upon the wall in time to avert such a catastrophe.

The congestion caused throughout the whole civilised world at this particular period of our history, by unsolved problems and by the multiplication of great events, which have been and still are following each other, makes it essential that we should probe, to ascertain the cause of the trouble when we shall undoubtedly find that labour cost is the principal reason; if it is impossible to reduce this, then the only alternative is to do without hand labour as much as possible. It is only to be expected that this modern tendency threatens to render so-called "cheap" manual labour more and more prohibitive for handling purposes, while making way for labour-saving devices, because the cheaper the labour market the greater the reluctance to lay out capital for machinery and vice versa. While such conditions obtain it is not to be wondered at that captains of industries are making every effort to replace manual labour by labour-saving devices and thus dispense as much as possible with such a difficult and costly element as hand labour. the masters being only human one cannot wonder at their attitude. One after another handling operations which were formerly done entirely by hand are being performed by labour-saving devices.

In the United States conditions appear to be no better, for we read the following remarks in a recent issue of "The Coal Age," which expresses sympathetic sentiments :—

> The Labour situation, in a sense, has been responsible for almost every improvement in mining, from the laying of the first pair of mine rails to the adoption of the modern coal-cutting machine. . . . Coal production is now little more than a series of mechanical processes. The missing link in the chain of mechanical operations is the device which will replace or simplify hand-loading."

There never was such an opportunity in the history of the industries as the present. A kind of transition period between war and post-war conditions, and it lies with the captains of our industries to bring about a marked improvement in the post-war conditions over those existing in pre-war days. It is of significance to remember that for years Germany has included handling installations in her principal industrial undertakings, and we must not be blind to the fact that she has done so far more extensively than we have. We thus realise how it was possible for her to send such a vast percentage of her male population to the fighting front without crippling her industries. In one Alsatian steel-works alone, a conveyor plant was installed in the beginning of 1914, which handles the raw material with 24 workers, a performance which formerly took 101 men to accomplish. If necessity is the mother of the invention of mechanical devices, enterprise may lay claim to the fatherhood. And if the manufacturer continues to ignore the investigations of the inventor and refuses to venture on the new path opened out for him by the trained pioneer he has only himself to blame if, by halting between two opinions, he finds himself involved in labour troubles.

At a casual glance it is difficult to realise how profoundly the possibilities of industries have been modified by the advent of labour-saving devices in substitution of manual labour, by the exercise of enterprise it brings an infinite expansion within their reach. The employment of mechanical means for handling is, moreover, justifiable in more than one way. First of all, machines, if judiciously chosen for specific handling purposes, will do the work at a smaller outlay per ton than man-power can—this becomes more evident as manual labour increases in cost. In the second place, machines are more dependable, they are not subject to fatigue, they work as well on Mondays as on Saturdays, they do not go on strike. They are, we must admit, subject to breakdowns, either spontaneous or sometimes with the assistance of discontented men, but there are remedies for these defects, which, do not exist for the alternative—hand labour. It has been said that hand-labour has the one advantage over mechanical handling, that it is immune from breakdowns, but what is a strike if not a breakdown ?

Something is radically wrong, and it is beyond the scope of this Paper to investigate what ; but the fact remains that the British workman draws higher wages than any of his European colleagues and yet strikes more frequently. Unless the British workman is on his guard there will not be a trade, vital industry or public service which will not employ labour-saving devices, which dispense with 50 per cent., and often more, of the once solely used hand-labour. There must be a definite reaction before us in the immediate future, and the tide can only be stemmed and disaster averted by the united action of men, masters and machines.

The Economy of Labour-saving Devices.

Labour-saving devices, or for short L.S.D., are necessary in our daily life and in the maintenance of our industries, whichever way we look at the problem it spells L.S.D. to us. This was true before the war, when the harvest was relatively small and the labourers many ; it must be more true now, when conditions are reversed.

Are we to waste the prospects of a world-wide industrial harvest because the ranks of those brave fellows who have borne the burden and toil of the day have been depleted ? Certainly not. We have command over both the mechanical and financial L.S.D., and have also, the writer trusts, a sufficient number of honest toilers. Only by increasing the turn-out of our industries, and, consequently, our national wealth and well-being, shall we be able to reinstate conditions of civilisation which have been thrown so rudely out of balance.

When a man is wheeling goods in a truck each load he handles requires his time for loading, transporting, unloading, and, what is most galling, the returning with the empty truck, whereas with a conveyor equipment the only manual attention necessary should be for adjusting slides and gates, or a feeding device, in order to assist the material in a regular stream on to the conveyor, and possibly a little general supervision might be required, and a little help in putting the articles on at the feed end and removing them at the delivery end. An automatic handling device can often do all and more than can be done by a man in infinitely less time.

The initial step in deciding where hand labour should be employed, and where the machine, for transporting materials must be to ascertain the amount required for capital outlay for a mechanical equipment. The second item, which is of equal importance, is the consideration of the labour conditions obtaining in the locality, such as the cost of labour necessary to do the work by hand as an alternative. Another point which needs consideration, especially at the present time, is that the price of labour may at any moment be subjected to change and always in an upward direction.

The labour expenditure for handling goods in a factory, being unproductive, must not cost more than a certain percentage of the price of the finished article, such percentage necessarily varying according to circumstances and the value of the object. If inflated wages are demanded for the unproductive part of the process either the machine must be employed instead, or the selling price of the article or commodity must be revised with the possible consequences that the sale of the merchandise in question is restricted and the industry may even be crippled. On the other hand, we must realise that mechanical devices are only preferable to hand labour when the amount of material to be handled is sufficient to justify capital expenditure for their installation. The most up-to-date handling plant cannot be an economical investment if the quantity to be handled by it is below an annual limit, which, of course, varies according to the cost of manual labour and the capital expenditure for such plant. Expenses which have to be taken into consideration include interest, amortisation of capital, repairs, driving power, supervision and store.

Mechanical handling devices will always become economical when comparatively large quantities have to be handled, but with every type of machine there is a point below which hand labour must be cheaper ; the more inexpensive a machine, the smaller the capacity for which it becomes economical. An outlay for mechanical handling in any large proposition, is, therefore, generally advisable to-day, although under pre-war conditions it might or might not have been justified. Conveyors should always be employed where large quantities of materials have to be handled between fixed points at regular intervals, or where a large number of objects of similar size and weight have to be handled in a continuous stream at approximately regular intervals. No hard and fast rule can be laid down concerning handling installations, as every problem must be dealt with on its own merits.

Choice of a Conveyor for a Specific Purpose.

If a choice has to be made, which of the many types of conveyors on the market is the most suitable for a specific case, Fig. 1 may be used as a general guide, it must, however, be used with discretion and in conjunction with general data concerning each individual type of conveyor mentioned later. It will, for instance, be noticed that the worm or archimedean screw conveyor is not referred to in the diagram, although it may be used for small capacities in almost any direction, the diagram refers more particularly to the continuous or endless running chain or belt types of conveyor, which are by far the most generally used devices, and, moreover, have considerable affinity to each other although they are known under a great variety of names. The diagram can thus only be a reliable guide for average conditions, and it is not applicable to objects extremely heavy, extremely light, extremely friable, sticky or hot ; or to any other unusual purpose, in which cases expert advice should be taken. In Fig. 1 a number of conveying devices are indicated radiating in a fan-like fascicle, the feeding terminals of all being shown united in the same spot, while the delivery terminals branch out in all directions. It is assumed that the materials to be handled will run down an incline of 45 deg. and thus feed automatically on to any of the conveyors by gravity. The circle on the datum line being the feeding terminal for all types of conveyors, and according to their direction the device may be what is commonly and arbitrarily called an elevator or a conveyor.

From the requirements of any specific proposition it will at once be obvious in what direction we have to convey. All that has to be done, then, is to ascertain the angle of the conveyor to the horizontal, and we find what type or types of conveyors or elevators will serve our purpose best. We thus have bucket elevators from an angle of 90 deg. to 52 deg. to the horizontal, at a lesser angle the devices suitable will, step by step, pass in turn through the stages of bucket, tray, push-plate, slat, apron or band conveyors, and if we follow the diagram below the datum line we find angles at which a conveyor will run by gravity carrying the material without the expenditure of driving power; others in which a conveyor will develop surplus power (as a motor): again, others in which no conveyor at all is needed as the material will run by gravity in a plain shoot. For steeper downward inclines retarding conveyors or, as they are sometimes called, reverse elevators, are used, and finally, for a vertical descent the spiral shoot. The retarding conveyors will, of course, also produce power.

While most of the conveyors with a downward gradient below the datum line produce power all those above must obviously be power-driven, and the expenditure of such power depends upon the elevation to which the material has to be raised, plus an additional amount to overcome friction of the conveyor. In other words, the driving power necessary is at its maximum for the vertical elevator, all things being equal, and it will gradually decrease until the conveyor is parallel with the datum line when only frictional resistance is to be overcome. Below the datum line gravity enters into the calculation and at a downward gradient of about 7 deg. gravity alone is sufficient to overcome frictional resistance. As the gradient in favour of the load becomes steeper gravity asserts itself increasingly, so that it may become worth while to harness it in order to drive other plant, or to destroy it by a brake.

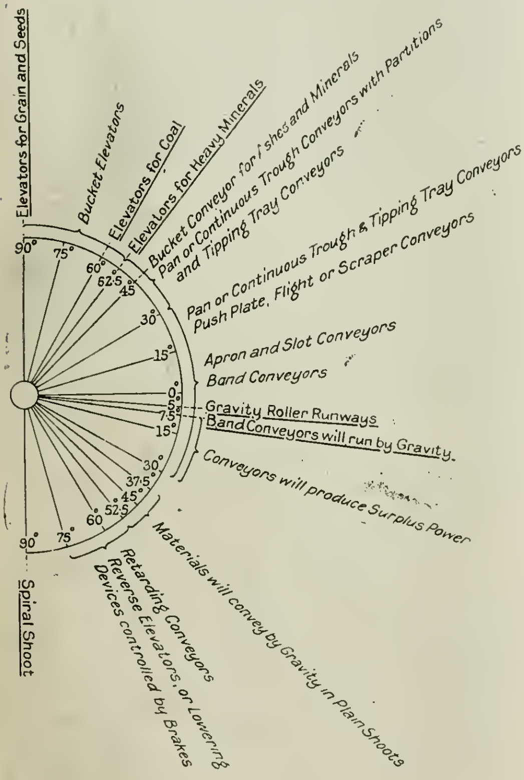
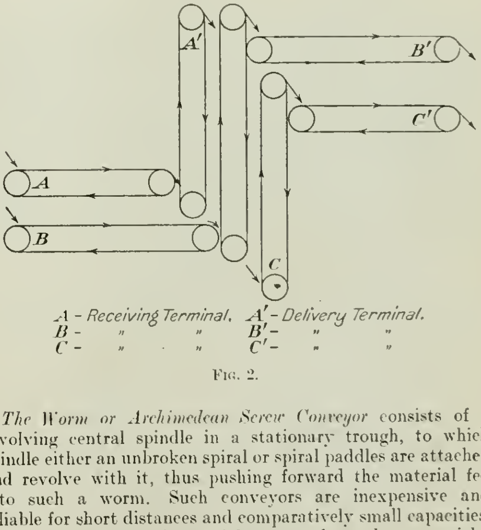

Elevators for Grain and Seeds
Bucket Elevators
Elevators for Coal
Elevators for Heavy Minerals
Bucket Conveyor for Ashes and Minerals
Pan or Continuous Trough Conveyors with Partitions and Tipping Tray Conveyors
Pan or Continuous Trough & Tipping Tray Conveyors
Push Plate, Flight or Scraper Conveyors
Apron and Slot Conveyors
Band Conveyors
Gravity Roller Runways
Band Conveyors will run by Gravity.
Conveyors will produce Surplus Power
Materials will convey by Gravity in Plain Shoots
Retarding Conveyors
Reverse Elevators, or Lowering
Devices controlled by Brakes
Spiral Shoot
90°
75°
60°
62·5
45
30°
15°
0°
5°
7·5°
15°
30°
37·5°
45°
52·5
60
75°
90°

FIG. 1.

In the early days of the art a separate elevator and a separate conveyor were used if the material had to be moved both horizontally and vertically in the way indicated by Fig. 2. Nowadays it is considered better practice in 90 cases out of 100 to use one handling device for both purposes, provided this can be done in the same vertical plane. In order to do so it must be ascertained what gradient has to be negotiated and then find from Fig. 1 what kind of conveyor is most suitable for the incline in question. this will almost invariably also answer for the horizontal portion. We thus get conveyors as shown in Fig. 3. When the devices cannot be in the same vertical plane, two independent devices are indispensable. There are conveyors which will work in more than one plane, but this subject is too complex for our present purpose.

As a rough guide it may be taken that a sum of about £1,000 may be economically expended in a handling installation which dispenses with the services of one man. In order that the cost of different handling propositions may be approximately estimated the data given herewith in the charts (Figs. 4 to 12) may be of some use. There are two charts for most types of conveyor, one, giving the approximate cost of the power consumption and the other the approximate cost of the conveyor, together with its electro-motor erected, but without cost of foundations. From the second chart (Fig. 5) the capital outlay, interest, amortisation and probable cost of repair can be arrived at with sufficient accuracy for our present purposes. With the help of these the reader will be able to ascertain also whether his handling work can be performed at less expense than what he is paying now for hand labour, and what number of men he can dispense with by labour-saving devices. The capital cost for different conveyors is based on pre-war prices and includes the complete installation with motor, erected at the site, but exclusive of excavation and masonry.



A - Receiving Terminal. A′ - Delivery Terminal.
B - " " B′ - " "
C - " " C′ - " "

FIG. 2.

The Worm or Archimedean Screw Conveyor consists of a revolving central spindle in a stationary trough, to which spindle either an unbroken spiral or spiral paddles are attached and revolve with it, thus pushing forward the material fed into such a worm. Such conveyors are inexpensive and reliable for short distances and comparatively small capacities, and can be used for all materials, except for such as are sticky and friable, very abrasive, or which contain extra large or long pieces. The principal sphere of usefulness for the screw conveyor lies in factories for the production of flour, oil, cement, artificial manure, and also for handling small coal For handling fine powders, such as plaster-of-paris, cement flour, gypsum, drugs, &c., worm conveyors are particularly suitable.

Table I., given herewith, will be found useful; it contains speeds and capacities of different sized worms when handling a variety of materials. The prime cost of a worm conveyor may be found approximately from Fig. 5. Fig. 4 shows the power consumption of worm conveyors for different duties and lengths in kilowatt-hours. This chart and the succeeding ones are based on a material of the density of coal, *i.e.*, 40 cubic ft. to the ton; and the data for materials of other density can readily be arrived at from this. After having ascertained the prime cost of a conveyor for any purpose from the chart, all other expenses, such as interest on capital outlay, depreciation, supervision, &c., can be determined, and the approximate cost of handling the material per ton can be arrived at. The same scrutiny may be applied to several alternative types of conveyor for the same proposition, for comparison and the most economical installed. The depreciation of this kind of conveyor is considerable relative to its first cost, when handling cutting substances, but the actual cost of repairs is not excessive. The operating charges are very small, as, when once set to work, such a conveyor requires practically no supervision. An arbitrary figure may be put at a farthing per inch diameter of the worm per hour. As to cost of supplies, a farthing per hour per horse-power may be allowed, as such conveyors should be well lubricated.

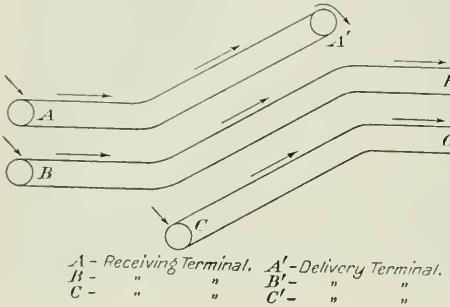


Fig. 3.

The burden of interest on investment, insurance, taxes, &c., is about 8½ per cent. of the initial cost; in addition to this, there is a renewal charge of about 20 per cent., together 28½ per cent. per annum.

The Push-plate, Scraper or Flight Conveyor consists of an endless chain, or, as an alternative, a pair of matched chains which are provided at regular intervals with a plate or bar at right angles to the chain or chains. A trough of suitable section is provided, in which generally the lower strand of the chain travels in such a way that the transverse plates or scrapers convey the material fed into the trough, while the upper strand returns idle. These scraper conveyors are generally made for capacities of from 5 to 50 tons per hour; they are principally used in gas and power undertakings for handling small coal, and in sugar factories for beet chips. They are also employed in paper works and breweries, in the former for handling rags and waste paper and in the latter brewers' grains. Flight conveyors are employed for material which does not deteriorate much by friction, and where the expenditure of driving power is of less importance than the initial cost of the plant. The capacity of the push-plate conveyor is relatively great for its width, though the speed is slow. Advisable speeds for different materials may be found in Table II., which records the most suitable speeds for different types of conveyors on a variety of materials.

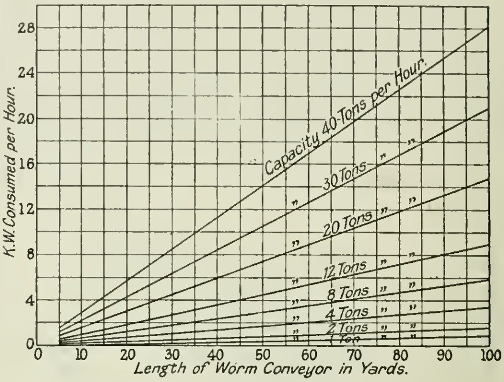


Fig. 4.—Power Consumption of Worm Conveyors in Kilowatts per Hour.

Table III. gives capacities in tons per hour of push-plate or flight conveyors when running at the economical speed.

Table I.—*Capacity of Worms in Tons per Hour.*

Diam. of worm.	Revs per minute.	Coke.	Ashes.	Fine coal.	Lime and cement.	Sand and gravel.	Ore.	Crushed stone.
4	220	...	...	...	4	5	6	8
5	205	...	...	...	6	10	12	15
6	195	5	6	7	10	15	16	22
7	185	6	9	10	13	22	25	32
8	175	10	12	15	18	32	36	46
9	170	12	18	20	25	44	48	55
10	160	17	22	25	33	60	72	80
12	150	27	37	42	55	90	100	125
14	140	40	60	62	80	135	150	190
16	130	60	75	85	110	190	205	265
18	120	75	100	110	145	250	350	...
20	115	100	125	137	180	300	345	450
24	100	150	200	220	280	475	500	...

Table II.—*Conveyor Speeds.*

Material.	Average weight in lbs. per cubic ft.	Economical speed of conveying belt or chain in feet per min.			
		Push plate conveyors.	Bucket conveyors.	Band conveyors.	Bucket elevators.
Coke	33·5	100	40	250	100
Broken stone (coarse) ...	165·0	125	50	275	125
Run of mine coal	55·0	125	50	275	125
Ashes	45·0	150	60	300	150
Lime and cement	65·0	150	60	300	150
Ore (average)	125·0	175	70	350	175
Crushed stone...............	160·0	175	70	375	175
Sand and gravel............	110·0	175	70	375	175
Fine coal.....................	50·0	200	80	400	200
Light grain and seeds ...	40·0	...	...	400	300
Heavy grain and seeds ...	48·0	...	...	500	400

Table III. *Size and Pitch of Flights in Inches.*

Material.	4 × 12 × 21 in.	4 × 12 × 18 & 5 × 15 × 24 in.	5 × 12 × 16 in.	4 × 12 × 12 in.	6 × 18 × 24 in.	5 × 12 × 12 & 5 × 15 × 16 in.	6 × 18 × 18 in.	6 × 18 × 16 & 8 × 18 × 24 in.	8 × 20 × 24 in.	6 × 18 × 12 & 8 × 18 × 18 in.	8 × 18 × 16 & 8 × 24 × 24 in.	8 × 20 × 18 in.	8 × 20 × 16 in.	8 × 18 × 12 & 8 × 24 × 18 in.	8 × 24 × 16 in.	8 × 20 × 12 in.	8 × 24 × 12 in.
Coke	10	20	25	30	35	37	45	52	60	72	80	85	100	120	130	135	175
Ashes	26	45	60	70	75	82	100	112	130	150	175	180	205	225	265	275	355
Run-of-mine coal	30	50	62	75	80	85	110	120	140	165	185	190	212	240	275	285	370
Lime and cement	40	60	88	100	105	125	150	160	195	220	250	265	300	345	385	410	525
Fine coal..................	50	75	100	110	120	130	160	175	205	230	260	275	305	360	400	420	540
Broken stone	105	150	205	225	235	275	325	370	425	480	550	575	640	735	830	865	1,110
Ore	120	170	225	235	255	300	350	380	455	520	580	610	680	785	880	920	1,100
Crushed stone............	140	205	275	305	325	375	435	490	575	655	735	775	875	1,000	1,125	1,165	1,510
Sand and gravel.........	160	225	305	330	350	400	460	525	610	700	780	820	910	1,050	1,175	1,225	1,580

Inclining a conveyor in an uphill direction reduces its capacity by 1⅔ to 2 per cent. per degree of angularity with the horizon. The economic value of a flight conveyor depends upon its operation at the highest permissible speed for the particular material handled (*see* speed, Table II.). The electrical energy consumed by flight conveyors may be seen from Fig. 4.

Skidder-bar flight conveyors when fully loaded consume about 10 per cent. more power than similar conveyors with roller flights, and, in addition to this, the rate of depreciation is reduced and the initial cost increased ; but, taking all circumstances into consideration, the roller supported flights are an economic gain. Fig. 6 gives the power consumption in kilowatts and Fig. 7 gives the approximate initial cost of these conveyors. The depreciation of flight conveyors, except when handling abrasive materials, is slight, especially when coal is handled, which has a polishing effect upon the trough, and when once polished the abrasion, as well as power consumption, is very small.

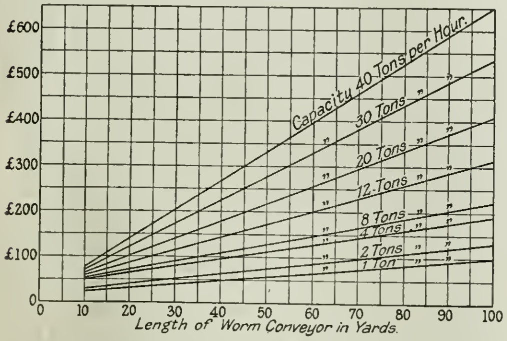


Fig. 5.—Approximate Initial Cost of Worm Conveyor Installation.

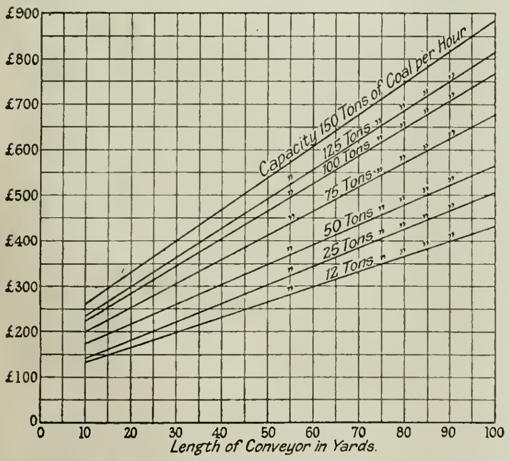


Fig. 7.—Approximate Initial Cost of Push-plate Conveyor Installation.

The labour charge per foot for a flight conveyor per hour may be taken at between 1d. and 1½d. per inch of width of conveyor. Incidental supplies and repairs would be covered by about 1d. per hour per horse power consumed for conveyors with skidder bars, and about 10 per cent. less if the flights are provided with roller supports. The burden of interest on capital, insurance and taxes should be about 8½ per cent. per annum on the initial cost, and there is usually an annual renewal charge of about 20 per cent.

The Bucket Conveyor consists of two matched strands of endless chain, to which a series of buckets are attached at regular intervals. This chain can travel on a horizontal path as well as on a steeply inclined one, and therefore possesses the combined advantages of an elevator and a conveyor. Such appliances may be fitted with rigidly attached buckets, when they are known as tray conveyors, or with pivoted buckets, which are suspended above their centre of gravity, and are, therefore, always in an upright position, whether they travel horizontally or vertically. These latter machines are known as gravity bucket conveyors. There are other varieties of this type. The V-bucket elevator with a rigidly fixed bucket which acts as a scraper on a horizontal run, and the tip tray conveyor, which, unlike the tray conveyor, can discharge at intermediate points like the gravity bucket conveyor. While the gravity bucket conveyor and the V-bucket elevator can negotiate a vertical ascent, the tray and tip tray type can only be used for inclines of about 20 deg. without any modification in their designs ; for steeper ascents they may be fitted with "back lips" or cross pieces to prevent the material from sliding down. The power consumed by a conveyor of the gravity bucket type or the tip tray type (or, in fact, any conveyor which lifts as well as conveys) is small : the ascending strand balances the descending one, so that only the actual weight lifted, plus the friction, need be taken into account. The economic speed and capacity of chain bucket elevators depends upon the material handled, and is given in Table II.

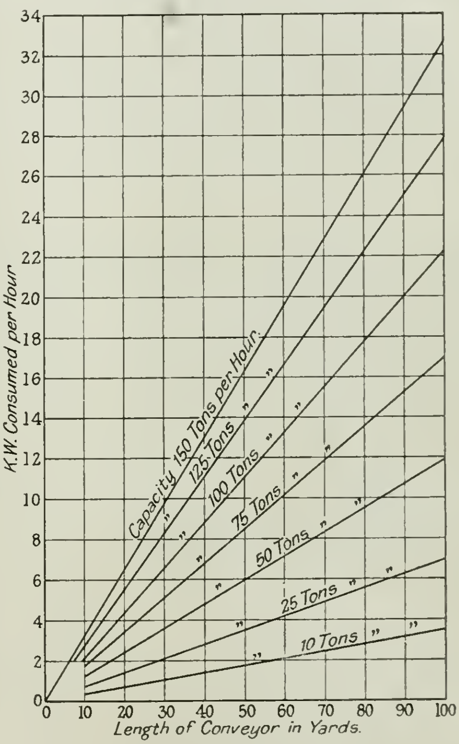


Fig. 6.—Power Consumption of Scraper Conveyors in Kilowatts per Hour.

The initial cost of chain bucket and similar conveyors is high as compared with almost any other type of conveyor or elevator ; the operating charges are also higher than with other conveyors, so that 2½d. per hour per inch of width of bucket should be allowed for supervision charges for rigidly fixed buckets, and 2d. per inch per hour for those with pivoted buckets. In the former case ⅜d. should be allowed for store per horse power per hour, while with pivoted buckets ⅛d. per horse power per hour is sufficient. The annual depreciation in the former case may be taken as 33⅓ per cent., and in the latter 20 per cent. for average duty.

The Belt Conveyor is undoubtedly the most popular one, and more or less suitable for handling all materials, except hot and sticky ones. It is particularly useful for dealing with large quantities with a minimum of abrasion to the materials. The cost of conveying depends principally upon the life of the belt itself, the cost for repairs to the rest of the machine being insignificant. The life of the belt depends, in turn, upon its quality, the nature of the material handled, the methods of feeding and of withdrawal, and the support of the terminals and idlers.

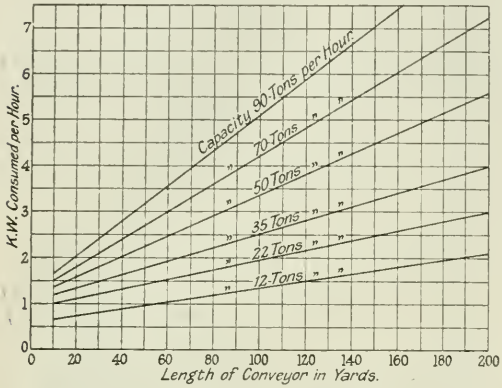


Fig. 8.—Power Consumption of Band Conveyors in Kilowatts per Hour.

Table II. gives the economical speed for band conveyors.

Table IV. given below, shows capacity in tons of different materials when the band is running at the economic speeds given in Table II. The figures in the first column coincide with the materials tabulated in Table II.

The capacities given in Table IV. are approximate, and can only be attained when the conveyors are perfectly loaded. At any rate, 90 per cent. of the figures should be easily attainable.

A ready way of discovering the approximate cost of handling by band conveyor is to refer to Fig. 8, which gives the consumption of kilowatts per hour for certain duties, while the approximate prime cost of a band conveyor is given in Fig. 9. The fascicle of oblique lines proceeding from the lower left-hand corner are for this purpose, while the cost of the renewals of the conveying band may also be found by means of the set of oblique lines starting from the lower right-hand corner. Thus, if the cost of conveying is debited with the decimal fraction of a shilling per hour, as given in the chart; it will be approximately equal to its share in the depreciation of the band. If band conveyors are fitted with ball bearing idlers, the driving power is 33·3 per cent. less than that necessary for ordinary bearings, while the cost of a conveyor fitted with ball bearings is only about 5 per cent. more, with roller bearings 15 per cent. more, so that in reality the employment of ball or roller bearings will be more economical. The annual depreciation on belt conveyors should be put at 25 per cent. of the initial cost of the belt itself when grease lubrication is used, and 10 per cent. on the rest of the equipment. The expenses for grease or oil and other incidental stores to keep the equipment in working condition are, with conveyors constantly in use, very nearly in direct proportion to the horsepower consumed in driving them. This averages about five-sixteenths of 1d. per hour per horse-power, and of the above about ¼d. is for supplies. With ball bearing idlers this would be one-sixteenth of 1d. per hour per horse-power. The deterioration and amortisation is a complex subject, because a conveyor belt, like all rubber goods, deteriorates rather more when standing idle than when constantly in use in a reasonable manner, though depreciation proceeds to a certain extent, whether the belt is in use or not, owing to the hardening of the rubber and consequent loss of resistance. The above is, however, a safe figure for depreciation. These depreciations do not, of course, cover the usual charges, consisting of interest on capital invested, insurance and taxes, for which 8½ per cent.

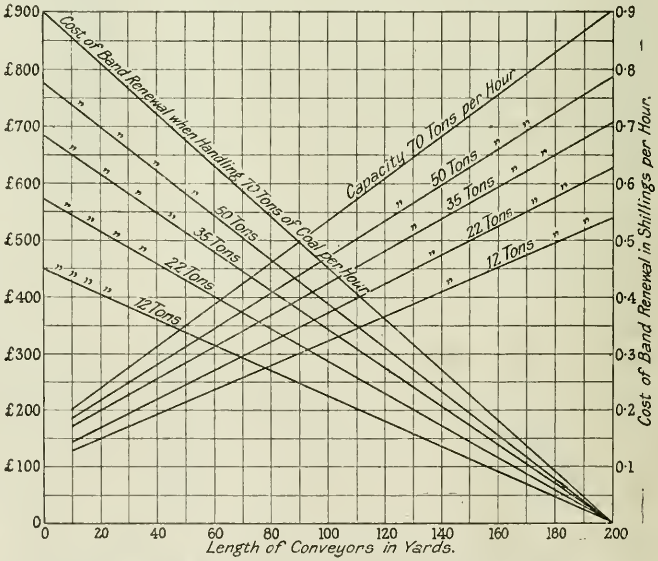


Fig. 9.—Approximate Initial Cost of Band Conveyor with Cotton Band and One Throw-off Carriage. The Curves also Show the Cost of Band Renewals.

Table IV.

	12 in. band.	14 in. band.	16 in. band.	18 in. band.	20 in. band.	22 in. band.	24 in. band.	26 in. band.	28 in. band.	30 in. band.	32 in. band.	34 in. band.	36 in. band.
Coke	18	20	25	30	40	50	60	70	80	90	110	120	135
Broken stone	25	40	45	60	75	90	110	135	160	180	200	230	260
Run of mine coal	30	45	50	63	80	100	120	145	165	195	220	250	280
Ashes	40	50	70	90	110	130	160	190	215	245	280	320	360
Lime and cement	50	60	75	95	120	142	175	200	225	260	300	340	390
Ore	60	80	110	120	170	205	240	290	330	390	440	500	560
Crushed stone	85	120	155	195	235	285	340	400	465	540	610	690	780
Sand and gravel	90	125	160	200	240	300	355	415	480	555	630	715	800
Fine coal	95	135	170	215	265	320	380	450	520	600	680	785	865

per annum on the invested cost should be allowed. The working cost of flat conveyors is usually somewhat less than that of troughed conveyors, not only because a cheaper quality belt may be chosen, but also because the depreciation is only about 25 per cent. of that of troughed bands. The operating charges of belt conveyors are almost negligible, but, on account of periodical inspections, they should be charged with some arbitrary labour expense, say ¾d. per hour per inch width of conveyor for conveyors with grease lubrication and ½d. for conveyors with ball bearings.

The Bucket Elevator, by which bulk material is conveyed at a steep gradient or in a vertical direction, is too well known to require any general description. Its capacity depends on the speed and size of the buckets, the latter ranging from about 60 to 1,600 cubic in. per bucket. These measure respectively from 6 in. to 21 in., which latter is the maximum for a single chain. The pitch of the buckets ranges from 1 ft. to 3 ft. The speed depends upon the nature of the material to be handled, and is from 60 ft. to 200 ft. per minute. (Grain is sometimes handled as fast as 400 ft. per minute).

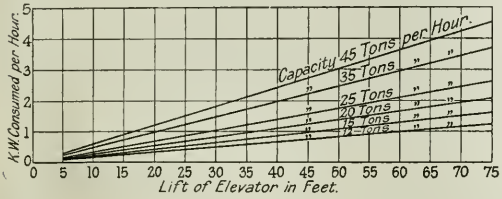


Fig. 10.—Power Consumption of Vertical Grain Elevators in Kilowatts per Hour.

Table II. also gives advisable speeds of elevators for different materials.

For power consumption for grain elevators see Fig. 10, while Fig. 11 gives that for inclined mineral elevators. Fig. 12 gives the approximate prime cost of grain and mineral elevators. To ensure economic working, the uniform feeding of an elevator is of the greatest importance, for if fed irregularly or spasmodically its dimensions have to conform with the peak demand upon its capacity, and it is therefore larger and more expensive than when strictly conforming to the average load. The maintenance charges are similar to those for bucket conveyors.

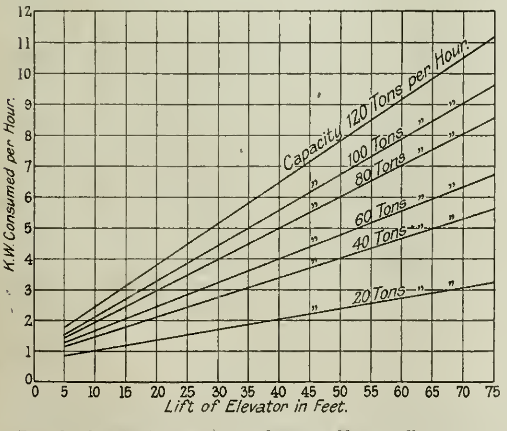


Fig. 11.—Power Consumption of Inclined Mineral Elevators in Kilowatts per Hour.

One of the fundamental conditions for an economical and successful handling scheme is never to lay down any material when conveying it by a handling device until its destination be reached, the bunker, for instance, over a boiler, retort or mixer, to which it can gravitate. If the material conveyed cannot be used immediately, it should be laid down upon a place so prepared for it that it can be withdrawn by gravity on to a conveyor when wanted. In other words, the material handled by labour-saving devices should always be delivered, if not direct to where it is to be used, then into a receptacle at a sufficient height to be tapped off when required, or from whence it can gravitate into a handling device at a lower level, so that in both cases gravity can "carry on." In many cases it will be found that the largest unproductive portion of the cost of labour is for movement of material; eliminate such costs and more work will be turned out at the same overhead charges. The smaller the amount of labour—*i.e.*, physical effort—employed in relation to the task accomplished the greater the wealth produced. In order to benefit to the full by the installation of labour-saving devices it will be necessary to ensure that the process of manufacture is carried on continuously; that the routing is on scientific lines, and that the organisation of the whole establishment is on up-to-date lines. The remainder of the space is, therefore, devoted to these three subjects.

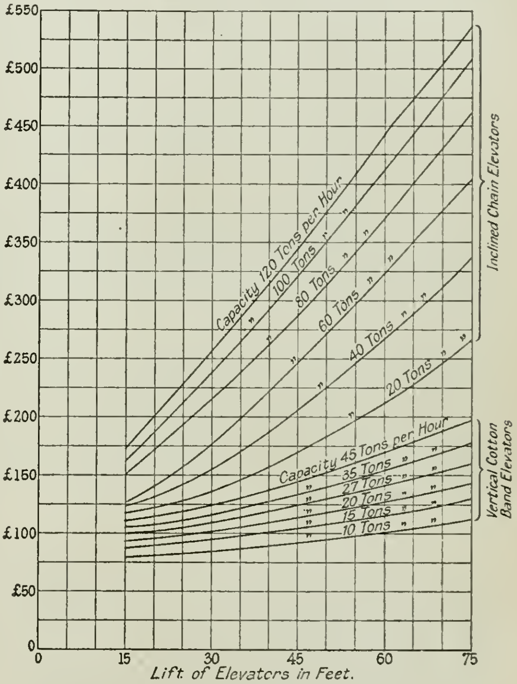


Fig. 12.—Approximate Initial Cost of Bucket Elevators for Grain and Minerals.

Continuity of Progress.

If any manufacturing process is to be carried out to the greatest advantage, it must be rendered as continuous and uninterrupted as possible, in order that the manufacturing plant (which embodies site, building value, that of machines and apparatus, as well as remuneration of the permanent staff) may be productive to its full capacity. Continuous working is not possible without continuous supply of raw material, and no continuous handling is economically possible without labour-saving devices. Continuity of process is not only a commonsense proceeding in a factory, but it includes features which are not at once obvious: for instance, it prevents men and machines being idle, and "every wait is a weight" which burdens the expenses account and hampers progress, for idleness spells unproductive capital. In a given manufacturing process all handling operations between machine and apparatus, if on lines of continuity of process, are interdependent. If one fails they all suffer more or less. Now, if the human element is employed for such handling processes, delays and interruptions are almost unavoidable, for "to err is human." As regards the machine, however, we know exactly what its capacity is, and this is permanent and positive, provided it is fed as a unit of a series of machines should be. The aim of those installing conveyors of any kind should be to arrange for uniform loads throughout the day, in particular, "peak" loads should be avoided. By such means continuity of progress can be upheld. The only exception should be in cases where material has to be unloaded from railway trucks or vessels where it is a case of saving demurrage; then the handling device should be such as will unload in a minimum of time, but this does not interfere with the rest of the plant, as such supplies always go on to dumps or into stock bunkers. It might be supposed that intermittent handling devices are not suitable in the chain of proceedings of continuity of any process, but this is not the case, for so long as the intermittent loads follow each other in an unbroken succession of individual loads, carried one every so many minutes, or even hours, the process is for our purpose continuous. For instance, some methods cannot be carried out in absolutely unbroken continuity. Concrete mixing, carbonising of coal in gas works, mixing of dough for bread and biscuits, and so on; these must be performed in batches, but the machines used for each purpose can, none the less, be connected with conveyors, which bring and accumulate the material during the interval of the process in question, so that at its conclusion the necessary material for the next batch is ready to be shot into the machine instantaneously from such overhead receptacle. A bucket elevator which receives and delivers material in a continuous stream might be deemed to be intermittent, for each bucket carries its own little load; but they fill, pass and empty with such precision, each containing the same amount, each passing at the same speed and at the same distance apart, that at the receiving and delivery ends the intermittent nature of the process becomes obliterated, something like a cinematograph picture, which is produced by an intermittent process, shown as a succession of pictures which give our perception the impression of a continuous process.

Routing.

The question of correct routing in industrial establishments has not as yet received the attention it deserves in this country; one only too often finds the routing zigzagging haphazard through the works. A scientific routine must be laid down for a manufacturing business and followed implicitly; this is best done by keeping to a *modus operandi* by which the flow of work to each unit in the process is uninterrupted and of the required quantity, if otherwise it disorganises the plant. If anyone will map out a factory, or, say, one floor of it, to a small scale, showing all working tables, machines apparatus, hoppers, bins, etc., which the objects will have to traverse, and mark their path in red ink, he will see at a glance if his routing is along the shortest line, or whether it crosses and recrosses travelling over a roundabout way. A saving of from 20 to 30 per cent. can often be effected by the re-arrangement of the routing and the rearrangement of a few machines, etc.; satisfactory routing also cheapens piecework rates, particularly where handy men and unskilled labour are largely employed. What is necessary is to find that method or co-ordinated set of methods of routing which will save the greatest amount of labour and consequently speed up output. In many cases the arrangement of the factory buildings is at fault and responsible for confused routing, as after a works has outgrown its housing, and additions have, from time to time been made to the buildings, to meet the growing demands, the routing has often become more intricate and more hopelessly confused. In such cases nothing but a wholesale rearrangement will reduce conditions to anything like order.

When the laying out of a new plant or the reorganising of an existing one is contemplated the first step should be a careful study of the specific conditions which obtain in the particular industry concerned; the time occupied in each process should be observed and recorded, as this will facilitate the choice of not only the most effectual equipment for the handling of the materials but also the best routing. A knowledge of the local conditions will also be a great help in the laying out of an industrial plant, particularly as regards solving the problem of transportation of fuel and raw material along the shortest and most direct route to the boiler house and works respectively, also in the disposal of the ashes and other offal. In the internal handling arrangements of a works, not only the handling from department to department and from workshop to workshop must be considered, but also the mechanical handling of objects in course of manufacture from bench to bench, from apparatus to apparatus, as well as their conveyance to the store, packing, or forwarding room when finished.

Organisation.

Organisation may be defined as the employment of a number of workers and devices in such a way that they unite by their combined efforts in a happy and successful creation of that commodity of life which it may be the object of an industry to produce. In other words, the desired efficiency should be obvious and unhampered. In the production of some of the commodities of life the daily routine of any industrial establishment consists of certain recognised processes which are followed in a more or less stereotyped fashion. As a rule, the manufacturer follows the routine which he understands; generally he brooks no interference from outsiders with those methods which he considers represent the only correct and most advantageous notions. It rarely occurs to him that his cast-iron rules and routine are in themselves the improvement on a previous and obsolete procedure, and that cruder methods still preceded this, and conversely, that to day's best methods will be the obsolete ones of to morrow. The labour trouble will help him to decide whether to amend his ways or to put the shutters up. A large share of the weekly labour bill is and must be unproductive and invisibly spent on the process of conveying material in bulk or in packages, and an important saving can be effected in most establishments by more up-to-date organisation of the internal transport facilities. Many factory managers do not even know how much they spend in this way. Demurrage bills are nearly always due to indifferent organisation of, or non existence of, efficient handling devices.

Not so very long ago our Prime Minister said, "Industrially we are an ill-organised State." The subject under discussion will not, we know, be sufficient to solve the problem, but it will go a long way towards doing so. What is difficult to understand is the deplorable want of labour-saving devices, even in important Government establishments of the greatest repute and standing. They are in some instances far behind the modern munition factories which sprang up like mushrooms, but yet are up to date.

Conclusion.

In the foregoing we have seen that unskilled labourers as a class, have, by their constantly increased demands for higher wages reduced their sphere of action very considerably. This process of partially closing to them industry after industry began in 1881, and with every strike it has received a fresh impetus. It might be estimated that half the handling operations are now performed by machines, *i.e.*, one half of the men formerly employed in conveying loads had, and have, to find new spheres of labour. If labour prices increase still further the machine will encroach upon hand labour pro rata, and if by the demands of the labour market, the industries are confined to manufacturing for home consumption only, fewer labourers still will be required. The rates of pay in the neighbouring countries being so much lower than in our own, will not favour our export trade with them. If, on the other hand, the men are satisfied with reasonable remuneration for their toil, the adoption of the labour-saving devices will probably not spread into such industrial spheres as have hitherto been unaffected, and at least the smaller works of most industries will be content with hand labour. As civilisation advances the machine is bound to come in as it has done, for the benefit of the general community, but there would be not so extensive a transformation were not the industrials driven to employ it in order to compete with the world outside this island. Both hand labour and the machine have their legitimate spheres, and if all goes well neither will encroach upon the other, for the safeguard of the men is the Capitalist's reluctance at all times to spend his money.

We also see that the success of any process or manufacture is in a great measure due to the employment of labour-saving-devices and continuity of proceedings and the greatest possible automaticity, not only during the different processes of manufacture, but also in the connecting links between these, viz., the labour-saving devices, be they by gravity or by mechanical conveyors. It may be predicted that a keener international struggle for supremacy will be waged in the immediate future, which to win will mean for us a continuation of national prosperity, to lose, disaster.

If man must do more work than ever before in order to uphold British industries he must have the tools to do it with. No man must be employed for any work which can be performed better, quicker and cheaper by the machine. The ranks of the philistines who oppose progress are fortunately dwindling fast. We are both able and apt to deal with the problem, provided we employ scientific methods and use the machine to release the man for a better job than for the exercise of mere brute force.

In this article the writer has supplemented his own experience by extracts from the writings of Reginald Trautschold and Prof. Aumund.

Coal Face Conveyors.

By H. C. JENKINS.

Summary.—The author first describes various types of conveyors, including the belt and shake conveyor and deals with the best conditions of working for each type. It is pointed out that the present high cost of labour means an increase in the use of conveyors, and the conditions under which conveyors can be installed and the difficulties of working them are described. The question of the employment of conveyors is mixed up with labour difficulties, such as unprofitable working and "ca' canny" attitude adopted by the miners, and in installing these machines it is pointed out that the methods of payment of the men must be carefully gone into. Finally, the use of portable conveyors for surface work is described, together with the utilisation of gate conveyors and the savings effected by their employment.

IN coal mines where long wall faces are in use, the colliery management are faced with the problem of removing the coal hewn by the miner in the cheapest and most expeditious manner to the shaft bottom. The usual practice is to have "gates" or roadways every few yards of the face, into which a tub is taken to be filled by the miner direct. This method means that stone walls have often to be built on either side of the gate road to keep up the roof. In addition, the coal has to be thrown from the face itself two or three times before it is placed in the tub. The tubs are usually brought out by ponies on to the main road, and hauled by a rope haulage to the shaft bottom.

To increase production on the coal face, systems of conveying have been applied with varying success. The coal faces vary from 60 yds. to 250 yds. in length, the thickness of the seams varies from 17 in. up to 7 ft., the gradients of the seams vary from 1 in 3 against the load to 1 in 3 with the load. The design of conveyors has to be such that it can be applied to any or all of these conditions. The usual method of working necessitates the "flitting," or moving forward of the conveyor every 24 hours, a distance of from 3 ft. to 6 ft. to keep it close up to the coal face; therefore it must be compact and portable, also rigidly built to withstand rough handling. The most satisfactory method of working is a systematic cycle every 24 hours. On a machine cut face the afternoon shift undercuts the coal the whole length of the face, the night shift men move the conveyor forward and set it in position ready for the morning shift, who fill coal on to the conveyor. Where the faces are hand-worked, it is usual to have two filling shifts and one flitting shift. The great advantage of this system is that the coal is removed systematically, approximately the same amount of coal being removed each day, thus facilitating haulage and winding arrangements, and the general pit lay out. Many of the roof troubles cease, as it can now be controlled easier. More men are concentrated in one area, resulting in more coal being produced per man, also fewer roadways, with consequent reduction of wear and tear, are necessary.

A great deal of ingenuity has been expended in designing underground conveyors, but the chief difficulty is to get an article that will stand up to the rough handling due to coal face conditions. It has been a case of the survival of the fittest, and the two types chiefly in use are the band or belt conveyor and shaking or jigging trough conveyor. These two conveyors are of the continuous discharge type. Experience has shown that the men fill more continuously on to this type, as there is no waiting for the conveyor as with intermittent conveyors. The belt conveyor consists of a driving head, a double length of belting along the coal face, and a tension drum at the far end. The conveyor head is entirely self-contained, the belt is passed over three drums, the first one acting as an idler, and the other two as driving drums. The motor and starter are rigidly attached to the head, and speed reduction is obtained by means of a combination of worm and spur gearing. The motor is of flame-proof production, and is direct-coupled to the worm-shaft. The starter is of the drum type, the drum being in the same cast-iron box as the resistance in the case of direct-current motors. The alternating-current motors are of the squirrel-cage type, wound for star-delta starting. The leads between the motor and starter are passed through screwed tubing to protect them from damage. The average horse-power exerted by the motor driving a 100-yard length of conveyor is approximately 4½ H.P., but an 8 H.P. motor is always fitted to give an ample margin in case of sudden loads, due to pieces of roof and timber falling on the belt. Fig. 1 shows a conveyor of this type.

The conveyor head frame work consists of two steel plates fitted with cross-stays and sufficiently rigid to allow of it being dragged bodily over rough ground. Various types of belting have been tried, but the service is exceedingly severe. The conditions may be hot and wet or exceedingly dusty, and belting which may work satisfactorily on surface installations would not last many months on underground conditions. The belt which has stood the best of all is about ⅜ in. thick by 20in. wide, and is made of best woven cotton treated with a special preservative compound. This compound must penetrate the whole belt to prevent rot setting in, and must keep the belt in a flexible condition. If the belt is too hard the fibres will crack when passing round the drum. It should not be sticky, or it will pick up dust, which will work into the fabric. The edges should be hardened to prevent wear due to rubbing on props or other projections. The tension drum consists of two short lengths of girder, on which are mounted two bearings to take the drum shaft. The belt is carried along the face on roller frames consisting of flat bar steel frames, on which are mounted cast-iron bearings to take the drum spindles. The drums are 5 in. in diameter, and are made of old circular pit props, with a steel rod driven through them, or of short lengths of steel tubing.

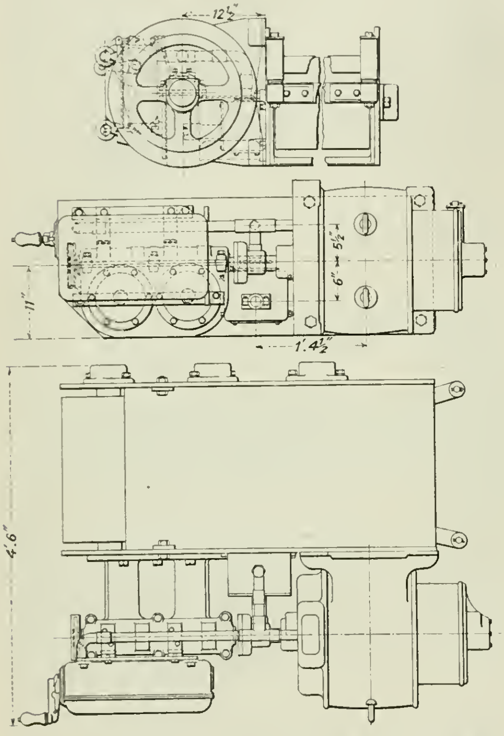


Fig. 1.—Meco Belt Conveyor with D.C. Westinghouse Motor Controller and Plug Box.

If it has been decided to instal belt conveyors in a particular coal seam, the conveyor head is fixed at the delivery or gate end, in such a position that it can deliver direct into the tub. Where there is bottom ripping—*i.e.*, where the rock below the level of the coal seam is excavated to give head room—the head is allowed to project over the edge, and the tubs pass underneath as they are filled. In cases where there is top ripping—*i.e.*, the rock above the coal is removed—the front of the conveyor head has to be elevated to deliver into the tubs, as shown in Fig. 2. This can be done by putting the head on a special frame, or, if only a small amount is required, by putting some timber underneath. The conveyor head is then fixed either by wedging props against the frame or preferably by attaching chains to the frame and carrying them across the gate to a prop fixed specially for the purpose. Tension is put on the chain by means of tension screws or a prop withdrawer. The belting is taken down the pit in rolls, usually 25 yds. in length; these are unrolled and laid on the roller frames, which are from 12 ft. to 15 ft. apart. One length is threaded through the drums on the conveyor head, another length is passed round the tension drum, the belt fasteners are then coupled up, and finally the necessary tension is put on by means of tension screws attached to the tension drum. After this section of coal has been filled on to the conveyor it is moved forward ready for the next filling shift, the tension is first of all taken off the belt, and the belts uncoupled and moved from 2 ft. to 6 ft. nearer the coal face. Where there are a large number of props it may be necessary to thread each section of belt between the timbering. The usual plan is to roll up each length, push it between the props, then unroll it again. In some cases, where there is little timbering, the belts and rollers can be pulled over bodily, the head being moved into position at the same time and then coupled up. Conveyors of this type have been dismantled, moved forward 3 ft., and then re-erected by two men in four hours, but a fair average time is four men in four hours.

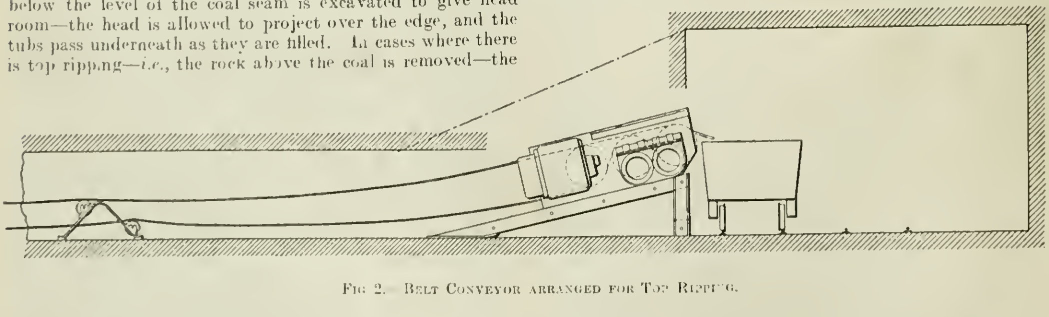


Fig. 2. Belt Conveyor arranged for Top Ripping.

The majority of belt conveyors in use are electrically driven, but in cases where compressed air drive is necessary, an 8 h.p. to 12 h.p. compressed air turbine, running at 1,200 revs. per min. is fitted. Compressed air turbines are of American origin, but they are manufactured in this country now. They consist of two accurately cut helical gears in a housing on which the compressed air impinges. Being simple, extremely reliable and fairly efficient, they are admirably adapted for driving underground machinery. The air turbine is coupled direct to the worm-shaft, similarly to the motor, with the addition of a simple gear change for reversing purposes (Fig. 3). The conveyors are made reversible to enable timber and packing materials for keeping up the roof to be sent up the coal face when the conveyor is not delivering coal (Fig. 4).

The shaker or jigging trough conveyor is not so generally applicable as the belt conveyor. In contradistinction to general practice, it is almost as efficient with compressed air as with electric drive, the reason being that it depends entirely on a reciprocating action which can be obtained more effectively by compressed air than by electricity. The compressed air shaker conveyor can be divided into three parts. The compressed air engine or motor, the driving gear, and the troughing. The engine consists of a plain cylinder with two end covers; at the piston end there is a gland, the valve gear being fixed at the other end. The valve gear is mechanically operated from either the side rods as illustrated, or from the piston, by means of rollers and projecting taper keys (Fig. 5). The cylinder diameter varies according to the weight of troughing and the gradient, but averages from 10 in. to 14 in., the length of the stroke being adjusted by altering the position of the taper keys. The method of connection between the troughing and the engine depends upon the conditions. Where possible the engine is fixed underneath the troughs and connected direct by means of a connecting rod. In thin seams, where this is not possible, the engine is placed on the side of the troughs, a cross-arm is attached to the engine and pivoted on a column, the connecting rod being attached to the cross-arm (Fig. 6).

The troughing consists of pressed steel plates about 20 in. across the top and 5 in. deep. They are in 11 ft. sections and bolted together. On each section is rivetted an inclined roller path, an identically shaped roller path being fastened to a light frame which is placed directly underneath, and rests on the ground. A pair of solid wheels on an axle is placed between the top and bottom roller paths. The coal is loaded into the conveyor troughs which are pulled up the inclined roller paths by the engine, and then allowed to back run by gravity, a certain momentum being imparted to the coal and at the instant the troughing reaches its lowest point the valve reverses the air on the engine, and immediately checks the troughing, the coal shooting forward. This procedure is repeated 60 or 70 times per minute, so that on each stroke of the engine the coal is impelled forward. In the electric drive a similar reciprocating motion is obtained by means of reduction gear and crank motion.

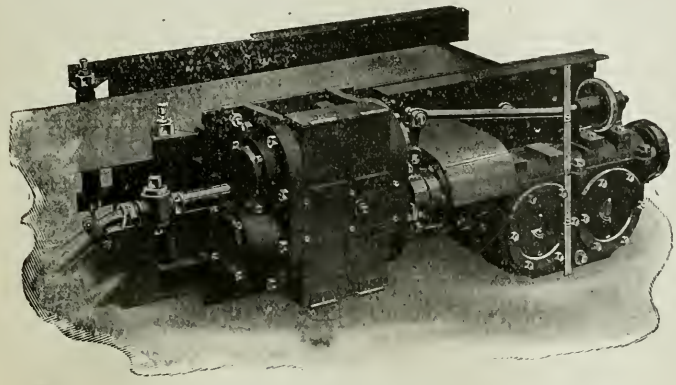


Fig. 3.—View of Air Turbine.

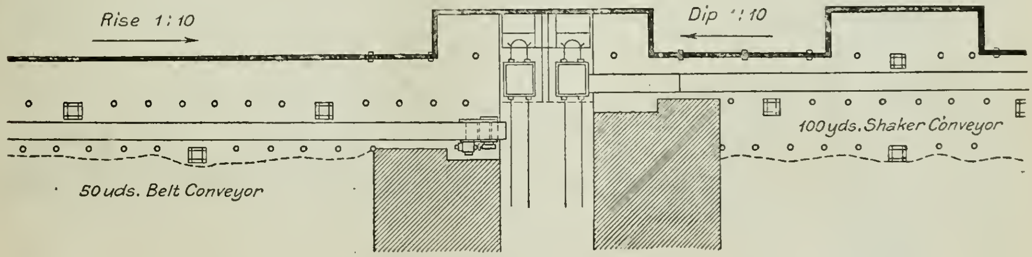


Fig. 4.—Combination of Belt and Shaker Conveyors.

In pre-war days the use of conveyors was only making slow progress, as the cost per ton with hand labour in this country was comparatively small, especially compared with that in several other countries. With the reduction in output and the consequent increased demand for coal, the utilisation of labour-saving devices is being greatly extended in the coal mines. The present position of the coal trade is such that output from each individual pit has got to be increased to cope with the demand, and the Government in their arrangement with the coal owners have kept this point very much to the front, and are stimulating increased production in every way. The chief difficulties in the way of the installation of conveyors are the actual working conditions underground and the attitude of the men to the introduction of conveyors. In addition to this, many of the older pits are not equipped with either the haulage or winding facilities so as to obtain a greater output from the individual pits, and in some instances it does not pay to put in conveyors to increase the output, because there are no facilities for handling this increased output when obtained. These cases, however, are few and far between, and it has been ascertained that the introduction of conveyors will increase output in the area where the conveyor has been put in, and it will pay to stop work on the hand-filled faces and concentrate the men on the conveyor filled faces. This has a considerable advantage in the fact that men engaged on the conveyor filled faces are more concentrated, and, therefore, supervision is simplified. In addition, the coal being conveyed to the shaft bottom is concentrated in that area, so that the improved haulage facilities can be installed in this area and immediate returns are made.

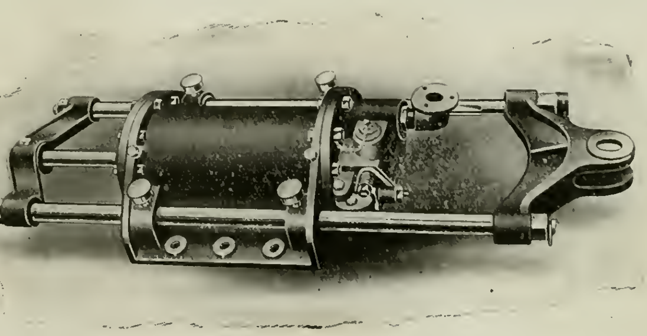


Fig. 5.—Compressed Air Engine for Trough Conveyor.

In dealing with underground mining conditions, one of the chief factors to consider is the question of roof and floor actually on the coal face. In this instance no definite rule can be laid down. In most cases conveyor working will improve the control of the roof, because a conveyor-filled face advances much more rapidly than a hand-filled face. In addition, it is kept perfectly straight, and the face can be let down in such a manner that it does not break off close up to the coal, and cut it off altogether. In other words, a bad roof can be improved by conveyor working. On the other hand, in some cases it has been found impracticable to maintain the roof and keep it under control by this method. These cases, however, are few and far between. The arrangement of timbering employed when a conveyor is used with such roofs is shown in Fig. 7.

If the management have decided upon a policy for conveyor working it requires very often during the first six months a great deal of perseverance and courage to proceed with conveyors. In one instance in South Wales, for nearly six months the management were continually faced with roof troubles, making conveyor working practically impossible owing to the high costs, but they were convinced that eventually this could be overcome, and to-day this colliery company has got a remarkable record of production. If they had abandoned their conveying scheme in the first six months this would not have been possible. Great credit is due to the management of a large number of collieries in the way they have persevered with the use of underground machinery and their attendant difficulties, and in the majority of cases they have been, one by one, able to overcome their troubles and obtain a very satisfactory working with a considerable increased output of coal per man, compared with ordinary hand labour. On the other hand, certain companies have tried in a half-hearted fashion with one or two conveyors, and the failure may be attributed to various causes which can very often be diagnosed upon careful investigation. Often the hauling facilities for getting away the coal have not been increased compared with hand methods, therefore, a block occurs in the transmission of the coal from the conveyor to the pit bottom, and the conveyor is continually being stopped owing to lack of tubs. This means, of course, in many instances a considerable expense in widening the roadways and putting in additional haulage, but the capital cost is more than amply repaid once it has been expended by the increased output. Another cause of failure has been due to breakdowns of the conveyor itself. This was much more in evidence in past years than it is to-day. Conveyor design has been improved out of all recognition, and it is no uncommon thing for a conveyor to run underground for a period of 12 months without a single stoppage for repairs. This does not mean that the conveyor has never been inspected during this time, for in all well-managed concerns underground machinery of this type is periodically inspected and worn parts renewed, but with reasonable care a modern conveyor will run continuously for a period of at least two years without any considerable overhaul. If the conveyor machinery is neglected breakdowns will occur, with a consequent loss in output and increased working costs.

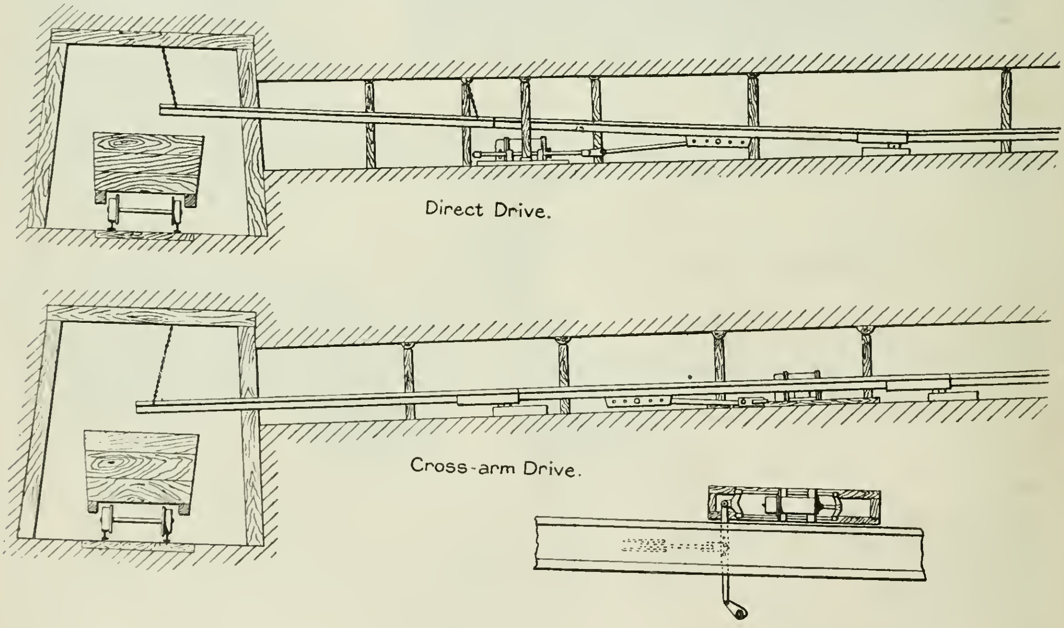
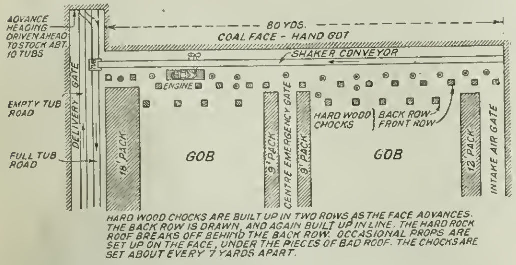


Fig. 6.—Method of Using Shaker Conveyor.

Perhaps the most frequent cause of unprofitable conveyor working can be traced to labour difficulties. Possibly the antagonism to underground machinery by the miners is not so great as has been stated in many places. The chief difficulty is to obtain a satisfactory piece work rate, so that the operator and the owner feel that they are getting a good baragin and a square deal. In some instances the owners forget that the conveyor will give them an increased output with the same establishment charges, and they may be arguing over the question of 2d. a ton, while the miner, if he were to receive this small addition per ton, would work with a better will, and give the necessary output, and the owner on his side would gain, owing to the fact that with the large standing charges of the average colliery he would be getting an increased output on the conveyor faces, and so bring his costs per ton down, even if the miner did get a little more for the coal that he filled than the owner wished to give. I do not wish to deal with the question of limitation of output of miners, as more competent authorities have gone deeply into this question, but there is no doubt whatever that the policy of "ca'canny" is being exercised to a considerable extent. A miner still thinks that if he increases his output his rate per ton will be reduced. It is usual to start up a conveyor face on datal rate—*i.e.*, payment by the shift—without taking into consideration the amount of coal got off the coal face. After the face has been opened out, if no price list has been fixed for conveyor filling in that district, the miner will not do a good day's work in putting coal on to the conveyor. In other words, he considers that it would give the show away. On the other hand, if a price list has been settled and the individual miner feels a grievance, he will not put his back into it and fill off sufficient coal to justify the use of a conveyor. In many instances it is usual to settle the price list before conveyors are installed, so that the manager knows what saving per ton he is going to get by the introduction of conveyors in that particular seam. This reduction per ton, of course, will be on the net labour costs of getting, and it is absolutely essential that the miner should meet the owner in this respect, as the amount of work entailed by the miner in putting coal on to the conveyor compared with putting it into a tub is very considerably less. The men and the men's leaders fail to recognise this, and very often increased output is retarded and the country suffers, due to this point being forgotten. In general, when a mutually satisfactory price list is settled, and the conveyor face opened out, increased output is obtained, which, in the present days of coal shortage, is of vital importance to the nation. It is an accepted fact that the further installation of underground mining machinery does result in a decrease in cost, and in many cases means an increase in the wage of each individual worker, and the further application of underground machinery in coal mines should be the object of both masters and men, so that in the national interest we should have cheaper coal without decreasing the average earnings of the underground worker.



HARD WOOD CHOCKS ARE BUILT UP IN TWO ROWS AS THE FACE ADVANCES. THE BACK ROW IS DRAWN, AND AGAIN BUILT UP IN LINE. THE HARD ROCK ROOF BREAKS OFF BEHIND THE BACK ROW. OCCASIONAL PROPS ARE SET UP ON THE FACE, UNDER THE PIECES OF BAD ROOF. THE CHOCKS ARE SET ABOUT EVERY 7 YARDS APART.

Fig. 7.—Shaker Conveyor with arrangement of Timbering with Hard Rock Roof.

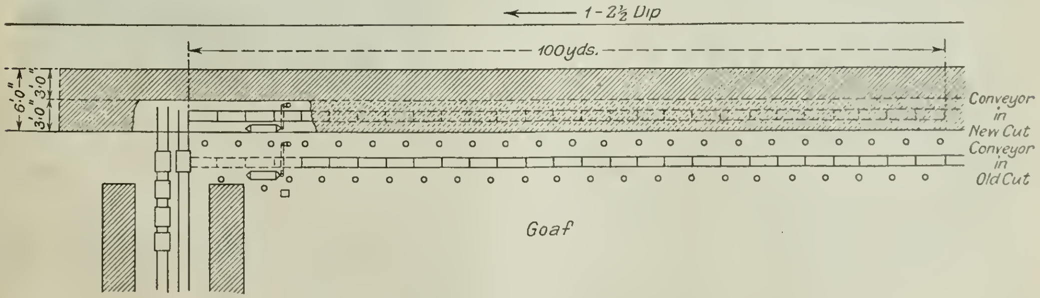


Fig. 8.—Shaker Conveyor showing method of Flitting.

The remuneration of each individual coal hewer on the coal face on a proper piece-work system is a matter of considerable difficulty. There may be anything from 5 to 15 men working on one conveyor coal face getting coal and filling on to the conveyor. In several instances the matter has been solved satisfactorily by the employment of one man as a contractor. He undertakes to put the coal into the tubs at a fixed price, and he himself pays the men under him, either a fixed daily wage or a wage plus a certain additional amount per ton filled off the whole conveyor. This greatly simplifies the matter from a management point of view, but is somewhat unsatisfactory from a point of view of the men working under the contractor. The men must be paid, of course, by the number of tons of coal that actually come off the conveyor, because it is impossible to differentiate which coal is filled by each individual man on to the conveyor itself, as the coal is actually weighed on the weigh-bridge at the pit bank. In some other instances, the men agree to share jointly the price per ton paid, so that if there are 10 men engaged on the conveyor face each is allocated one-tenth of the amount paid per total sum of coal got off the conveyor. One of the simplest and most satisfactory methods of paying the men is not by the tonnage, but by yardage; that is to say, by the number of yards advance made in the coal seam in the seven hours. It is usual for each man to have chalked out for him, or painted with a whitewash brush, the length of face he has got to fill off—that is to say, if there are 10 men on a 100 yds. face, a mark will be made every 10 yards, and each man will have to fill off the coal between the two marks. If any man was not working satisfactorily it would be very evident by his not clearing off the coal up to and including his mark on either side. The spirit of competition then comes in, and each man feels anxious to clear his own coal out as quickly as possible.

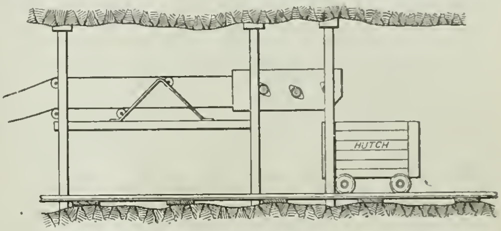


Fig. 9.—Belt Conveyor mounted for Gate conveying.

The question of output per man is a very debatable one. It is difficult to differentiate between individual coal seams, so that a fixed standard can be obtained. With an 18 in. to 20 in. seam probably three tons per man will be an excellent performance. On the other hand, with a 5 ft. to 6 ft. seam, the output per man should be anything up to 12 or 15 tons. By output per man, of course, is meant the number of men filling coal on the coal face on to the conveyor, and does not include all the other auxiliaries necessary for work on and about the coal face. In one instance, when conveyors were introduced it was found that each man was only filling ½ cwt. per shift. Very much better figures had been obtained with ordinary hand filling. This was a thin seam, where the output should have easily been from 4 to 6 tons per man. The fault was eventually traced to dissatisfaction caused by the price list, and after the management had tactfully readjusted this price list the output went up almost immediately. Unfortunately, this can only be taken as a case where the "ca'canny" attitude was overcome; in many other instances there is only as much coal coming off the conveyor face as previously was filled into the pit tubs, although in similar coal seams in other districts the output has been nearly doubled by the introduction of conveyors. In certain districts the men are realising that coal conveyors are also to their advantage, but the greater majority are still antagonistic, especially in those places where conveyors have not previously been installed, although there are very few cases to-day of malicious damage to this type of machine, as, if the conveyor is not wanted, the "ca'canny" principle of limiting output is much more effective than any damage which may be done to the machinery to put it out of action.

The development of these portable underground conveyors which are liable to stand rough usage and moving about, has led several collieries to put in conveyors for handling stacks of coal and disposal of rubbish heaps, &c. These have been very successful, and undoubtedly surface conveying in this country for contractors, colliery people and others who have to handle a large amount of minerals will be more extensively dealt with in the future. The disadvantage in the past has been that the fixed conveyor installations have been so costly and also unadaptable for the removal of material first from one place and then from the other. The utilisation, however, of portable conveyors of the type described should open up a new field for this type of labour-saving device. In one instance, a colliery had a jigging type of conveyor delivered, and they were not ready for it underground. Owing to the shortage of railway wagons previous to the delivery of the conveyor, they had a stack of small coal on the side of the line. The underground conveyor was fixed up to deliver the coal direct into the railway wagons, and instead of the usual wheel barrow and plank method, the whole heap of coal was put into wagons, and by this operation alone the conveyor practically saved its entire first cost in a few weeks. The conveyor was then dismantled and put down the pit, where it is working to-day. All classes of material can be conveyed, from sand, wet coal, up to large pieces of coal or rock, the sizes of coal or rock, of course, to be of limitable dimensions. In one instance, a complaint was sent regarding the operation of a belt conveyor, and upon investigation it was found that the men on the coal face had been endeavouring to get lumps of coal from 3 ft. 6 in. to 4 ft. cube on to the conveyor belt, which was 20 in. wide, and, of course, found it would not work. Fig. 8 is a diagram of a conveyor for this class of work.

In some cases it is possible to have two coal faces working on to one main gate. This concentrates the coal filling to one place, and where it is possible to do this in many instances it will pay to put in an additional conveyor, which is usually known as a gate conveyor. The gate conveyor is made of sufficient size that it would easily take the output of the two face conveyors. By this means the roadways do not require to be ripped to leave head room into which to get the tubs, the coal is conveyed direct from the face down the gate to the most convenient place, either adjoining the main road of the mine or in a position where the gate already exists sufficiently wide and sufficiently high to take the tubs. The delivery end of the conveyor is fixed, and the other end of the conveyor is gradually extended as the coal faces move forward. A single gate conveyor can be used up to 150 yds. long. If, at the end of 150 yds. the faces still advance, another gate conveyor can be installed, which will deliver into the existing one. Or, alternatively, the road can be cleared and the haulage brought up to this point. With gate conveyors of the shaker type extension is obtained by adding an additional trough as the face advances. With the belt conveyor (Fig. 9) short lengths of belts are introduced and the tension drum pulled forward when required. Gate conveying is almost in its infancy, and undoubtedly will be a considerable factor in the future.

In one instance a colliery management was faced with the following problem: They had excellent conditions for two conveyor faces, but the roads that were driven into that district were narrow, and the roof conditions were such that it was not possible to widen them. The distance the coal had to be worked to the boundary was about 250 yds., and it was not far from the shaft bottom. For the amount of coal that was available, it would not pay to put in an expensive haulage system, as horses were being used. A gate conveyor was installed, which overcame all the difficulties of transportation of the coal. No mechanical haulage is used, but horses are employed to drag the tubs of coal to the pit bottom. Also, owing to the war, there was a shortage of tubs, and the men were continually waiting for empty tubs, but now the gate conveyor has been installed with the other two conveyors, there is practically no stoppage, the distance travelled by each horse is much shorter, and the number of tubs required to transport the coal is considerably less than previously required.

The main points to consider in employing a gate conveyor are: It means less haulage costs, fewer number of tubs are required for the same output of coal, it provides a fixed filling station so that the output is concentrated in one place, while there is a considerable reduction in the ripping costs due to there being no necessity to leave a double roadway open in order to handle the tubs satisfactorily near the coal conveyor face. In many cases, owing to the present day shortage of colliery tubs, it will amply repay the management to consider the question of the use of gate conveyors more extensively than has been done in the past.

Electric Vehicles at Cardiff.

We are glad to hear that electric vehicles are increasing in popularity in Cardiff and district. "In connection with this business," writes Mr. Arthur Ellis, city electrical engineer and manager, "we have three charging stations, and at the moment are charging up daily nine vehicles, and there are at least three more on order. We have been undertaking the usual maintenance work in connection with the batteries, but anticipate a large increase in this direction and, our accommodation being limited, we have endeavoured to interest some private people in this business, we on our part being only too anxious to give all assistance and advice. In addition to our own charging stations, the public works department is putting down one to meet its present and future requirements, the vehicles it has in use (and on order) being for general work, including refuse collection and haulage of building materials. We are out to assist clients in making a success of the electric vehicle. One enterprising firm here has four vehicles running, including one private car, and it has on order another heavy vehicle."

Battery Driven Tower Wagon at Cardiff.

Our illustration shows one of two Edison 1-ton tower wagons now in use at Cardiff, and it has been found that battery-operated vehicles have everything to recommend them when it comes to executing repairs on trolley systems. In spite of its initial cost, the electric tower wagon is a money saver, and is both efficient and reliable. For instance, it can manœuvre close to poles, can reach any electric light for inspection and repairs, while the simplicity of driving is proverbial. It may also be pointed out that the absence of a bonnet allows the vehicle to be driven close up to the tramway pole where repairs are needed, and for pole to pole inspection its use results in an appreciable saving of time.

The electric tower wagon can be given a boosting charge at odd times during the day, and it is practically always ready for emergency "calls." Everything being electrical, any repair work can be effected by the depot staff. Finally, it obviates the trouble of storing petrol, and does away with the necessity of having employees with a knowledge of petrol engines.

Portable Loading Devices.

By G. BELL.

Summary.—The article describes a number of portable loading devices which may be taken as typical of what is being done to meet present-day needs. It is pointed out that the future, with its vast fields of new enterprise will demand an ever increasing supply of machinery of this class to transport its materials quickly and economically. Workmen are beginning to object, quite rightly, to being beasts of burden, and dirty and laborious work of transporting materials is one of the most degrading forms of labour extant. The labour of man can be used in a higher form than pitting his strength in competition with machinery.

Modern Methods of Moving Material.

MANUFACTURERS in almost every industry are turning with increased interest to the possibilities of reducing their loading and unloading costs by mechanical means. Heavy and bulky goods are generally loaded or unloaded by cranes of various types, but in the case of loose materials and small goods, the handling is far too often carried out by manual labour, which is slow, expensive and far from satisfactory. The keenly competitive times which are assuredly coming will make the adoption of some form of labour-aiding machine a prime necessity, and the manufacturer who avails himself of every means in this direction, will strengthen himself as a trade producer, besides helping to develop a very important branch of the engineering world. The writer by no means intends to deal exhaustively with the subject, as the last word in labour-saving machinery has yet to be written. New designs and new principles are being constantly evolved to meet the requirements of the times, but if the attention of interested parties can be directed towards the possibilities of speed and economy, which is to be gained by using machinery, this article has not been written in vain.

The following are typical examples of what is being done by the expert in mechanical handling to cope with the questions just laid down.

Coal Bunkering Machine for Ships.

The coal bunkers of our largest liners have a capacity of 6,000 to 10,000 tons, and have to be "coaled" from 20 to 30 times a year, when in full commission. The method of "coaling" adopted is usually the elevator and lighter system, and must be carried out as expeditiously as possible to enable the ship to depart in accordance with its schedule. When the bunkers are filled from the port holes at the sides, only about half the coal can be put in by gravity, the remainder having to be brought from the shoots and trimmed by hand. Usually 80 to 100 men are employed in completing this very arduous, dirty, and somewhat dangerous task, in the time available. Just before the war, Messrs. W. J. Jenkins & Company paid a great deal of attention to the question of trimming by hand, and came to the conclusion that it could be done mechanically in half the time and at much less cost. They proved their conclusions most successfully by an adaptation of their well-known "D.B." patent projector, a machine which has for many years been used for charging coal into gas retorts.

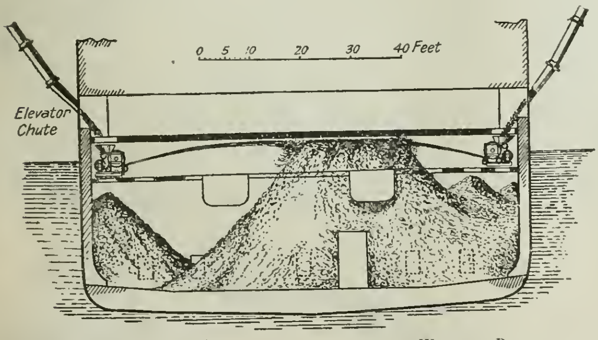


Fig. 1.—Diagram of Coal "Projectors" in the Working Position.

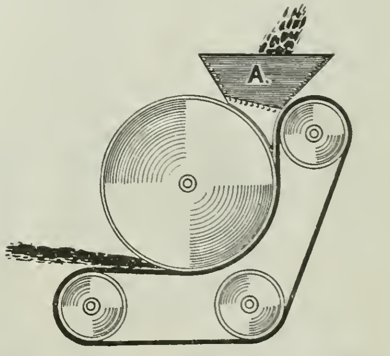


Fig. 2.—Diagram Showing Principle of Coal Projector.

Following very satisfactory experiments 12 of these projectors, capable of projecting or throwing coal 60 ft., were installed on an Atlantic liner. The results obtained were highly successful. With six machines only at work the trimming of the bunkers was carried out as quickly as the coal could be supplied, viz., in 18 hours; adding the same time for direct coaling from the elevators, the entire bunkering operations only occupied 36 hours, a vast saving of time and labour as compared with every previous method. The cost of mechanical trimming was about 25 per cent. less after allowing for power, supervision, maintenance, depreciation and wages. Fig. 1 shows a diagram of the machines in position, and Fig. 2 shows the principle of the projector. This consists of an endless vulcanised rubber belt, 27 in. wide, ⅝ in. thick, fitted over three pulleys, and passing partly around a special grooved drum of large diameter. The coal is fed in through the hopper at *A* and is carried by the belt, through the groove, and along the horizontal part of the belt, then is projected by centrifugal force, caused by the belt running at high speed. The farther it has to travel the higher the speed of the belt. For mixed coal the speed is about 3,500 ft. per minute. The projector is driven by means of an electric motor of the totally enclosed type, having a variable speed of 900 to 1,200 revs per min., and an output of 30 B.H.P. The speed is varied by a controller of the tramway type which permits the use of five speeds. The machines are provided with turntables and wheels to run on rails, so that they can be moved out of the way, whilst the coaling is carried direct from the overhead system. When the machines come into action, the overhead streams of coal are diverted by the projectors and swung in every direction, by means of the turntables, thus filling the bunkers fore and aft, as well as athwart ship. The weight of each machine, complete with motor, turntable, &c., is approximately 4 tons.

Another device, designed for the same purpose, was brought out by Mr. Geo. Jones, and a description of it may be found in "Cassier's Engineering Monthly," September, 1918. This invention consists of a short self-contained band conveyor, possessing several most interesting and novel features, for instance, a specially designed motor with its complementary reduction and driving gear incorporated within the driving drum. This gives the terminal a remarkably neat appearance and renders it entirely dustproof, the latter feature being a vital necessity to the conditions under which these machines have to work. The conveyor is carried on a series of overhead rails on specially designed slings and rollers. When in commission, three or more of these machines work in series and are connected together. They are controlled by the leading conveyor, which has an ingeniously contrived gearbox and "feeler" plate, attached to the distributing end. The coal is fed from the elevator shoots on to the first conveyor which passes it in turn to the intermediate, and finally to the advanced or leading conveyor. This latter is virtually the distributor, and delivers its load over the end in the usual way. When the coal is being stored in its farthest position the pile in growing climbs on to the "feeler," which, bending back, closes a circuit in connection with the gear box. This causes the conveyor to move backwards, taking the others along with it, thereby allowing another portion of the bunker to be filled. The movement is repeated until it becomes necessary to remove in turn the intermediate or feeding conveyors. The series have a further movement imparted to them through the gear box, which is in a lateral direction. This is rendered possible by cross-rails running at right angles, to the longitudinal ones previously mentioned, which enables the whole of the bunker to be filled.

Loading Machines for Other Works.

We now come to public undertakings and works, such as electricity stations, gas works and power users generally where coal is stored in the yard, for use in cases of emergency The storage ground is often too far away from the elevating plant, or covers too wide an area to warrant the expense of installing and maintaining a permanent conveying plant for occasional use only. In such cases extra men must be engaged temporarily to load wagons or carts for transferring the coal to where it is required. In these days it is often difficult and sometimes impossible to obtain the men just when they are wanted. To meet with such an emergency several well-known firms have designed comparatively cheap machines, self-contained and portable. It only remains for the stocks of coal to be stored alongside the railway sidings, to be easily and quickly reloaded into wagons when required. One or two men with such a machine can do the work of a big gang, and at far less cost.

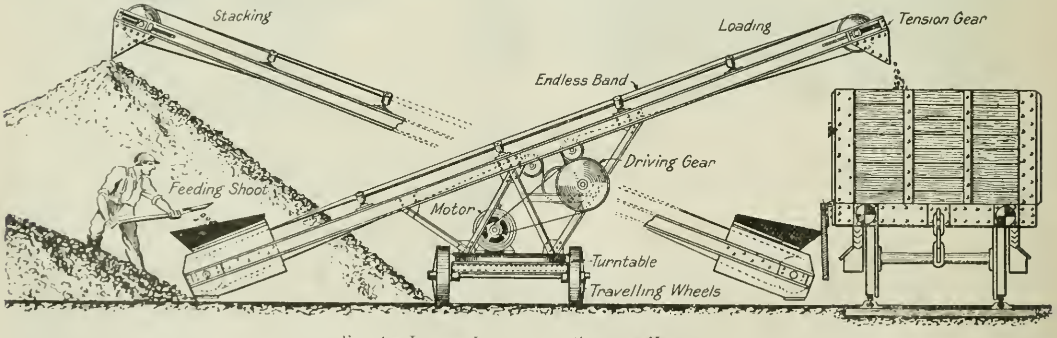


Fig. 4.—Jenkins Loading and Stacking Machine.

One such machine as made by Messrs. W. J. Jenkins & Company, Ltd., is shown in Fig. 4. It consists of an ordinary inclined band conveyor and turntable, mounted on a travelling carriage. The machine is usually fitted with large diameter road wheels, with wide treads for travelling about the yard, but in cases where there are convenient rails, smaller flanged wheels are substituted. The machine shown is 28 ft. from centre to centre of terminal pulleys, and is provided with an endless band 16 in. wide, supported on the loaded side by means of the usual type of troughing idlers. The returning strand passes over and under three drums, the upper two acting as supports, and so arranged as to give a good arc of contact to the driving drum underneath. The power for driving the conveyor is furnished by an electric motor, oil engine, or steam engine, as occasion demands, and is mounted on the surface of the turntable. The transmission is by belt drive, then through a pair of machine-moulded spur gears. The power required is about 2½ h.p., and the belt speed 200 ft. per min. This gives a capacity of about 1,000 cubic ft. per hour, or say, 20 tons of mixed coal, up to 5 in. or 6 in. cubes. The approximate cost of loading wagons by this method is about 4d. per ton, allowing for only 100 days work per year and including wages of two men, cost of power, interest and depreciation.

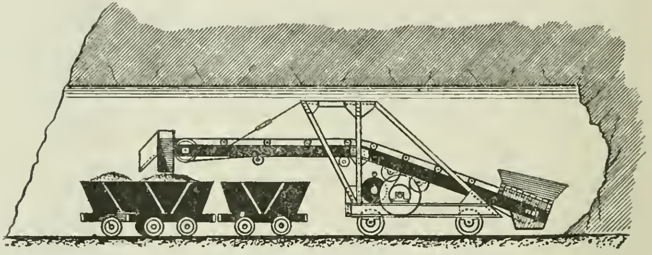


Fig. 3.—View of Portable Band Conveyor for Tunnel Work.

Other well-known makers are keenly alive to this class of work, and supply machines for a similar purpose. Each maker has some novel feature of interest. Take, for instance, the "Mitchell" Loader.* This machine is generally on the lines of the one described above, with the exception of the conveyor frame, which is made telescopic. The purpose of this arrangement is to keep the receiving end, with its projecting hopper, close in contact with the heap of material to be loaded. This object attained, the coal is then raked into the shoot, no shovelling being necessary to the general mass, with the exception of the layer below the top of the shoot to ground level, which must be cleared by the attendant.

Another type mentioned in the same article as the "Mitchell" Loader, is the "Hepburn" Conveyor (made by the Hepburn Conveyor Company, Ltd., Wakefield), which is especially designed for emptying brick kilns and loading the bricks into wagons. This conveyor has an armour-plated belt and is mounted on a centre frame fitted with only one pair of large diameter wheels on which the conveyor is balanced. When in use a telescopic stand is fixed near each end for adjusting the working angle and also to give greater stability to the apparatus whilst in motion.

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* Described in "Cassier's Engineering Monthly," 1918.

The Jeffrey Loader.

This loader is quite a departure from those previously described, inasmuch as the elevating is done by endless chains with buckets. Various designs are available, made to suit different conditions and different classes of material to be handled, such as coal, sand, gravel, cement and other homogeneous material. In general, the elevator is mounted on a lorry containing the motive power. On the simpler machines and where the sphere of action is not too great, the transporting is done by man power, but where long distances are to be covered, the travelling is accomplished by the power unit, through suitable gearing. The travelling gear is further utilised as a power feeder to keep the elevator in contact with the head of material to be handled. It is sometimes necessary to separate the dust from certain materials before they are loaded ; in such cases a screen is fitted for the purpose. Hoppers are also fixed to store the material and enable the elevator to work continuously where the loading is intermittent, as in the case of barrows, or when filling bags.

Fig. 3 shows a special form of portable band conveyor, of which a number were made and supplied to a firm of contractors engaged on tunnel work, and where steam navvies were impracticable. As will be seen, the conveyor consists of an endless band running in two planes and supported by a frame mounted on a travelling carriage. It is driven electrically by a small motor of 4 H.P. to 5 H.P. and propelled by hand. The feeding end is enveloped by a wide hopper, the sides of which make an effective dirt-shield and drum-protector. The delivery end terminates in a series of shoots, all of which are controlled by one central valve of peculiar construction, so arranged that small wagons can be loaded at either side or in front. When in commission the conveyor is mounted on narrow-gauge rails running up to the face of the cutting. Other rail tracks are fixed at each side, so that three sets of contractors' wagons can be fed in turn from the shoots.

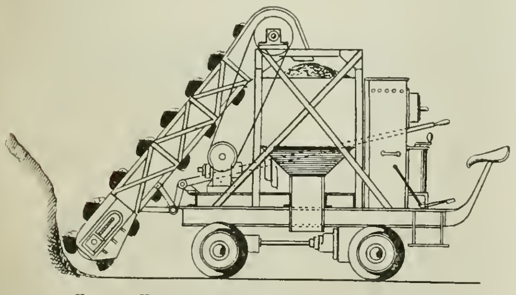

Fig. 5.—Equipment for Transporting Fertilisers.

Loader for Luggage.

Many of our London shippers are now using portable conveyors for transferring passengers' luggage, small packages and cases from the dock side to the deck of the vessels. The type usually adopted is on the slat principle, consisting of a double roller chain, fitted with mild steel or hardwood slats at intervals, thus forming a continuous travelling belt. They are entirely self-contained, the driving gear, motor, &c., being completely enclosed and embodied in the lattice framework. The upper or delivery ends are equipped with large hinged hooks for attaching to the bulwarks of the vessel, whilst the feeding ends are left free to run on the dock side by means of swivelling rollers. As will be understood, this movement is essential, for the conveyors must automatically adapt themselves to the constantly varying inclinations, due to the rise and fall of the tide. The machines are lightly built and can easily be lifted into position by the ships' tackle.

Portable Elevator for Fertilisers.

A useful device for transporting fertilisers from the storage warehouse to the bagging and weighing shed is shown in Fig. 5. As will be seen, the machine consists of an elevator and hopper, mounted on a steel truck fitted with rubber-tyred wheels and propelled by motor supplied from a battery of accumulators. A seat is provided for the attendant within easy reach of the controller switch, and the lever for operating the hopper outlet door. The elevator is fitted with buckets capable of digging the fertiliser from the heap and delivering the contents into a hopper of 10 cwt. capacity. The frame of the elevator is hinged at the top on trunnion bearings and fitted with screw adjusting gear at the bottom, for altering the angle of inclination within certain limits.

Loader for Ashes.

A somewhat uncommon type of loading appliance is used in the United States for removing ashes from underground boiler houses. A short description may be of interest. It is well known that in their towns the houses are built on the huge flat system and heated centrally from boilers, situated, as a general rule, in the basement ; so the question of removing ashes and refuse is necessarily on a greater scale than we experience over here. This calls for some mechanical means of dealing expeditiously with the refuse. The apparatus they find most suitable is the one just alluded to, and consists of an extensible bucket elevator, working vertically from a cellar underneath the causeway. The buckets are mounted between two chains, and the head and boot fitted with bearings to carry the terminal shafts and sprockets in the usual way. The frame is in two sections, each consisting of a pair of steel channels, the top pair being made to slide in the bottom pair, thus forming a telescopic frame. When out of use the telescope is closed, the buckets and chain resting inside and over the boot. When it is required for duty a hinged paving stone is lifted in the footpath. The elevator, which is immediately beneath, is extended by means of racks and pinions until the top half projects high enough to deliver the ashes over a hinged shoot into the waiting lorry. The elevator is driven at the bottom by means of a small steam engine kept for the purpose.

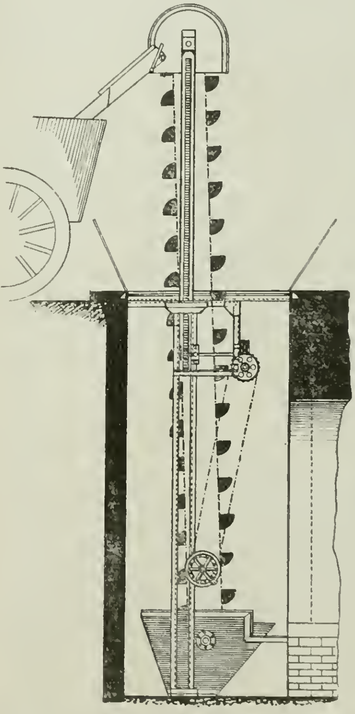

Fig. 6.—Diagram of Elevator for Removing Ashes from Flats.

Fig. 6 shows an outline of this very ingenious contrivance. There must be many conditions in this country where a similar installation would be of great service, but it is obviously impossible owing to our street by-laws to use the apparatus for the purpose described.

The Automatic Electric Telpher and Its Use in Industrial Establishments.

By NORMAN G. KAPP.

Summary.—The article criticises the obvious "direct" and unimaginative method of dealing with handling problems, generalises the requirements of a good conveying plant and shows how these may be met by the automatic electric telpher.

No conveyor plant is perfect. If I were asked what was wrong with a plant which did not answer its purpose perfectly I should answer "lack of imagination." The obvious is never the best, and nearly always the worst way. The obvious is the least trouble, and therefore very popular. The obvious way of writing an article is to begin at the beginning, which is description, and end at the finish, which is doing the job.

I will endeavour to follow the inverted mental process of the creative designer and begin at the end which is the means to be achieved, and trace through the various steps to the method of achieving them. The problem of conveying over short distances is usually exceedingly simple: Picking up the goods, carrying them to their destination and dropping them; that's all. That is why there are so many ways of solving the problem, and so many ways of solving it badly.

If a quantity of material, situated at a certain locality A, has to be picked up and taken to B, the simplest—that is, the most unimaginative—way is to send some men to fetch it. It is a strange thing, but nevertheless a fact, that this simple unimaginative and costly way has held its own successfully and obstinately against the advent of more economical methods for so long. There are, however, signs of a change. The next step is being cautiously tested. The next step, however, is often hardly less unimaginative than the first. If the work of shifting material becomes too heavy for men to do it on their backs a machine is devised which substitutes motors for muscle. This substitution is in all seriousness the most usual method of dealing with handling problems by mechanical means. How often we come across 10 grab cranes, or some similar appliance, supplying 10 feed points from a store. Such a device merely substitutes 10 mechanical giants for 100 ordinary men, the system of handling being the same. Machinery represents an advance on nature, and by attempting to hold it down to do man's work in man's manner we are apt to fetter its development.

There are two general principles common to all machines which should never be lost sight of when casting around for suitable mechanical devices; to get the best value out of machinery it should firstly be run without stopping until it is worn out, and secondly, it should be run at top load continuously. Every minute of stopping or running light represents a loss on the whole plant. Translating these two principles into terms of handling plant it becomes obvious that conveyor service to give maximum economic value should be continuous and undirectional, that is, the empty return of a handling appliance must not interfere with the constant flow of material. Whether this will always be possible or even desirable will depend upon the hourly output desired, and the distance through which the material is carried. If the hourly output is very small or the distance carried very great, it may not pay to run a small trickle of material over a conveyor continuously. In such cases the spasmodic service of a horse and cart for short distances, and the railway for long distances, will be the best solution. Although continuity of operation of the handling plant should be aimed at, it alone is not the only consideration which determines the design. If material is picked up somewhere it must have been brought there previously, and if it is dumped it must be removed somehow to make room for more. It is no use designing to convey at a greater capacity than can be dealt with at the end stations of the plant. Continuous feed to the loading point of the conveying plant will be very rare. In the vast majority of cases the arrival of material to be dealt with will be spasmodic.

The obvious method of ensuring a continuous supply at the point of discharge between deliveries to the loading station is to instal a stock bunker or store at this point. Obvious as this solution is it is nevertheless common enough to find the design of the layout of a plant so lacking in imagination that the storage bunker has been provided but inserted in the wrong place. Before we continue in pursuance of a method of handling and conveying which will answer some specific requirements, let us glance at an example of handling by mechanical means taken from actual practice, which affords a good illustration of the defects arising from a layout conceived from the point of view of man handling instead of from the point of view of the machine which is to do the work. The manager who is an expert in his own particular branch of industry, is rarely an expert on handling and conveying as well. If he would but call in the conveyor expert before the layout was settled, the chances are that he would get a better plant for less money. Referring to this point I notice that in the report of the Sub-Committee of the American Society of Mechanical Engineers, presented in 1913, paragraph 53 reads:—

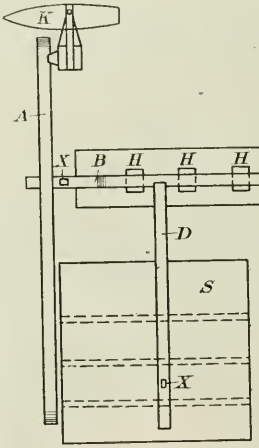

Fig. 1.—Diagram of Bad "Telpher" Layout.

> "The history of nearly every important movement in the development of the art of hoisting and conveying shows that the engineer freely laid his plans and ideas before the prospective user, both being masters in their own particular field. In order to develop what is required by the producer, complete co-operation between the two is of the utmost importance."

A minute description of the plant to be discussed would be of little interest. I will include merely as much as may be necessary to illustrate the disadvantage of fixing the layout and then attempting to build a conveyor to suit it. The plant is installed to charge material from the barge K, Fig. 1, to the hoppers H, or as an alternative, to a storage ground. Barges should be cleared as quickly as possible when they arrive, as what is true for every machine is true also of the barge, namely, that every minute spent lying up represents a loss on the capital outlay of the vessel and of the canal. The arrival of barges is spasmodic and irregular. Any plant used solely to unload the barge will, therefore, be required at irregular intervals also. Between shiploads it will be idle. It will be like those most expensive of employees who do a tremendous amount of work when the boss is looking. Any plant, therefore, which has no other use but for unloading should be designed in such a manner that only the barest structural necessities are ever unemployed. Moving parts should be brought into action elsewhere if the unloading is held up for lack of a barge. That such an economic distribution of machinery is possible we shall see when we come to the discussion of unloading by electric telpher. If material is to be stored, the best place for the storage is as near the barge as possible, so as to waste neither time in unloading nor capital outlay on this portion of the plant. If the unloading was done by means of an army of carriers on the other hand, this consideration would not enter, and storage might be placed to better advantage as near to the working centre as possible. The latter consideration seems to have prompted the choice of the site for storage marked S in the plant before us. The material is brought to the store S by means of a belt A, passing below a hopper on the wharf which is filled by a grab; grab, hopper and a long belt all come under the category of semi-employed machinery. The belt, A, passes the hopper house and when feeding direct from the barge, a bucket-conveyor, B, takes the material up to the hoppers, into which it is charged by means of a third conveyor, C, which is a belt running over the hoppers. When feeding from the store a fourth conveyor, D, of bucket type takes the material to the hoppers, but it will be noticed that as this conveyor strikes the conveyor belt, C, midway between two hoppers, the belt, C, must be reversible. All these mechanical contrivances follow the direct and obvious path of a man carrying the material by hand along galleries and up ladders

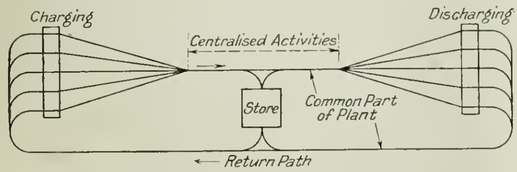

FIG. 2.—DIAGRAM OF GOOD "TELPHER" LAYOUT.

Apart from the economic disadvantage accruing from an expensive loading plant with a bad load-factor, the system introduces further defects which might easily have been overcome if the layout had been designed together with the plant. The material must be crushed before use at the hoppers. As there are two conveyors up to the hoppers, a crusher marked X, had to be introduced into each circuit, only one of which is ever used at a time. This is a glaring instance of ignoring a principle which is often overlooked, namely, that of centralising operations—not splitting them up. The material to be worked on should be brought to the working centre, that is the object of a conveyor; not many similar working centres established to suit the geographical position of the material. Such centres may be crushers, weighbridges, counting clocks, supervisory stations and the like. Even if no such centres occur in the working, the layout design should strive towards centralisation for the sake of saving mobile and structural equipment. The tendency towards which a good layout should strive may be illustrated diagrammatically (Fig. 2). This shows such a layout for a very usual conveying problem. From scattered positions material must be collected and conveyed to the points of working; this represents the charging end and discharging end of the conveyor. Between these two scattered positions are the outward and return path of the plant which is common to all sections. Short-circuited across the two common paths is a storage ground. Fig. 3 shows a bad layout for the same problem. Each operation is proceeding independently, as in the case of the plant just discussed. Apart from the extra amount of structural and mechanical parts required supervision is less facilitated. The main advantage of the centralised system, however, is the great saving of men effected in most cases. This most important point will be further dealt with when we arrive at the actual method of conveying which approaches the ideal requirements which we are now evolving. At this stage, however, it will be clear that to meet these requirements such a conveyor must be extraordinary flexible with regard to corners and difference of level; and mobile, as a well organised army is mobile, which may be disposed of at any place where it is most needed.

Returning to the study of the plant under our critical observation, we notice a further defect in the layout which may serve as a warning against similar mistakes in future. The belt A passes along the wall of the storage house S. When storing takes place material is thrown off at three places into trucks which are pushed by hand and tipped within the shed. Now such a point constitutes a most seriously dangerous link in the chain of conveying operations. To deal with 90 tons of material per hour, which is the output of the belt A, by hand, requires a fair number of men. The object of a conveyor is to save men. If men are necessary at any point then a strike might bring the whole plant to a standstill. The design of an efficient conveyor system should tend towards complete automaticity in handling, including automatic loading, conveying and discharging. If men are necessary at any point, however, they should be worked to their maximum capacity. Spasmodic service, such as is found on a storage ground, should not require men in large numbers. We now come to the last defect of this plant which may serve as an illustration against a very common practice in conveying. Change of direction is effected by passing the material from one conveyor to another. The transfer cannot be effected without loss of height, and loss of weight means loss of power.

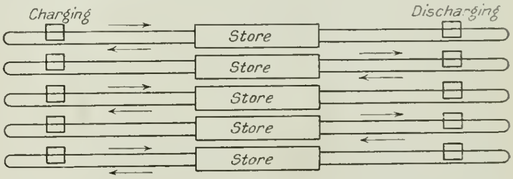

FIG. 3.—ANOTHER BAD LAYOUT.

Let us examine the loss of power in the case before us. When using the storage the material is raised through 20 ft. to the belt A, and dropped 5 ft. on to the storage floor. To reach the conveyor D it has to drop back to ground level. D raises it through 17 ft. and drops it back to ground level through the crusher. From there it is raised 60 ft. and dropped 15 ft. on to C and through another 15 ft. into the hopper. The height to which the charge must be raised from ground level is 30 ft., the total distance through which it is actually raised is 97 ft. If we allow 15 ft. at the hoppers, and 17 ft. at the crusher as justifiable losses, we get a necessary height of 62 ft., as against the actual height of 97 ft.; 35 ft. are, therefore, wasted on this plant. In other words, more power is wasted than actually used in raising the charge to hopper level. Let us gather some idea of what this loss may mean annually: 45 tons per hour is handled by the conveyor D: this quantity raised through 35 ft. every hour uselessly represents a loss of power of 1·8 H.P. per hour, or 15,000 H.P. wasted every year.

Resuming our investigation in quest of a conveyor system which will be free from the defects discovered in the criticised plant, let us enumerate the requirements of an ideal conveyor. (1) The ideal conveying plant should be flexible, that is, reach any part of the industrial area within its field of operation. (2) It should be automatic in action, requiring the minimum of attendance. (3) It should have a high load-factor, that is, all running light or stopping, or waiting for the return of empty appliances should be cut down to a minimum. (4) It should be capable of extension of its radius of operation and its capacity with a minimum of alteration, and without interrupting its service. (5) It should be transferable to parts of the works where spasmodic service may be required at a moment's notice. (6) It should be capable of dealing with both very large outputs and very small outputs without loss of efficiency. (7) It must be reliable. (8) In the event of a breakdown the service must not be interrupted, the standby nevertheless being of such a nature that it represents a small capital outlay. (9) It must allow of rigid control of the material transported. (10) It must be economical in wear and tear and power consumption. (11) It must not take up any room which might be used for other purposes. (12) It must be of such design that it can be installed in old and crowded industrial centres without much alteration.

This is indeed a formidable list of requirements, nevertheless it is possible to meet them all by suitable design. There are many cases where such stringent requirements will not be demanded. The above is a generalisation. If a plant can be made to cover them all, then the special case may find an easy solution. The design suggests itself if we look more closely at three of the most important requirements on our list. (1) The plant must be flexible like a flowing stream which will pass round any corner with ease. (2) It must not take up floor space which might be required for other purposes, therefore the stream must flow overhead. (3) It must be mobile to allow for increase or decrease of capacity at any point like a fleet of motor lorries; that is, the conveying appliances must be independent of each other. Being independent in action they must carry and control their own motive power. Such an appliance is the automatic electric telpher. The overhead rail from which the telpher cars hang limit the movements of the car to some extent, but it cannot be said that this limitation is a serious one, since very sharp corners may be taken. If a large area such as a storage ground is to be brought within the sphere of operation of the telpher, the cars may be deflected from their track by means of a drag switch, and run across a gantry which spans the width of the storage ground and travels the length of it.

The individual telpher cars may carry loads which vary between a few hundred pounds and several thousand pounds. The frequency with which they follow each other will depend upon the output required, which will also determine the total number of cars used on the line. The cars are spaced evenly along the line, and the distances between them is automatically regulated by means of a block system which deprives a car of current should it approach too closely to another one. The technical method of interblocking the cars at crossings, switch points, hoists, &c., and preventing collisions on the level track has been repeatedly published, so I will not enter into this matter here.* It will suffice to mention that the block system used in modern telpher plant is of an extremely simple nature, requiring no solenoid switches or delicate apparatus which are likely to give trouble. The switches are all of simple drum type, operated mechanically by the passing of a car. One of the most important points about any conveying plant is the necessity for a robust design. This applies all the more to such plant which is required to work automatically with a minimum of supervision. Moreover, it not infrequently happens that a conveyor is required to go through places which would be impossible for men on account of fumes or even flame. The design of the telpher, therefore, forestalls the possibility of a breakdown owing to rough usage by enclosing all apparatus, including the electromotors in dust and weatherproof steel casings and making them of knockabout dimensions. Some years ago the writer witnessed an accident on a very extensive telpher plant used for blast furnace charging. The plant was badly neglected and slight mishaps were ignored until some accident forced the attention of the manager to the carelessness with which the plant was being handled. Thus a defective switch point had been allowed to become so damaged that a car fell off the rails at that point. The motor carriage, skip and 1 ton of iron ore fell about 15 ft. into an empty hopper. The man in charge of the hopper appeared to be quite used to the occurrence and calmly put it all back again, when it ran on as if nothing had happened. Naturally, the repair charges at this works were particularly high; how small they may be, however, when the plant is properly treated, may be illustrated by a furnace-charging plant in Belgium, where the manager had engaged a fitter whose sole duty it was to examine and repair the 30 cars on the system. One man easily dealt with one car per day, overhauling it, greasing it and entering it up in a special book.

Having now arrived by following up the needs of conveying in general terms at the automatic telpher as a means of satisfying these needs, let us look at some of the advantages of this appliance. It stands to reason that a system of handling by means of which conveying, emptying and even loading the skips and weighing them, can be made entirely automatic, must show a very considerable saving in labour; but, as mentioned above, not only men may be saved, but often structural work as well. The cars may be fitted with winches which are operated from any desired position on the ground or elsewhere, by merely plugging a portable controller to a wall contact. The extreme mobility of the telpher cars renders it possible to use them at any moment in large numbers where they are most required. Thus, for instance, it is possible to unload a ship automatically with a grab working from a winch car and controlled by means of a portable controller. When the ship is empty, the same grab may be run to any other part of the industrial site, such as a storage dump. Thus all that is ever idle on the whole plant may be confined to some yards of rail and structural supports. The question of a standby is a very vital one, since the breakdown of any important link in the chain of conveying may dislocate the entire working of the manufacturing process. Here again the telpher has the advantage over other systems by virtue of its multiplicity. If the transport depends upon the working of one big machine, then another big machine is needed as a standby. The spare machine will be idle and not yield any return on the capital outlay. If the transport depends upon a lot of little machines of like pattern running in parallel, then only one little machine will be needed in addition to the normal working number as a standby; and by occasionally running the standby machine in with the rest, it may always be kept in perfect working order ready for an emergency at a moment's notice.

Closely allied to the question of a standby is the matter of overloading. The Sub-Committee of the American Society of Mechanical Engineers pointed out in their report on conveying that it only too frequently happens that with increased output in the works, the conveyor is gradually overloaded to such a point that the factor of safety is endangered. Such an occurrence is not possible on a telpher line, since each load parcel is limited in weight by the size of the skips. On the other hand, overloading is not necessary as it is a very simple matter to increase the output at any time by adding more cars to the line. This can be done without holding up the existing traffic, since the only addition necessary to the static equipment is an increase in the number of block switches. A most important point in any conveyor system is the control of the material transported. No one who sees a large telpher plant in operation for charging blast furnaces, can fail to be impressed by the thoroughness with which every pound of material thrown into the furnace is checked and registered on a central weighbridge; and although every scrap of material which goes up to the hoppers passes this central bridge, only one man is needed to supervise the weighing, even at works where three or four furnaces are discharging 200 to 300 tons of iron per day each.

No works is more in need of suitable conveying appliances than blast furnace works. These works run permanently day and night, and the amount of material handled is considerable. More especially of late, owing to the introduction of the eight-hour day and the increased danger owing to industrial unrest, a labour-saving plant is of utmost importance to the coal and iron industry. Of the more modern devices for furnace charging, two systems hold the field as competitors. The one was originated in America and first introduced at Dusquesne, near Pittsburg, in 1897. The origin of the other system dates back as far as the early eighties, when Prof. Fleeming Jenkin first coined the word "Electric Telpher." Like so many inventions of English or American origin, it was the non-creative but ploddingly industrious mind of the German that developed both these systems to their present state of commercial possibility. The two systems are opposite in method. The one emulates a single giant, occasionally dropping an enormous charge—ready mixed—into the furnace. The other follows the practice of the "Trolls" of the Norwegian legend, an army of busy workers who do their building when no one is looking. Both systems are well known, so I will cut the description and enumerate in the light of the previous discussion some of the advantages of the telpher over the drop-bottom skip-charging device more commonly known as the "Staehler" system.

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* "Mechanical Charging of Blast Furnaces," "Journal of Iron and Steel Institute," 1914. "The Automatic Electric Telpher," "Engineering and Industrial Management," July, 1919, by N. G. Kapp.

Beginning with the discharge of the railway trucks into the bunkers, the Staehler system necessitates a disposition of bunker cells, described and adversely criticised in our sketch, Fig. 3. Each giant transporter, having its own group of bunker cells, the trucks have to be shunted and manœuvred over these cells in order to drop the proper material into the correct pockets, thus entailing more preliminary handling than is the case when the same class of material can be dumped in one part of the bunker only. Such pooling of similar kinds of material offers a further advantage over the system which necessitates splitting it up inasmuch as the risk that a particular bunker cell may run dry at an awkward moment is obviated.

As regards the filling of the skips under the bunkers the Staehler system is at a very great disadvantage since the filling operation, which is also a checking operation, is in the hands of as many men as there are furnaces, and as these men have purely menial duties to perform it does not pay to place well paid officials at these stations to operate the shoots. No correction of the charge is possible once the material is in the gigantic bucket, and the even distribution of the charge—such an important consideration in furnace charging is not only very difficult to obtain, even though the bucket be revolved on filling, but once the charge is in the bucket, it cannot be checked by an overseer. To what extent this grave defect may influence the output may be judged from the fact that the managers of one of the biggest steel works in Germany where the writer saw a Staehler plant in operation just before the war, were led to offer the men in charge of the bunker shoots a bonus on the *quality* of iron produced.

Turning to the much discussed question of the load factor the handling by means of giants shows a very poor figure compared to handling by means of pigmies. Taking a case which recently came to my notice there were five furnaces which swallowed about 100 tons per hour of charging mixture. Using 7-ton drop bottom skips this could be done in 15 trips, leaving 4-minute intervals between charges. One complete charging operation was calculated at ½ minute, leaving the plant idle for 3½ minutes. In other words, each giant would have ten months holiday in the year.

On the question of power consumption the Staehler hoists for this particular plant were estimated at 150 kw. each. As there is every prospect of them all moving together sooner or later, the cables and switchgear must be designed big enough to deal with 750 kw. peak load, although only 150 kw. would usually be needed, and even this would come on the station as a peak load. A power estimate for a telpher for the same plant showed a steady power curve of about 96 kw. at the generating station and no peak loads, the total amount of power being the same in both cases.

Next to the coal and iron industry the greatest field for extensive handling plants may be said to be gas works, on account of their ceaseless working and the complexity of their handling problems. One of the largest automatic telpher plants in the world was designed for conveying in a gas works. This plant originally designed by a German firm was completed during the war by the firm for whom it was built—a big gas undertaking in Australia. To fully describe this remarkable plant would go beyond the scope and the space allotted to this paper. Without undue transgression, however, the extensive plans, as conceived by this company, may serve to indicate what can be done by automatic electric telpherage.

I am indebted to Mr. Pearson, of the British Ropeway Engineering Company, who during the war purchased the business known formerly as Bleicherts Aerial Transporters, for some valuable information regarding the lay-out of the gas plant in question. At this point I would like further to thank Mr. Mitchell, of the Mitchell Conveyor and Transporter Company, for his kind assistance and information regarding lay-out design and automatic telepher problems, which class of work, having been until now practically a German monopoly, at last stands a chance of becoming at his experienced hands, a British industrial proposition of the first order.

As is usual in gas works, the conveying problem resolved itself into taking coal or coke from a wharf to the crushers, to extensive storage grounds, and to the retort hoppers.

The grounds extend to about 400 yards length and 150 yards breadth. The total length of the aerial track suggested was about 1,000 ft. at 3 ft. level, 7,500 ft. at 32 ft. level, and 1,800 ft. at 64 ft. level. To effect the raising and lowering of the telpher skips there were 10 spiral elevators arranged for. These elevators are continuous in action, and pass the cars to their various levels without stopping their forward motion, at the same time taking up no more room than an ordinary vertical hoist. To cope with an output of 225 tons per hour a possible distance of 60 ft. between cars was suggested. This means that some 170 cars would be used on this extensive plant. Coal and coke is picked up from the storage ground by grab, and thrown into the telpher skips which circle round the travelling gantries capable of sweeping the whole area of the storage ground. The speed of travelling is the usual speed for automatic telpher cars—about 200 ft. per minute, and the power consumption per car on the level with its 24 cwt. of coal works out at about 0·8kw.

Owing to the war not all of the above scheme could be carried out, but a good part of it was completed in 1914. The mere fact, however, that such a scheme was being arranged for after the closest study of alternative methods by expert consulting engineers, is in itself a testimony to the possibilities of the telpher.

The automatic telpher is not a new device or a new mechanism. It is the means of opening out an entirely new system of handling and conveying. Perhaps this is the real reason why it has not yet been fully claimed by the industries of this country. At the time of writing there is only one automatic telpher plant at work in Great Britain. This plant has now been successfully running for five years. But on the Continent the telpher has been well known for some 12 years, and hundreds of large plants are at work in Germany, Belgium and France. The four years' industrial isolation of all countries prevented the experience of telpher performances on the Continent from spreading to our own industries. But now this new form of conveying appliance will have its chance over here. Its advent need not be feared by makers of conveying plant at home, as it is more in the nature of a supplementary organ than a competitive one. It will not displace the belt, scraper, gravity conveyor or the ropeway. These all have their uses, but they have also their limitations. It must be left to the conveying expert to judge which type of appliance is most suitable for the special cases presented to him. This brings us back to the opening of the present discussion which insisted upon the importance of designing the lay-out. Let me close this article with an appeal to all works managers who have a load to lift and a place to drop it in. Let them think twice before ruling too many lines in the wages book, and above all let them call in the conveyor expert before fixing the lay-out. Let there be the closest possible co-operation between the managers of every kind of works and the conveying engineer. Thus may needs meet possibilities, and further possibilities be created to satisfy the needs.

The "City of Hypothea."

By J. P. KEMP, M.I.E.E., A.M.I.Mech.E.

THE conditions appertaining to electricity supply in the "City of Hypothea" may be taken to be within quite a small percentage of the actual average of 10 large industrial provincial cities in Great Britain, the financial and electrical records of which can be found —with a little research and the help of a slide rule—in the very instructive and useful monthly supplement of the "Electrical Times" (alias "Lightning"). The figures themselves have been only slightly rounded off to make them easier to handle, and for this no extra charge to the reader has been made.

About a quarter of a century ago the Lord Mayor, Aldermen and Councillors of the City of Hypothea, rather timidly introduced a young electric power station for the supply of energy for illumination to some of the more venturesome of their citizens. After a variety of experiments and experiences, the electricity undertaking prospered and developed to such an extent that the present population of 625,000 good and faithful citizens, now have the benefit of a cheap and efficient power supply from a generating and distributing plant of 50,000 kw.a capacity, on which they have expended altogether 2,000,000 *Pounds Sterling*.

The vagaries of the demand for general electrical power supply for factories, tramways and lighting are such that in the average industrial city, the heaviest period of the load is between the hours of 8 a.m. and 6 p.m., with a temporary lull between 12 noon and 2 p.m., a long period of reduced activity setting in after 6 p.m. until about 8 a.m. the following day; the full effect of this will be more readily appreciated from the following analysis of the average week day load shown in Fig. 1.

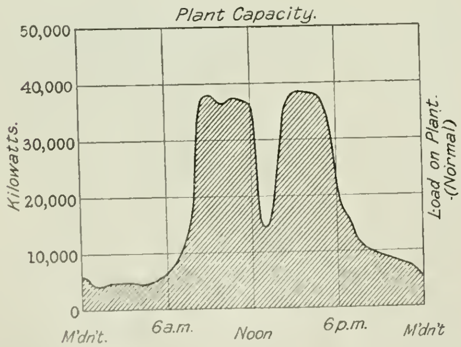

Fig. 1. Plant Capacity Load Factor 36·0 per cent. Maximum Demand Load Factor 47·0 per cent.

Analysis of Load Curve (Fig. 1.)

Times of load	Midn't 8 a.m.	8 a.m to 12 noon	12 noon to 2 p.m.	2 p.m. 6 p.m.	6 p.m. midn't	Mid.'t midn't
Hours of load	8	4	2	4	6	24
Plant capacity loaded	13·6%	74·4%	39·2%	67·5%	18·7%	36%
Plant capacity spare	86·4%	25·6%	60·8%	32·5%	81·3%	64%

This might be expressed more briefly by stating that for eight busy hours (out of 24) about 72·0 per cent. of the plant is fully loaded and 28·0 per cent. spare, but that for the remaining 16 hours of each working day only 20 per cent. of the plant is fully loaded, the remaining 80 per cent. being available for use, but unemployed for lack of suitable load. The conditions are naturally worse at week-ends and holidays. The present annual records of the electricity undertaking are as follows:—

Electrical energy sold	125,000,000 kw.-hours
Average price obtained	1·2d. per kw. hour
Annual revenue from all sources	£625,000

It is interesting to note that the kilowatt hours sold per head of population equals exactly 200, and the average revenue obtained is £1 per head of population per annum.

It is just possible that the Committee of the Electricity Department are quite satisfied to float along comfortably without making a profit or showing a loss and allowing their consumers to reap the benefit of whatever economies they can effect in the production of electrical energy, by letting them have it at its commercial cost price. This might be taken to be ideal municipal enterprise. The present plant actually produces for sale only 25 per cent. of the amount of electrical energy which it is actually capable of producing, and, as an indication of the amount of spare electrical energy that is available from the same plant during "off peak" hours Fig. 2 has been prepared. It is particularly fortunate that this amount of spare electrical energy is available at the very times when it would be most suitable for charging electric vehicles, and, as an indication of its value, it might be mentioned that the "Eddystone Lighthouse" in the centre, alone indicates that there are about 21,000 kw. of plant capacity to spare during the daily luncheon interval, the total area of the curve being approximately 30,000 kw. hours daily which would be available for mid-day boosting for those wise vehicle drivers who take advantage of every possible opportunity to put nose-bags on their vehicles. Assuming that 70 per cent. only of this energy were sold for vehicle boosting, the revenue from this source alone, at 1s. 2d. per unit, would amount approximately to £30,000 per annum, and as most of this energy would be available from plant actually running, the cost of producing it would be just a trifle over the actual cost of the increment coal required. Fig. 2 in its entirety represents a total revenue of £625,000 per anum, and its latent value should not therefore be ignored.

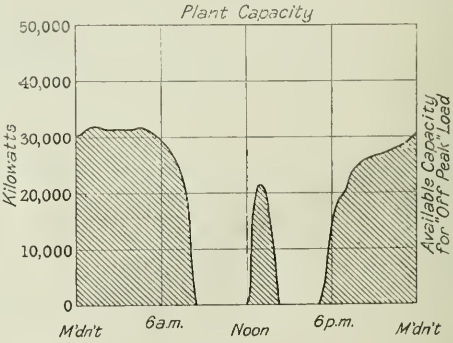

Fig. 2.—Energy Available during "Off Peak" Hours.

There are many uses to which "off peak" electrical energy available at the hours indicated in Fig. 2 can be put, but undoubtedly the class of load which fits most readily into the curve is that required for the charging of the batteries of electric vehicles. It is obvious that the adoption of such a load would not necessitate any capital expenditure for generating plant or mains. It would, of course, be necessary to instal additional transforming plant and accommodation for some of the electric vehicles at the municipal charging stations, but as practically all big clients would provide themselves with these facilities, the total additional capital expenditure necessary would be comparatively trifling as compared with the capital already expended.

Fig. 3 shows the effect on the Electric Supply undertaking, and particularly the Power Station Plant, of adding the problematic, but highly possible load of Fig. 2 to the existing load on Fig. 1. The combined loads shown in Fig. 3 represent an ideal condition which would entail no serious addition to the existing overhead charges, the cost of production being confined practically to coal, wages and depreciation of plant, with a slight additional charge for distribution, transformation and vehicle attendants' wages. At first sight it would appear to be a gloomy proposition for the City of Hypothea, but the majority of power station engineers would be willing to give their most precious possessions to have a load curve similar to that illustrated, and one can readily imagine the satisfaction with which the resident engineers would contemplate a probable 25 per cent. reduction on works cost per kilowatt hour generated. From the point of view of padding the load curve, the electric vehicle load would be ideal, as it is under the most perfect control of the power station and sub-station staffs. The city mains and distributors, which are normally sufficient to carry the peak load, would also be of ample capacity to carry the night load, and this could be regulated and arranged to fit into the valleys of the load curve on Fig. 1 like a well-made glove on a lady's hand.

To show the probable effect that this contemplated additional load would have upon the finances of the electrical undertaking Table I has been prepared, but its accuracy is not vouched for! These are extraordinary figures indeed, and might appear to represent a Utopian idea, but the fact remains that, in a busy industrial centre like the City of Hypothea such a scheme would be perfectly practicable if *all* the horses and motor lorries used on city delivery work alone were replaced by their more efficient and economical rival for this class of work—the "Electric Vehicle." Taking the running cost of electricity per electric vehicle to average 24s. per week for all sizes from ½-ton capacity to 5-tons capacity, the revenue obtained by the Electricity Department would be £62 10s. per vehicle per annum, so that the total additional revenue obtained (£625,000) would represent the use of 10,000 electric vehicles, and, large as this number may appear, it is quite conceivable that they could readily be absorbed in an industrial city of this magnitude. The effect of such a metamorphosis, from the point of view of the Municipality, the vehicle owners and the general public would be colossal. The Electric Supply Department, with a 25 per cent. increase in capital, would double the output of their plant, double their revenue and boost up their net profits to a degree that would paralyse accountancy. They would be attaching to their mains a type of load which could readily and without disadvantage be shaken off at their own discretion in times of stress, but which, on the other hand, by reason of its obliging and steady nature and reversibility, be of extraordinary benefit to the Electric Supply Department, inasmuch as it would act as a flywheel on their system in the event of their ever desiring temporarily to utilise an available discharge capacity from the electric vehicle batteries alone of 10,000 to 20,000 kw. (for which no charge would be made by the electric vehicle owners!).

From the points of view of the Salvage Department and the Public Works Department of the city, it would soon be observed that, owing to the absence of horses, there would be less disintegration of the road surfaces, less dust, less damage to roads, a total absence of odours, and less general nuisance in the streets. It might reasonably be estimated that this would very appreciably reduce the duties and operating costs of these important departments. To the general public, the greater silence of the city, the greater amount of room—due to the smaller vehicles and faster moving traffic the absence of fumes and unpleasant odours, the reduced obstruction, and the improved general cleanliness, would be a boon and a blessing. For the vehicle owners there is also a further small consideration which would interest them enormously. Experience has shown that where "electrics" have been introduced to take the place of horses on city delivery work they have (taking capital cost and every conceivable operating expense into consideration) done the same ton-mileage on city delivery work at 50 per cent. less cost. "Q.E.D."

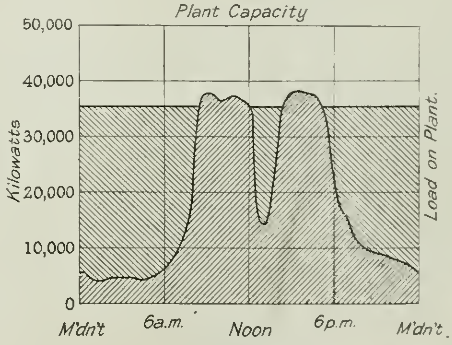

Fig. 3.—Plant Capacity Load Factor 72·0 per cent. Maximum Demand Load Factor 94·0 per cent.

Table I.—*Estimated Financial Effect of Doubling Plant Capacity Load Factor.*

Column	"A" Present.	"B" Future.	"C" Resultant.
Load on power station	Fig. 1.	Fig. 2.	Fig. 3.
Capital expended	£2,000,000	£500,000	£2,500,000
Electrical energy sold per annum, kw.-hour	£125,000,000	£125,000,000	£250,000,000
Annual revenue	£625,000	£625,000	£1,250,000
Ratio of revenue to capital	31·25%	125%	50%

Probable Effect on Operating Costs.

Running charges (say)	£400,000	£300,000	£700,000
Standing charges (say)	£200,000	£60,000	£260,000
Net profits (say)	£25,000	£265,000	£290,000
Total	£625,000	£625,000	£1,250,000

The electric vehicle is not put forward as a competitor of the petrol vehicle or the "steamer" in their own legitimate spheres of operation. Its principal function is to do city delivery work which is now mainly done by horses; but where it has to compete with petrol vehicles and "steamers" on this particular class of work, there is a marked advantage in the reduction of operating costs in favour of the "electric." Numerous instances can be quoted where one 2-ton electric vehicle has saved the owners £400 per annum net, but, if we restrain our enthusiasm, and take only half this amount to represent the general average saved by the proper use of each electric vehicle, their proud and fortunate owners will unitedly save themselves the not insignificant sum of £2,000,000 sterling per annum.

These are facts which ought to interest all important, real, live vehicle owners who have big local transport problems to consider, and electric vehicle manufacturers (and their agents) all over the country, are only too happy and willing to demonstrate to interested citizens of the City of Hypothea how this apparently Utopian idea might eventually become an accomplished fact.

The Electrician.

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The Handling of Materials.

This week's Electrician comprises our third Materials Handling Number. The first of this series was issued on December 14, 1917, when the war was in progress, and the second on January 10, 1919, when the dislocation of trade caused by the armistice was still prejudicially affecting our industries. We are now, it is to be hoped, settling down into our peace-time stride, but it is very necessary we should not relax our efforts in any way.

The handling of materials by any but the most elementary form of machine has then been forced upon us in modern times by two factors; the necessity for increasing production and the need for eliminating the human element. To go back to the days of ancient Egypt, the engineers who were responsible for the monuments, which still stand to-day as proofs of their skill, had at their disposal an almost unlimited supply of labour, and though, as far as we can ascertain, certain simple machinery was used it was more a convenience than a necessity. And so it remained until the age of machinery dawned at the end of the 18th century, when the invention of the steam engine opened up a field which has ever since gone on expanding. The labour problem was then not, however, so insistent as it is now, and for that reason, though the new methods led to an enormous expansion in many directions, the handling of materials by means of machinery was little employed for some time, as it was cheaper to use men than machines. Indeed, as Dr. Bryson Cunningham points out in the article which we publish to-day, although cranes were used 100 years ago in the London docks they were still driven by man power through an antiquated treadmill arrangement, and it was not until 1840 that the late Lord Armstrong showed how hydraulic power could be applied to the shipment and unshipment of goods. Since then we have gone ahead; the hydraulic crane has become antiquated, the steam crane has followed it, and their place has been taken by the more flexible, efficient and easily controlled electrical apparatus.

And this is where the labour problem comes in. The tendency nowadays, indeed, it is rather more than a tendency, is to employ labour-saving devices to the greatest possible extent. For if we are to be able to place goods on the market at the lowest price, and that means to manufacture them cheaply in as large quantities as possible, we must no longer employ time wasting devices, of which the ordinary human being is about the worst when it comes to materials handling. This means, however, a certain capitalisation of resources and the work must be done carefully. The problem, therefore, is not only to get rid of the human element, but to put in its place something which will do the work as efficiently a possible. This ideal cannot be realised simply by replacing the man with a machine. The whole problem must, indeed, be reconsidered afresh, as it is quite as easy to use the machine in an inefficient manner as it is to employ a human being in the same way.

Not the least important of our national problems at the present time is to increase our output of coal. This can be efficiently done by means of electrically-driven machinery whose employment in mines offers special advantages. An account of conveyors which are being used for this purpose is given by Mr. H. C. Jenkins, who, besides dealing with the ingenuity which has been exercised in the design of this apparatus, shows that here, again, labour difficulties have to be taken into consideration. The coal problem is also dealt with directly by Mr. G. Bell, and incidentally by Mr. N. G. Kapp and Mr. G. F. Zimmer, who in their articles go into the vital questions of the design and employment of labour-saving and time-gaining appliances. They all show what can be done by modern methods—given the chance to employ them. In this respect, Mr. Zimmer's article will be found most useful, as he is able to give a series of interesting figures and charts which will enable a solution of any material handling problem to be easily obtained by the use of the most suitable equipment.

Various types of equipment such as cranes, hoists, telphers, conveyors, &c., have indeed their special sphere of usefulness, and the employment of one should not exclude the others. For the way a particular material is to be handled depends on a very large number of factors and cannot be given any general solution. This point is well brought out in a consideration of another portion of the problem of materials handling, which is excellently dealt with in a Paper by Mr. A. J. Conradi, recently read before the Institution of Mechanical Engineers, an account of which will be found on another page of this issue. This is materials handling by road. The recent railway strike showed that road transport can be a valuable auxiliary to the older methods of conveying goods from one part of the country to another. In using this solution of difficulties which at present exist, one factor which has to be considered is the question of the road surface, but another more interesting one from our point of view is what type of vehicle should be employed for the transport of the goods. As electrical engineers we naturally incline to the use of the electric vehicle, and we are glad to learn that the employment of this class of vehicle is rapidly developing. At the same time a note of warning must be sounded, as Mr. Conradi shows, against an attempt to use this type of vehicle for all classes of road haulage. For when it comes to a consideration of mechanical traction on roads it cannot be said that the steam, petrol or electric vehicle can be used to the total exclusion of any one of the others. Each has its proper field where it can operate best, and in so wide a field as that of road traction there is plenty of development possible without poaching on anyone else's preserves. At the same time the "electric" must be pushed for all it is worth where it can be used not only for its own sake and because of the excellent effect its extended use has on the load curve of a central station. What this effect is is shown by Mr. J. P. Kemp.

This argument of a limited field of use, however, hardly applies when it comes to the consideration of such materials handling apparatus as cranes, winches and conveyors. In the driving of this machinery the electric motor is pre-eminent and it is hardly necessary in the columns of the Electrician to expatiate on why this is so. It is, however, a point which has to be insisted upon by electrical engineers in discussing the question with directors and users of plant who have no electrical knowledge. In this part of their work we hope they will find this particular issue most useful.

Wire Ropes.

By A. C. N.

THE popular idea that a wire rope consists of a number of steel wires, twisted up to keep them together, has of late years undergone considerable changes, especially as engineers have found how highly important wire ropes have become as a factor in engineering problems. In the building of bridges, and transporters, for cranes, and all lifting machinery, for ropeways and overhead transmissions, for the efficient mining of all minerals, and for oil well drilling, wire ropes are indispensable, with the result that much attention has been given to their efficient production, and to the suitability of materials and construction used therein.

Rope wire is drawn by specialists in that commodity from the highest grade of "crucible steel" rods, which is now really made in bulk by a Siemens-Martin open hearth process, similar to, but much more reliable than the old crucible method. Modern steelworks practice ensures the correct carbon constituent necessary to the heat treatment, whilst the injurious foreign constituents, phosphorous and sulphur, represent negligible amounts. Where ropes of special reliability are required, the material is drawn from "acid" or "special acid" material, which gives special immunity from basic slag inclusions and decarbonised patches. The heat treatment, known as the "Patenting" process, raises the tensile stress of the wire enormously, the amount being regulated by the carbon constituent and by the process given to the material. The tensile strain is limited by the ductility and reliability necessary to rope wire, which decreases as high tensile stresses are approached. The useful range of ultimate stresses varies from 80 to 120 tons per square inch.

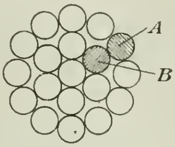

Fig. 1.

In round stranded ropes the usual basis of the strand is seven wires, laid six wires round one wire, and over the strand are laid further coverings of wires according to the flexibility and size of the rope being made. In order to obtain the maximum breaking strength from the rope, the pitch of the wires, or "lay" as it is called, must be carefully arranged, and in the case of a compound strand, the pitch of the various layers is so arranged that the load is equally distributed at all stresses. That is considering single wires A and B in different layers of a compound strand (*see* Fig. 1). Each wire is a helical spring, the pitch of which must be arranged so that the extensions on either A's or B's layer is the same for equal loads on the individual wires. Of course, the extension of the helicoid is very small in practice, as change of radius of curvature is rendered impossible by the fact that the layers of wires are solidly laid up. Ropes may either be made "ordinary" lay, with strands spun in one direction and rope laid up in opposite direction, or they may be made "Lang's" lay in which strand and rope are spun are laid up in the same direction. This latter type calls for very careful arrangement of the lays, owing to the tendency of both strand and rope to untwist in the same direction under the action of a tensile load, a condition which is neutralised in ordinary laid ropes. Lang's lay is adopted where heavy frictional wear on the ropes make it necessary to take advantage of the much greater length of each wire exposed to wear than ordinary lay affords.

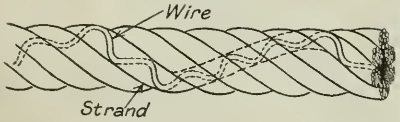

Fig. 2.

Much attention has been given of late years to non-rotating ropes, which are indispensable for certain conditions and uses. These are made in flattened strand and locked coil constructions illustrations of which appear herewith. Additional advantages of these constructions are that they are practically stretchless, and an important requirement of endless ropes for haulage and driving; also that they possess a much greater surface upon which to distribute frictional wear, giving longer life than round stranded ropes.

The first consideration in the selection of a wire rope is undoubtedly the size and the material thus obtaining the requisite tensile strength, but an equally important question is that of the flexibility of the rope. In order to get the maximum service from a rope, the outer wires should be made as large as possible, to resist crushing wear and crushing action. The rope, however, must be flexible enough to pass round drum or pulleys without unduly high bending and torsional stresses, and without "locking" the strands, which causes the wires to act as "struts" on the inner or pulley face side. If we consider an individual wire in a wire rope, we notice that it has been laid up in the form of a helical spring, the form of the helicoid being compounded of the lay of the strands in the rope, and the lay of the wires in the strand. Reference to Fig. 2 will make this clear.

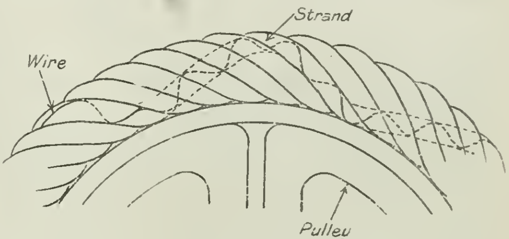

Fig. 3.

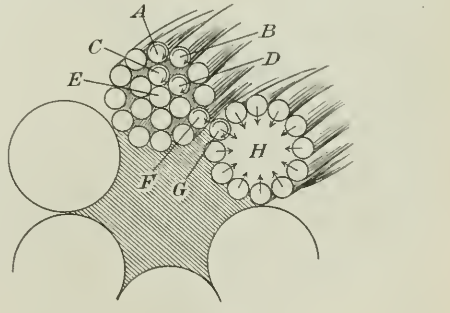

Fig. 4.

Now let us suppose that our rope is bent round a pulley (*see* Fig. 3), we notice the following actions: (1) Bending stress on the individual wires; (2) torsional stress due to the bending of the helice; (3) a direct tensile stress due to the load on the rope; (4) a torsional stress due to the lengthening of the helice when rope is under direct tensile load. In ordinary laid ropes, where the helices are in opposite directions, the torque of the wires counteracts that of the strands, with the result that its flexibility is reduced somewhat. In Lang's lay, however, where wire and strands are laid upon the same direction, the torsional action is not impeded, and full flexibility is obtained. When a rope is run on the correct drum and pulley, the torsion due to the helical formation in the strand at the pulley face end, and at the outer crown, tends to equalise, the individual wires giving the necessary flexibility to allow this. When pulley is much too small the friction between the strands locks them and prevents them from accommodating themselves, causing the wires next the pulley face to act as struts, with destructive results.

From the foregoing considerations we may observe that the internal actions which take place between the units in a rope are as follows (*see* Fig. 4, which represents Lang's lay rope on a pulley). In this case the wires A, B, C, D tend to rotate in the same direction, the centre wire E to a much less extent. Wires in different strands, much as F and G, also rotate in the same direction. The elongating effect of the load is similar to 1 and 2, whilst the tensile effect is to draw all the wires towards the centre of the strand, as at H. The bending of the wires and strands causes longitudinal displacement relatively to one another. If we add to the above the crushing action of the pulley faces, vibration, etc., we will realise that a wire rope needs careful lubrication in order to ensure a satisfactory life. In order to increase the flexibility of a rope we increase the number of wires in the strand, thereby decreasing their size. Then, since the torsion required to twist a solid wire varies as the fourth power of its diameter, and bending varies as the cube of its diameter, the flexibility is correspondingly increased.

From the foregoing it will be evident that problems regarding wire ropes are best referred to the manufacturer, who knows exactly the material, construction, and type of rope required to work successfully and economically any given conditions.

The Present Position of Mechanical Road Traction.*

By C. G. CONRADI.

TRANSPORT of all kinds has become of such overwhelming importance to all members of the community, both individually and collectively as affecting the welfare of the Empire, that no apology need be made for bringing the question of mechanical road traction under general review at the present time. The actual application of the power to the trains or vehicles on railways and roads is performed more or less in an efficient manner, and further progress is continually being made, if only slowly; but the methods employed for handling and carrying the goods are in most cases exceedingly crude, very few attempts having been made to employ the apparatus already available or to evolve new methods and machines for the saving of time and labour. Where full loads can be obtained the road vehicle, working direct from door to door, with the consequent elimination of handling, is bound to score heavily over the railways on the shorter hauls, and under certain circumstances even on long hauls. One of the great difficulties in the way of the economical operation of this traffic is the obtaining of full loads in both directions, and the constitution of freight exchanges becomes a necessity. There are two elements which constitute the system of road traction, namely, the roads and the vehicles which operate upon them. The former do not enter directly into the province of the mechanical engineer, but it may be noted that the condition of the road surfaces affects very largely the economical operation of the vehicles, and therefore becomes a highly important factor in the national economy.

It is obvious that the animal traction has a very limited field and, on account of the low speed and small mileage possible per day, it must be confined to short hauls; although, on the other hand, its low first cost makes it difficult of replacement by mechanical haulage for certain classes of frequent-stop delivery work. When all expenses have been duly charged against animal traction, or, as we know it, horse traction, it has been found that in practically all spheres of operation it is more expensive and less efficient than motor traction. The displacement of horses, however, by motors should not be undertaken too lightly, nor without a full investigation of each case, and the proper appreciation of the necessity for the operation of motor transport on scientific lines so as to ensure economic success. Much of the traffic congestion in our large towns is due to the slow-moving horse, and the only practical means of speeding-up the bulk is to eliminate the horse altogether from the most congested areas. One frequently hears it stated that motors cannot compete with horses on short hauls, but this is not the fault of the motor so much as the method of application. The motor-truck is a time-saver; it will carry the same or a greater load much more quickly than horses, but *it is only a time-saver when moving*. Hundreds of motor-vehicles are not moving for as great a proportion of their time in commission as they should, and are therefore not so economical as they might be.* The diagrams shown in Figs. 1 and 2 have been taken from a report on road trans

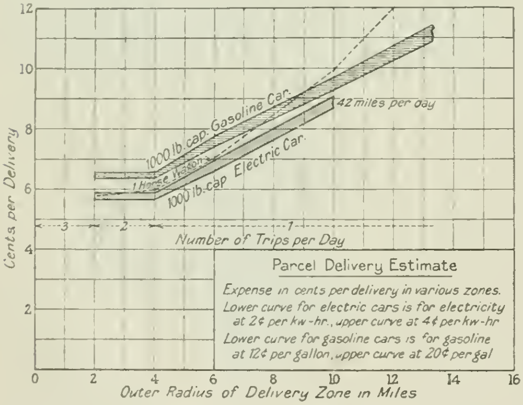

Fig. 1.

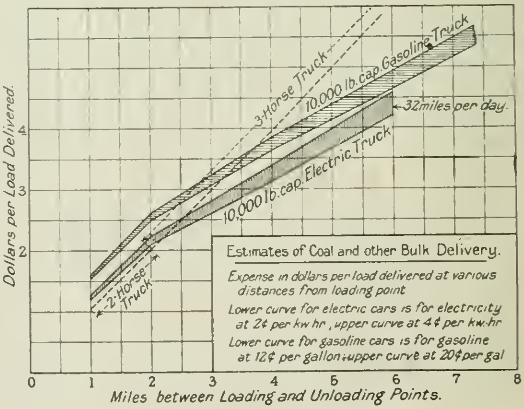

Fig. 2.

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* Abstract of a Paper read before the Institution of Mechanical Engineers.

* L. Brockman, "Self Propelled Electric Vehicles." Trans. Institution of Engineers and Shipbuilders in Scotland, January, 1917.

port issued some time ago by the Massachusetts Institute of Technology, and are based on 100,000 individual observations and owners' records during a period of four years. The width of the cross-hatched areas for electric and petrol motors shows the effect upon total expense of variations in the charges for electricity from two to four cents per unit (1d. to 2d. = 100 per cent. variation) and in the cost of petrol from 12 to 20 cents per gallon (6d. to 10d. = 70 per cent. variation). Actual money results must now be modified, but the author's experience goes to show that the relative positions of the curves have not materially altered except by way of improving the position of "The Electric." It will be observed from these curves that the horse is shown to have a slight advantage over even the electric vehicle on the heavier work within a radius of 2 miles, but better methods of operation can reverse this position in the majority of cases. Time lost in loading and unloading is responsible in almost all cases for motor inefficiency and for the fact that in some instances the cost unit delivered is greater than with horses. Great waste takes place annually because users have not installed modern time-saving devices in connection with their motor service, and it should be recognised that motor-traction cannot be made a commercial success if it is still to be operated on horse-pace methods. In too many cases the same methods of loading and unloading as obtained with horse-haulage are continued when a change to motor-haulage is made, no cognisance being taken of the fact that the high standing charges of the motor are still going on whilst it stands idle, and that it only makes money if saving time and therefore if moving. The comparatively high capital cost of all mechanically or electrically propelled vehicles, and the shortened working day, necessitates the fullest use being made of them, and advantage should be taken of all accessory apparatus which will cut down the time lost in loading or unloading or enable the vehicle to carry a greater load.

A normal day's work of 10 hours for a vehicle used in town delivery work may be analysed as follows: Running 3 hours, meal 1, loading 3½, unloading 2½ hours, from which it is seen that by saving even only one hour out of the two latter items the running time (which is the true-money-earning portion) can be increased by 30 per cent. Fig. 3 shows the effect on cost per mile of increasing the miles run per day or the average m.p.h. taken on the total time in commission. The engineer is still, however, helpless in the face of existing haphazard methods of operation where "waiting turn" at docks, warehouses, etc., is still in vogue, with consequent idleness and waste of time.

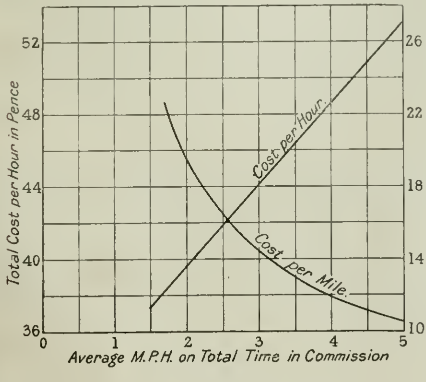

FIG. 3.

Since the average vehicle loses more time at the loading point than at any other part of its route, devices which assist rapid loading are perhaps most numerous as a means of improving that state of things. Removable bodies or variations of the demountable principle are probably the most effective of such devices, and isolated cases have been in use for a considerable number of years. In an extensive system using such an arrangement of body, a cheap slow-speed electric vehicle which might be designated the Conveyor, and used to lift, convey, and deposit the bodies as dealt with, could in the case of railway transport supply the link between the wagon and the road vehicle without any upheaval of existing methods or the provision of expensive machinery and buildings. Full-loads between stations would be dealt with on the same bodies, but by employing overhead cranes for the transfer from rail to conveyor or road vehicle. A further modification, and one used where no means exist for supporting the bodies, consists of providing special legs with hinged feet which are turned up out of the way to give road clearance when travelling. Fig 4 shows such a body as fitted to a 2-ton electric vehicle by the Edison Accumulator Company. The lifting gear is driven by a separate small electric motor which is arranged with an automatic cut-off to prevent overrunning. To provide for easy entrance of the chassis under the body, the front legs of the latter are made to pull out to give additional clearance (position 1, Fig. 4) and when pushed to the normal position present no obstruction in traffic. The provision of lifting gear of this description allows the driver to discharge a loaded body and take on another in a very few minutes unaided and with no special exertion.

Several methods employing bodies which can be rolled off are in use, such as the Stamper loading truck,* and known at the D.C.C. system, the inventors being Messrs. Dalziel, Crocker and the author.

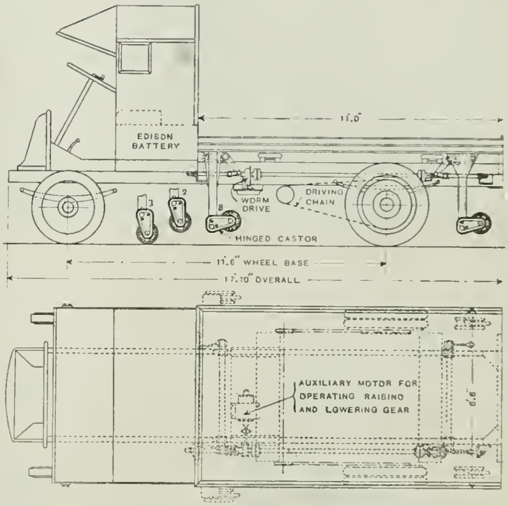

FIG. 4. DEMOUNTABLE BODY WITH LEGS.

The main underlying idea in this case is the provision of a loose frame carrying the body, which can be twisted in any direction or traversed across so as to bring its rails into true alignment with those of the other vehicle, the two vehicles having previously been only approximately and quickly placed in alignment. The rollers in this system are fitted to the bodies, which run on rails carried by the vehicles, whilst disused horse-lorries are generally made use of as the tender-vehicles. Short telescopic rails connect the two vehicles and the rails on the tenders are formed into loose frames carried on rollers and controlled by levers and chains from either side. In this case after the vehicles have been roughly positioned and the connecting rails dropped into their sockets, one or both ends of the frame carrying the rails on the tender are drawn across until the rails are in alignment with those on the motor-vehicle. It will be readily seen that an operation such as this is necessarily much quicker and easier than trying to meet the same end by see-sawing the motor back and forward. A feature of the D.C.C. system is that the body can be taken off or put on to the tender-lorry at either end whichever happens to be handiest at the moment. With any of these foregoing arrangements, bodies can be exchanged in a few minutes, and an added advantage from the loader's point of view is that the loading can be carried out at his convenience and to the best advantage. In some cases it is desirable that bodies which have been dealt with should be removed from the loading deck to make room for others, and, when tender-lorries are in use, this can be readily accomplished by a horse or cheap form of tractor. The warehouses and yards of private traders, however, may not allow of the use of tender-vehicles, in which case the frames for alignment may be placed on the decks so that the bodies may form part of the floor space. By such an arrangement one of the objections to the Gattie system, namely, the difficulty of handling the containers at the average trader's premises, can be readily overcome.

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* See *Engineering*, March 30, 1917.

What amount in effect to removable bodies are the trailers, semi-trailers and road trains, whilst they have the advantage under favourable circumstances of enabling a greater load to be hauled by the same power unit. Quite extraordinary claims have been made for the performance of trailers, especially in America, and no doubt for bulk loads, and on easy routes, they have their place, but the wholesale adoption of trailers behind ordinary vehicles carrying loads cannot be justified, as a trailer takes power to haul it, reduces the speed of working, accelerates depreciation of the mechanism, and increases type wear. In this connection the law regulating the construction and use of trailers has done much to limit their adoption, the main points to which exception may be taken being that the speed of a motor-vehicle hauling a trailer must not exceed five miles per hour, and that it must not haul more than one at a time. There is no reason whatever why trailers should not be operated safely up to 10 miles per hour, and this would at one sweep double the nominal capacity of the combination for doing work, and by fitting them universally with rubber tyres no more damage would be done to the roads. For bulk loads, trailers or road trains drawn by suitable tractors form a very economical combination, but their use in congested areas should be confined to night work. The tractors for such work must be specially designed, as they require to be very robust to withstand the sudden and violent strains to which they are subjected in starting and braking the trailing load, whilst in tractors of the internal combustion type, as the power unit is run more nearly at full load for considerable periods than is the case in ordinary vehicles, particular attention should be paid to the cooling surfaces, and it is also usual in this type to provide more than the usual number of gear changes. A comparison between the full trailer and the semi-trailer is interesting as showing the work for which each type is most suitable. The full trailer is a separate vehicle on four wheels, and can be more readily left for loading and unloading whilst the tractor is away on other work, but the combination has the disadvantage of being very deficient in manœuvring properties, especially in backing. This has been got over in certain trailers by the provision of individual steering-gear and, when desired, forecarriages at each end which can be locked at will.

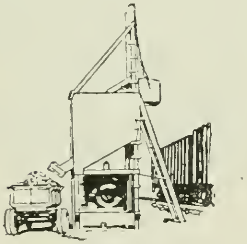

Fig. 5.—Loading and Unloading Machinery for Lorry.

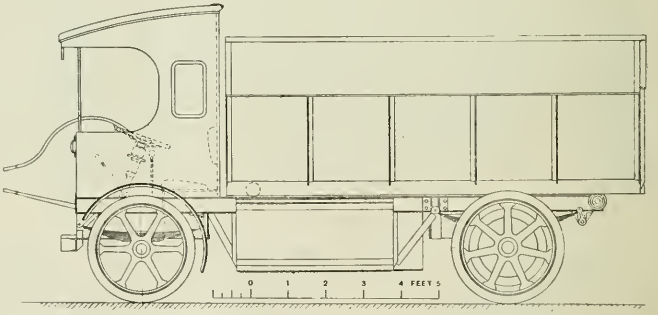

Fig. 6.

With the semi-trailer the tractor partly carries and partly hauls the load, the front end of a two-wheeled vehicle being carried on a platform directly over the rear or driving wheels. About 40 per cent. of the load is usually taken in this manner, the remaining 60 per cent. being carried on iron-tyred wheels. A load of 10 tons can be easily dealt with by this combination without the truck having to be made excessively heavy, as it otherwise would be if designed to carry the total load, if that were feasible under axle-weight restrictions. Additional load on a semi-trailer provides additional adhesive weight, but never more than 40 per cent. of the total. The three-axle arrangement thus obtained is allowed to run up to 12 m.p.h. it is more compact than the four-axle with two independent vehicles, and much easier to manœuvre, being somewhat on a par in this respect with a horse and lorry, although the side-stepping action of the horse can never be wholly equalled. By propping up the front end, the trailer may be left for loading or unloading, but this operation takes more time than the uncoupling of a four-wheel trailer, with which, however, there is always the danger of a man being crushed. For this reason some form of automatic coupling is advisable, which should then be arranged for release by the driver without his having to leave his seat. In an electric tractor and semi-trailer refuse wagon as made by the General Vehicle Company the connection is made by a rocking fifth wheel and cone bearing on the tractor with the cup on the trailer. In the four-wheel refuse wagon drawn by a Lloyd electric tractor, the rear wheels are lifted off the ground by means of a screw-gear. Such a combination gives a three-axle machine with good manœuvring qualities, but necessitates a front wheel drive and steer, which is obtained by fixing an electric motor directly to each front wheel which is driven by internal gear. This is the Mossay system used in the construction of the smaller-sized "Orwell" vehicles built by Messrs. Ransomes, Sims & Jefferies. It has not been found advisable to use four-wheeled trailers with petrol vehicles for the reasons already given, but numbers of two-wheeled trailers have been employed for special military purposes such as for the conveyance of aeroplanes, etc. It is very questionable, however, whether the conditions in this country are ever severe enough to warrant the extra expense in first cost and maintenance occasioned by the adoption of this design of vehicle, although it has much to recommend it in the case of heavy tractors. Vehicles constructed on the caterpillar or track-laying system are not likely to come into use for general purposes, and they will no doubt be restricted to work on bad roads and rough land or for military purposes.

Unloading, as a rule, presents less difficulty than that of loading, and in the case of rough material such as sand, road metal, etc., the now familiar tipping body is the most commonly used. Electric tipping lorries are extremely useful for refusal disposal, coal transport and such work, the tipping gear being either hand- or power-operated by a small separate electric motor. In the Orwell, the tipping gear is arranged with two screws of different pitch, and in such a manner that during operation, the body is carried to the rear at the same time as it is being tipped, whilst in the G. V.-Constable, the body is moved out by a single screw until a balance is obtained and then tipped, the power required being thereby reduced. A special feature is the method of mounting the door so that it remains in position whilst the body falls away from it and leaves a very free opening. The advantages of the "electric" for municipal and all town collection and delivery work are being rapidly recognised, and a great increase in this type is to be looked for in the near future. An electric vehicle which has been specially designed by the author for such house-to-house visitation work is shown in Fig. 6. In this case the entrance is at the front, the driver's cab being dropped between the side members of the chassis to such an extent that only one step up is required to enable the driver to mount, considerable time and energy being thereby saved. A special "inching" or "leading" control is also provided when desired for use in refuse collection, whereby the vehicle can be steered and driven slowly from ground level, thus obviating the necessity for the driver's mounting into the driving seat for a movement of probably only a few yards between stops. This gear is "foolproof" and can instantly be put out of action to allow of ordinary driving being resumed. It has been shown for clearness at the front of the vehicle, but might be equally well used at the sides. Fig. 5 shows the possibilities of using specially designed unloading machinery.

Heavy goods which cannot be dealt with by tipping bodies may be lifted off by self-contained cranes, either hand or power-operated. An ingenious piece of apparatus, which may be considered as a direct product of the war, is the Wilkins truck emptier. This is an adaptation of the roller-blind shutter which, as an unloading device, has the advantage that any fraction of the load can be readily dumped as desired, whilst it can also be used to facilitate loading.

In the loading of all heavy goods, barrows of some description are necessary, and for the actual picking up and moving of packages it is difficult to find a more efficient machine than the so-called miller's two-wheeled hand-barrow, the toe of which can be so conveniently inserted under a package and used as a lever to lift and carry the same. The capacity of such a barrow, however, is strictly limited, and if any considerable distance has to be covered it is advisable to adopt power haulage. Considerable numbers of hand-operated trucks with lifting tops and of capacities up to 15 cwt. are now in use. These are sometimes known as jack-trucks, being, as the name implies, a combination of lifting jack and truck, and are made in various forms to suit individual requirements. Where long runs obtain, electric baggage trucks carrying loads up to 2 tons, or acting as tractors for trains of small trailers, are useful in expediting the loading and unloading of the road vehicles, whilst for special cases they can be provided with power-operated lifting platforms and loading trays or small cranes for heavy loads. A lifting platform truck operating on war material is reported to have dealt with 150 tons of material in one day, whilst trucks working on long runs with trailers regularly deal with 200 tons and upwards per week. Where there is a steady stream of standard pieces to be transported, it pays to have the trailers specially designed to suit the work, saving in time being thereby effected in packing, arranging and securing the articles.

The steam vehicle for commercial work is a most reliable and useful machine, but is handicapped against universal adoption by the boiler, which does not appear capable of further improvement in the necessary direction. What is popularly known as the petrol vehicle has a characteristic governed by that of the internal-combustion engine on which it depends for its power of locomotion. This motor is essentially a one-speed machine with comparatively little flexibility, and has therefore to be combined with some form of starting and speed-varying gear. The necessity for gear changing has been reduced to some extent by the fitting of excessively large engines, but only at the expense of fuel consumption, car tax (in the case of passenger cars), etc. The petrol vehicle is best suited therefore, for work involving few stops and high speed, where starting and gear changing, with the attendant racking stresses, will be a minimum. The electric vehicle, on the other hand, having no change-speed gear, low maximum speed, high acceleration, no reciprocating parts, easy control in traffic, and limited radius of action is best fitted for short-distance frequent-stop service through congested areas, although it is also very suitable and has been used as a tractor for heavy haulages.

It will therefore be observed from a consideration of the characteristics of the various types of machines that there should be little competition between them, each having a fairly well-defined sphere of usefulness. The competition is rather between horse and motor, and even then only for short-distance work, where in some cases the former still has some advantages. Fig. 7 shows the relative positions of these three main classes of vehicles when their running costs, based on their nominal capacities, are compared, and it will be noticed that the "petrol" after the 3-ton point is reached has to give place to the "steamer," whilst the latter also approaches very closely to the "electric" after 5 tons is reached. Beyond capacities of 5-6 tons it is probable that the electric would be built as a tractor with trailer or semi-trailer. The deductions to be drawn from this chart agree very well with the conclusions obtained from the consideration of the characteristics of the type of machine, and the approximate field of usefulness when the conditions are favourable to the type is shown by the solid line. The very wide range of "The Electric" should be noted, and if the "Petrol-Electric" be admitted to this class all work excepting where speed is a *sine qua non* comes within its scope.

It is only in Britain, and perhaps more especially in England, that the steam vehicle has been used to any considerable extent, ample supplies of suitable fuel no doubt contributing largely to this result. The boilers, as previously indicated, are chiefly of the fire-tube variety, whilst the locomotive type predominates. Steam tractors and traction engines have been improved chiefly in the direction of increased economy by the introduction of compounding, etc., whilst many of them are now fitted with rubber tyres. The heavier type of steam tractors, known by the generic name of "traction engines," are fitted with engines and boilers capable of developing on the larger sizes 50-60 h.p. and of dealing with loads up to 25 tons, whilst their weight in working order may be anything up to 16 tons.

One of the most powerful petrol-engine tractors is the Foster 105 b.h.p. tractor capable of hauling 30-35 tons at a speed of 5 m.p.h. The engine has a governed speed of 1,000 r.p.m. and transmits its power through worm-gear to a differentially-geared cross-shaft which carries a pinion on each end, gearing in to toothed rings on the road wheels. The rear road wheels are 8 ft. diameter and 2 ft. wide. The petrol vehicle as a whole is well known and has not altered greatly in design within recent years, although it has been improved considerably in detail design and by the use of alloy steel in construction; both of these have made for greater reliability, freedom from breakdown and reduction in weight. The greatest strides in the use of the internal-combustion engine for transport and haulage work have been made in tractor design for military and agricultural work, much of which was the outcome of necessities occasioned by the late war. Purely agricultural tractors cannot bulk largely in road transport, owing to damage which would be caused to the roads by wheels made suitable for work on the land, and the logical conclusion is that the tractors designed for work on the land should be restricted to such work, and that the haulage of the produce on the roads be carried out by road vehicles of the ordinary type, or where badly made yards or field entrances have to be negotiated frequently, by four-wheel drive machines.

Electric battery vehicles, although rapidly increasing in number in this country, are not a very familiar sight in the streets, and, except to those specially interested in them, may be looked upon as a new aspirant in the field of mechanical road traction. It may be pointed out, however, that heavy electric vehicles have been in use in America for about 18 years, many of the original vehicles being still on the road, whilst in England and on the Continent numbers have been in use for many years. In greater New York it is understood that about 43 per cent. of the total number of vehicles used for commercial purposes are electric. After the failure of various attempts at battery traction, between 1885 and 1898, it was practically abandoned in this country, but in America, France, and Germany it was continued, with the result that, especially in the former, it was soon on a fairly satisfactory basis. Great credit is due to American engineers, who slowly but surely overcame the mechanical and electrical disabilities of the lead battery and brought the alkaline cell up to the point of being a commercial success. The chassis of some of the early machines which are still running are reported as showing no deterioration whatever, which is no doubt due to the low maximum speed and absence of vibration in the driving mechanism. The advantage of "The Electric" might be briefly stated thus:—Cost of energy is low, and until the effect of war conditions was felt had been steadily decreasing, no power is consumed whilst at rest, can be easily controlled by unskilled labour, horse drivers being taught to drive efficiently in a few days or even hours, the overall length is short, they have a high figure of reliability due to simple construction and the absence of rotating parts, and consequently low repair costs, they are clean, sanitary and free from fire risks. The most common, in fact practically the only, criticism levelled at the electric vehicle is its low speed, but what is required for town work, where this type has its field, is the maintenance of a reasonably high average speed. This is obtained by electric vehicles because of their easy control and high acceleration, and numerous observations go to show that when compared with petrol vehicles on the question of speed, the latter, with probably 75 per cent. greater maximum speed, has no time saved to its credit at the end of the day. The "Central Station" of America published some time ago the following results of a series of tests between a petrol and an electric lorry geared respectively for a maximum speed of 12 and 18 miles per hour. The course was triangular and

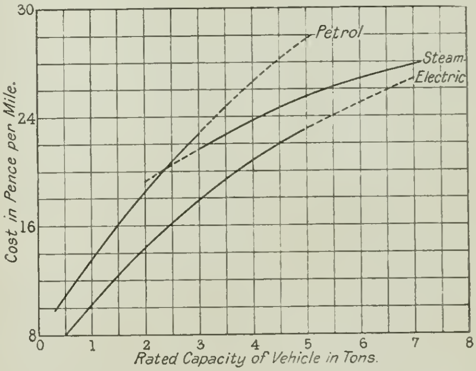

FIG. 7.

	Average Speeds.	
	Electric	Petrol
(*a*) Leg 1 level	10·76	9·41
2 up	7·08	8·85
3 down	11·12	7·2
Average	9·65	8·48
(*b*) Leg 1 level	11·4	10·08
2 up	6·9	7·83
3 down	11·8	10·56
Average	10·03	9·48
General	9·84	8·98

the roads good. Duration of stops in the case of (*a*) 2 minutes, (*b*) 1 minute, number of stops 24, distance between stops 0·42 mile. This shows the average speed of the electric lorry to be approximately 10 per cent. higher, although geared and powered for a 30 per cent. lower speed. The reliability of the electric vehicle is becoming proverbial, and if need be it would be quite feasible to run an electric vehicle for 365 days in the year. Brockman, in a Paper given at Glasgow, gave the relative ratios of working days to days in commission as electric 95 per cent., petrol 90 per cent., steam 85 per cent., whilst the author would be inclined to place the electric at 2 per cent. better than this. Little difficulty is experienced in obtaining adequate supplies of electricity, and the position in regard to this is improving daily. Electric power is exceedingly flexible in its application and will readily admit of vehicles being designed for special purposes in a way which will allow of the maximum possible duty being obtained from them.

The "Fram," which was a French machine, is an instance of the possibilities of designing electric chassis for special purposes, and these machines were used in large numbers for refuse collection by the Municipality of Paris. The power unit is complete in the form of a detachable forecarriage with battery and motors coupled direct to each wheel. A feature of the Fram control is that steering is assisted by accelerating the outside motor above the speed of the other by means of an automatic attachment to the steering wheel. This throws 27 cells out of the complete 44 on to the motor, which requires to run the faster, as against 17 on the other. The front wheels revolve on a fixed axle, and in steering, the whole forecarriage turns as in a horse vehicle, an extremely large lock being obtained. Regenerative braking is used, and in descending stiff gradients currents up to 80 amperes are returned to the battery.

Wheel drives, where the motors are built into the wheels, have been used to a considerable extent, and these allow of two or all four wheels being driven and also a certain amount of additional latitude in the design of special purpose chassis. In this class beside the Fram and the Mossay we may note the Cedes, in which a slow speed gearless motor is built into the wheel; the C.T. internal gear drive, the motor and pinion being concentric with the gear ring and engaging through a cluster of idler intermediate wheels, and the Couple Gear in which a high speed motor is carried in a horizontal position within the wheel itself and having a bevel pinion on each end of the shaft gearing with two level rings on which the road wheels are mounted. The motor is set at a slight angle to the plane of the wheel so that the pinions engage with their respective halves of the racks whilst being free of the other half. A reduction of 25-1 is used and an efficiency of 97½ per cent. is vouched for by the American Bureau of Standards.

With regard to the driving gear in general, final chain drives are efficient when new, but tend to soon become noisy owing to the multiplicity of small joints which are exposed to dust, dirt and the action of the elements, and which it is very difficult to keep lubricated. Bevel gear drives, double reduction and worm gears as usually designed all mean a heavier rear axle than the chain drive, and owing again to this increase in weight the gears themselves require to be made heavier to stand the severer shocks entailed and to which they are subjected. Bevel gears necessitate exceedingly fine adjustment, and therefore skilled attention, and for these reasons are not desirable components of a road vehicle. Its use on the heavier vehicles has already been much reduced whilst it is being slowly eliminated from the lighter ones. Worm gear has been much improved during recent years, but its overall efficiency under varying road and load conditions is a very questionable quantity, and its use, especially with electrically driven vehicles, is not at all desirable. Wherever possible spur gear, and preferably internal gear, should be made use of for the heavier classes of vehicle.

To enable vehicles to cope with distances which are beyond the capacity of battery vehicles and yet to retain the advantages of electric transmission, several petrol-electric systems have been successfully developed and used with advantage for omnibus service, especially where heavy routes have to be covered. In the Tilling-Stevens system, illustrated, the gear-box of a petrol motor is replaced by an electric generator coupled to the engine which supplies current to a motor driving a live axle of usual type. Durtnall in his Paragon transmission employs a petrol-driven A.C. generator with what he terms a clutch motor, the case of which revolves fixedly with the engine and generator. Control is obtained by altering the connections of the clutch motor field so as to drive its rotor at 50 per cent. below, at engine speed or at 50 per cent. above engine speed as desired, the rotor being coupled direct to a standard type rear axle. On the second speed a magnetic clutch drives the rotor mechanically, and the clutch motor electrical losses are then cut out.

The Thomas transmissions is a further variation of the petrol-electric drive where the lower speeds are dealt with electrically, but on full speed the electric motor is cut out and its losses eliminated by a direct mechanical drive. Hydraulic transmission with oil as the working fluid has been tried to a limited extent, and the variable-stroke pump driven by the engine gives an easy speed control with an infinite number of steps.

An unique system of electric traction is in use in Bradford which, although apparently having only a limited scope at present, may contain germs capable of great future development. A chassis is equipped with two 500-volt 20 h.p. motors with series parallel control and switch gear to allow of its running on railless routes with positive and negative wires, on tramway routes with earthing shoe on rail, or off the main routes by means of the battery. The connections are so arranged that the battery can be placed in series with the motors for charging whilst running on the trolley routes. The battery consists of the 124 Edison B4 cells, which have a capacity sufficient to run the vehicle for 10 miles on average roads. The vehicle was put into service in May, 1916, and has operated since then chiefly on the collection and delivery of tramway stores, although for the past six months it has also been used on a parcel service between Bradford and Leeds.

Mention is made in the report previously referred to, that it would be advisable to provide facilities for carrying out tests on the roads, and the author would draw attention to the ease and accuracy with which tests can be made on electrical apparatus. Even figures taken in the course of ordinary daily running, which can only be approximately correct, give very useful information, and information with an accuracy which cannot hope to be approached with steam or petrol vehicles. Fig. 8, for instance, shows the consumption of electricity throughout twelve months for three vehicles of different capacities and working on different routes. It will be noticed that they all exhibit the same general contour, and bring out the fact that for that particular period there were three peaks of bad weather and road surfaces, whilst in the case of L.M. 9,940 the high peak in January was found to be the result of running the vehicle with a broken spring. Defects such as this are quickly detected if such records are properly inspected and the information obtained made use of intelligently. Another instance, showing the ease with which defects are noticed on electric vehicles, occurred when two identical vehicles were run out on trial, supposedly after being properly tuned up, when it was found that one gradually drew away from the other and showed a speed of 1½ miles per hour faster. Investigation showed that the front wheels were out of alignment, and after these were adjusted the two vehicles made the return journey together, only a few yards separating them the whole way.

The following is also a case in point, and, as the results are somewhat interesting, the author takes the liberty of quoting them here. A short time ago cars without differential were built in America, whilst similar construction is contemplated in this country, and as the desirability of eliminating the differential was obvious as allowing of simpler and cheaper design, the author was prompted to run a series of tests with a view to putting a value on this item of the vehicle mechanism. A 15-cwt. van built by the Electromobile Ltd., was available, and the series of tests given in the [*] table below were run over the same course, by the same driver, and under the same weather conditions. The vehicle was designed for a speed of 15 miles per hour and weighed, complete with battery, 30 cwt. The electrical equipment consisted of a 60-cell A1 Edison battery supplying current to a double commutator motor and with a modified series parallel system of control. The chassis was arranged with an all-gear drive, the motor driving the live axle through double reduction double helical gear, whilst a bevel differential of normal type was fitted. The differential was securely locked when required, by the insertion of brass blocks between the pinions and meshing with the same, no movement being then possible. The current consumed was measured by a Sangamo ampere-hour meter, and showed current as charged to the battery, not battery output, as is more generally the case. It will be observed from the tabulated results that both light and loaded the consumption of current is greater when the differential is out of action, the percentage difference increasing with increase of load. This is to be expected, as with increased lead the tyres will grip the road better and more power be required to cause one wheel to slip when travelling on a curve. As the machine runs entirely on ball-bearings, the whole of the additional power is apparently absorbed by extra wear on the tyres, the face of the tyres, even after only a small mileage had been run, presenting a totally different appearance from that of a type running under ordinary conditions.

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[*] *See* THE ELECTRICIAN, August 31, 1917.

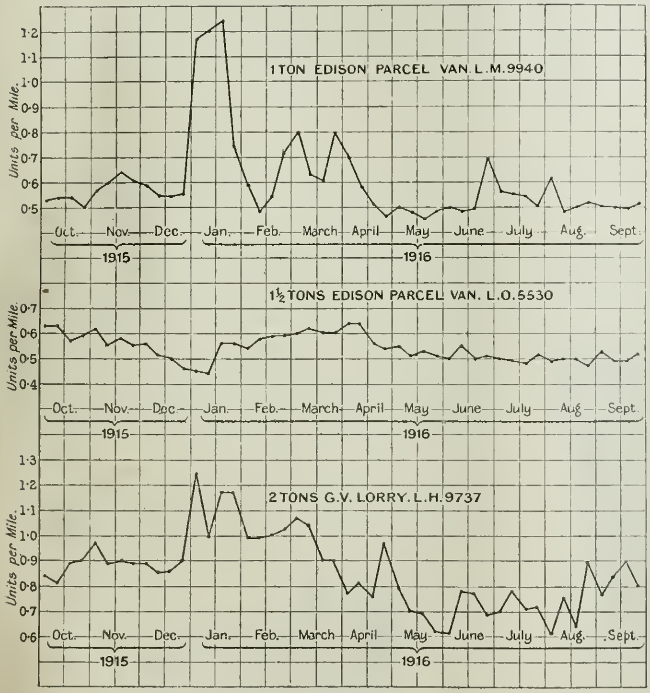


Fig. 8.

Condition of differential	Load.	Miles.	Amp.-hrs.	Amp.-hrs. per mile.	Saving per cent.
Locked	Light	18·1	100	5·52	—
Free	,,	18·1	93	5·13	7
Locked	11 cwt.	18·1	125	6·90	—
Free	,,	18·1	110	6·08	12

The question of passenger transport has not been specifically treated, but from what has already been said it will be clear that the bulk of the general work will be carried out by petrol vehicles, although the steam, electric battery, and petrol electric-driven buses, and where the traffic route is well defined the electric trolly bus and tramcar have their fields. The latter, however, appears to have had its day of usefulness, and in all likelihood will largely be replaced by railless vehicles, the obstruction caused by the track and its cost of maintenance being the *bete noir* of the rail-bound system. Electric runabouts and small closed cars will no doubt come largely into use for town work and be used by ladies for shopping purposes and by professional and business men making calls, their ease of control, cleanliness, quietness, and economical operation being greatly in their favour.

In conclusion, the goods transport problems might be summarised as follows:—(*a*) The collection and delivery of miscellaneous traffic from traders having an intermittent daily average of only a few cwts. (*b*) The collection and delivery of miscellaneous traffic from traders having sufficient traffic to warrant the use of containers or demountable bodies. (*c*) The transport of bulk loads for short distances. (*d*) The transport of bulk loads for long distances. (*a*) Calls for the use of economical vehicles with high acceleration and easy control such as is obtained in the electric vehicle, the high powered petrol vehicle on such a service being wasteful of fuel and highly expensive in repairs, and the provision of sorting facilities at one or both ends of the main journey. (*b*) Necessitates the provision of apparatus for loading and unloading the complete bodies with an average weight of probably 3 tons, together with the provision of sorting space at one or both ends of the main journey. (*c*) The most economical method of dealing with the bulk loads for short distances, except possibly in cases where railway sidings and loading machinery is already installed would appear to be by road vehicles with bodies designed to suit the particular traffic to be dealt with, and by the adoption, as far as possible, of loading and unloading labour-saving devices. The use of road vehicles has the advantage of reducing the handling of the goods to a minimum. (*d*) Goods in bulk to be transmitted long distances appears to call for containers of some form suitable for transfer to and carriage by rail. This means haulage by road vehicle and the lifting of the body into the rail wagon by over head crane. Where machinery exists for even the loading only of material such as, say, limestone, coal and iron, it would not appear to be economical to provide separate containers, the additional tare weight and possible reduction of net paying load more than compensating for any saving which might accrue from their use. The miscellaneous traffic may be long or short distance and all of it required to be sorted. The railway companies and a few of the haulage and express delivery contractors have the necessary sorting space, and, therefore, all miscellaneous traffic should be more economically dealt with by them and the short distance goods then conveyed by road from the terminal station to points within a radius of, say, 10 miles, arrangements being made so that the vehicles call on the return journey for miscellaneous goods. Handling would be reduced and much time saved on short distance goods, and the uneconomical local goods stations done away with or only used for bulk traffic where such exists. For all such traffic the road vehicles should be provided with removable bodies into which the traffic can be sorted ready for the vehicle on its return to the station. Traders delivering their own goods would preferably use electric vehicles within a radius of 10 miles and petrol vehicles beyond this, with, when required, "steamers" for the heavier work.

It is to be hoped that sufficient has been said to show the present state of the art of road transport from the mechanical engineering side and to point out means of improvement in economy, which are already available. In doing so, further means may now suggest themselves and greater progress be made in the near future. In transport work, as elsewhere, careful selection of the right tools is imperative, and a great mistake is often made by commercial men in pushing the sale of vehicles of a type unsuited to the particular business under review, a policy which is inimical to the advancement of road locomotion.

The Electrical Location of Sunken Ships.—We notice in the "Electrical Experimenter" a suggestion that the induction balance could be employed in locating sunken ships, which in general form isolated masses of metal. It is proposed that the two coils forming the terminals of a Hughes induction balance might be submerged and towed, at a considerable distance apart over the area where the ship is believed to have been sunk—a method that might have advantages in cases in which the ship has become partially covered with sand or encrusted with barnacles, and therefore has become difficult for divers to observe visually. We believe that a similar idea was suggested during the war for the location of submarines, and it appears to have possibilities.

What the Electrical Development Association Has Done and Will Do.

FORMED on a co-operative basis by the leading electrical associations and societies to carry out publicity and propaganda work on behalf of the electrical industry, the E.D.A. has now been in active operation for about six months. Naturally the establishment of this sorely needed branch of the industry has led to the emission of criticism from certain quarters where persons thought that the E.D.A. had but to be started and there would immediately be a great blowing of trumpets. We therefore thought it would be of service to our readers if we obtained first hand information regarding what had been accomplished and what difficulties, if any, had retarded progress. Our representative, therefore, interviewed Mr. J. W. Beauchamp, the director and secretary of the E.D.A. at the Association's offices, 84, Kingsway, W.C.2. We were agreeably surprised to find that, despite the short space of time which has passed since Mr. Beauchamp was appointed, some 20 pieces of literature have been issued, and prepared with the object of promoting the use of electricity for lighting, heating and cooking. They are offered for sale to supply authorities, manufacturers and contractors at very reasonable prices, and the large buyer is able to obtain a discount off these prices in proportion to the quantity taken. The purchaser of fair quantities can, if desired, have the literature over-printed, and thus obtain well illustrated and carefully prepared publicity literature at a much lower price than he could write, print and produce it himself. We illustrate six of these pieces of literature in the accompanying illustrations.

Small Examples of E.D.A. Propaganda.

"*Light in the Home*" (No. 27) is an attractively illustrated 16-page booklet, with a pleasing cover printed in colours. It contains illustrations showing how the best effects can be obtained with suitably placed electric light fittings and correctly designed shades, and finishes by driving home the advantages of cleanliness and economy which result from electric lighting.

"*The Land of Beautiful Reality*" (No. 6) is an eight-page booklet with attractive cover and illustrated throughout in colours. It opens with a fairy story, in which electricity is the fairy that banishes dirt and work, and concludes with a concise description of the advantages to be obtained by using electric heating and cooking.

"*Silent Aids to Comfort*" (No. 29) is a four-page leaflet, designed for use as an enclosure with letters and accounts. It deals with the subject of lamp-holder devices, such as kettles, irons, &c.

"*Use Electric Service*" is an illustrated four-page bulletin for general circulation, and mainly aims at directing public attention to the waste and dirt which arises from the direct use of raw fuel, and propagates the advantages to be obtained from the use of a central point for the distribution of light, heat and power in the form of electricity.

"*Letters of a Householder*" (No. 23) is an eight-page leaflet giving reprints of letters received from a satisfied consumer. They describe how this consumer altered his home, and finally used electricity for lighting, heating, cooking and cleaning, and finally dispensed with servants.

"*After Five Years*" (No. 28) is a four-page leaflet describing the advantages of electricity for shop lighting, particularly for outside window lighting.

It will thus be seen that much has been accomplished, although so far there have been no large advertisements in the daily Press. There have, however, been several paragraphs in the editorial columns of the weekly and monthly Press, which directly or indirectly owe their origin to this source. The blazing of trumpets so desired by some will come in due course, provided funds are forthcoming, and we hope that those who so desire such activity will be the first to subscribe liberally to the funds of the Association. Quite a large amount of time has been taken up in building up the membership of the Association, and in arousing the interest of all sections of the industry. Many manufacturers, supply authorities, in addition to the B.E.A.M.A., have generously helped by subscribing themselves and arousing the enthusiasm of others; but there are still some that remain outside. This is naturally inevitable. All things must have a beginning, and there will always be a certain number of faint hearts. When the now strong and well organised B.C.G.A. first started there were large concerns that remained aloof. Those municipal supply authorities who cannot subscribe to the funds can help the Association and their own electric supply department by ordering and purchasing the literature that is issued from time to time.

In addition to the publicity literature, which is a positive sign of activity, much good work has been done in a less direct way. It has been arranged to provide such facilities for distribution of information that the E.D.A. may be looked upon as a recognised source for distributing reliable information concerning the problems of the industry, to the Press, Government departments, &c., and ultimately to the general public. Further, it is hoped to make this Association a link between all users of electricity and suppliers of electrical energy and apparatus. To collect and distribute information regarding policy and design which will be to the ultimate benefit of the industry as a whole. Also it is intended to devote attention to the promotion of that feeling of goodwill which should exist between the suppliers and users of a public utility such as electricity. There is always a tendency for the public to criticise adversely and grumble at any public utility service, however good it may be, and this tendency can only be remedied by means of an educative publicity policy. The value of maintaining the goodwill of the users of a public utility service has long since been realised in the United States, but in this country such efforts have been mainly confined to the London General Omnibus Company, the Underground Railways and few others. Such propaganda interests the public, and affords a means of getting the public to view such undertakings from a community rather than a personal viewpoint.

Within the past month or so the E.D.A. has done a considerable amount of work in connection with the housing problems. Government officials have been interviewed and literature and information has been distributed to Government departments, local authorities and electric supply undertakings, all with a view to promoting the use of electricity in the new houses that will ultimately be built. Lectures and addresses have been given before various associations and societies.

The E.D.A. has been incorporated as a company not working for profit, and its revenues will be devoted to furthering the objects in view. The articles of association will shortly be ready for distribution amongst the members. We understand that provision has been made for members in the various groups and sections of the electrical industry to be represented on the Governing Committee quite apart from the representation on that committee acquired by the Associations which stand in the position of founders of the E.D.A.

The present members of the committee and also the members of the executive committee are to be congratulated on having at last brought into being that which had been talked of for several years past. That the need for such an association exists there is not the slightest doubt. In view of the fact that the next few years will probably produce great developments in the manufacture of electric apparatus for household purposes, and a reduction in price of these articles, it would be fatal to allow any opportunity for popularising the use of electricity to pass by unheeded. The lighting field has to a large extent been won, the other fields are open if the industry wakes up to exert itself to conquer them. The means of doing so is now at hand in the form of the E.D.A.; but it will not be fair to leave the burden of finding the funds on the shoulders of the founders. They have given the Association a good start. The industry, as a whole, must now support its youngest offspring. The subscription rates have been designed to be as equitable as possible to all parties, and even those who are not qualified to join as members can support the Association, and thereby aid the industry which indirectly must help the individual by becoming associates. We understand that the subscription for an associate is £1 per annum, entitling the subscriber to copies of general literature issued and any assistance the Association can give. All therefore have an opportunity of helping this movement forward. Keen, active, and energetic as he is, the director and secretary, Mr. Beauchamp, cannot put forward his best efforts on behalf of the Association if his work is hampered by lack of funds. The director will welcome suggestions and serviceable information from all interested in the furtherance of the objects of the Association. We are pleased to be able to report the satisfactory progress that has been made and look forward to still greater activities at an early date.

For several years past there has been a continuous direct and indirect propaganda campaign conducted with a view to thwarting the progress of the electrical industry in general, and the supply industry in particular. The latter is the main artery of progress, for if the development of electricity supply is held up, manufacturers, contractors and everyone in the industry will suffer. It is, threfore, incumbent upon everyone in the industry to wholeheartedly support the E.D.A. in its efforts to promote increased interest in the use of electricity and to combat the efforts of competitors.

Electrically-driven Winches and Capstans.

Among the firms that have specialised in electrically-driven plant for ship and dock-side work are Messrs. Laurence, Scott & Co. Their experience in this direction has shown them that only in exceptional cases has the ordinary standard electric motor with standard control gear proved suitable for this work. They have therefore developed a system of insulation to meet the special requirements, and thus overcome difficulties due to heat, damp and rough usage. It is in fact absolutely necessary in their opinion that micanite should be much more largely employed than is usual in ordinary commercial motors. The impregnation also must be more complete than is usual. Other disadvantages to be guarded against are those due to the very onerous sea conditions to which this plant is subjected, particularly such as their being submerged by heavy seas breaking on board, and tropical conditions of heat and moisture. To allow for the heating of the motors on deck by tropical suns it is advisable to provide a large margin in the power of the motor Fig. 1 shows a typical motor and controller designed by Messrs. Laurence, Scott for this class of work.

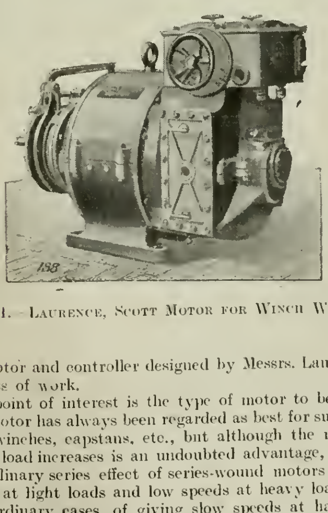


Fig. 1.—Laurence, Scott Motor for Winch Work.

Another point of interest is the type of motor to be employed. The series motor has always been regarded as best for such purposes as driving winches, capstans, etc., but although the reduction in speed as the load increases is an undoubted advantage, at the same time the ordinary series effect of series-wound motors which give high speeds at light loads and low speeds at heavy loads, has the d fect, in ordinary cases, of giving slow speeds at half load. A device known as the Scott-Bentley Load Discriminator has been designed to overcome this, and enables the designer to take the fullest advantage of the series effect to get a lower full-load speed than is usual, because this lower full-load speed does not bring down the half-load speed unduly.

The method in which the discriminator is used is shown in Fig. 2 while the apparatus itself is illustrated in Fig. 3. The device is shown applied to a deck winch, but it is equally applicable to cranes, hoists and other similar apparatus. It consists essentially of a means of diverting the main series winding of the motor by an automatic device which allows resistance to be put into and out of circuit by means of a contactor. When this contactor is closed the series winding is shunted by a resistance and some of the field current is therefore diverted. Under normal conditions of starting and with loads requiring the ordinary torque the whole armature current passes through the series field. If, however, the load, and consequently the motor torque and armature current are reduced below a certain value, the discriminator arm is pushed down by a spring and the contactor is closed. The effect of this is to increase the current in the motor armature owing to the field being weakened, and at the same time the speed of the motor increases. The discriminator can be designed to increase the speed to a value which allows the motor to develop its full horse power on the reduced torque. If under these conditions an excessive torque is exerted the discriminator cuts out the diverter and the motor again receives its full field excitation. It should be pointed out that the discriminator is not an overload device as such, though obviously it has the useful effect of anticipating and so preventing an overload. Normally it prevents the series excitation from being diverted by keeping the diverter resistance circuit open if the torque on the armature is above a certain predetermined amount. Arrangements

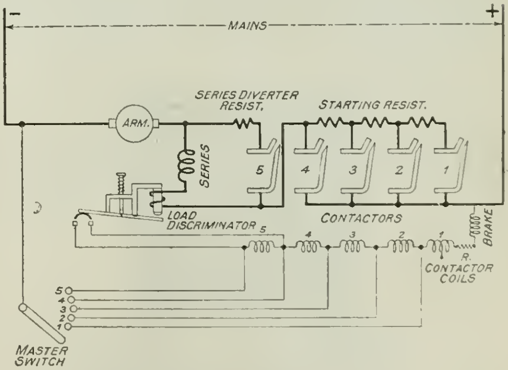


Fig. 2.—Connections of Deck Winch Motor.

can be made to shunt only a part of the coil, and for this purpose three terminals are provided as shown in our illustration, while the operating coil is also shunted by the diverter to prevent the electric bell action which would otherwise occur. It may further be pointed out that friction is reduced to a minimum by using a knife edge fulcrum for the discriminator arm, while the actual movement of the arm itself is also very small.

The best effect with the discriminator is obtained by using a motor which, when fully loaded, runs at quite a low speed. The Laurence-Scott Deck Winch electrical equipments have been arranged to lift 7 tons at 55 ft. per min., 5 tons at 75 ft. per min., 3 tons at 120 ft. per min., and dead light loads at 200 ft. per min (*see* Fig. 5), these changes of speed taking place quite automatically, according to the load that is lifted; and these ratios can be increased when required.

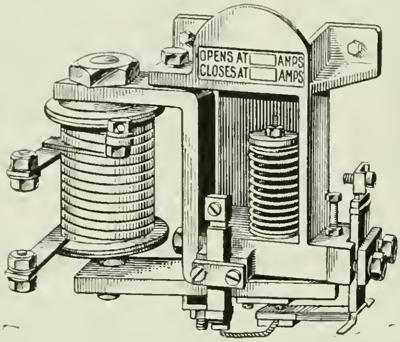


Fig. 3.—View of Discriminator.

There are various other points in connection with the design of electrical apparatus for this class of work which may be mentioned. For instance, deck winches are used in entirely different ways in different ports; in some ports the winding drums are used, whilst in others the whipping bollard is used. They are operated by very rough labour, such as is picked up at the ports of call, so that skill in operating them is a thing that must not be looked for. To meet this condition a hand-operated "master" controller, fixed on top of the motor and working a contactor controller stowed under shelter below deck has been designed. This cannot be operated so as to blow the fuses or otherwise put the winch out of action. This arrangement has proved a very great success on the ships in which it has been installed.

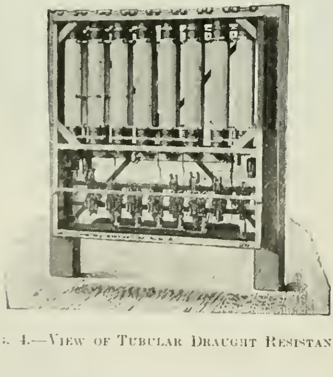


Fig. 4.—View of Tubular Draught Resistance.

Another point of interest is the design of the regulating resistances. In watertight resistances the heat generated in the resistance metal has to soak through the insulation material to the enveloping metal, which must therefore be arranged to have a large surface, and the whole rating must be very liberal to prevent the chance of excessive heat in the actual resistance metal. With ventilated resistances the heat is largely given off to the circulating air direct from the resistance metal or its support. To dissipate the heat in the best possible way Messrs. Laurence, Scott & Co., Ltd., have settled on the form of tubular chimney-draught resistance shown in Fig 4. This consists of a metal tube of generally 4 in. diameter, wound with micanite and other insulating material, then with the resistance metal, in the form of thin tape. These tubes are mounted so that there is a free circulation of air both inside and outside the tube, and preferably above the contactor, as shown, so that the heat produced does not affect the contactors themselves. It should be noted that the contactors used are all made with a very large margin of operating power. All the control requirements for ship winch working are embodied in this controller. Slow speed at light load can be obtained on the first step by working on the foot brake, the resistance on the first step being proportioned to make this safe.

Another thing that is found to be desirable for deck winch motors is a slipping device, so that in the event of the hook catching, such as in a coaming, which is always liable to happen, the inertia of the armature does not cause an excessive stress on the rope. This armature inertia is rather a serious matter in connection with electric winches, as the armature acts as a flywheel. The remedy is to put in a slipping device, so that in the case of a sharp excessive load the armature slips. This device was found to be necessary for windlass motors and on coaling winches for the Navy. The slipping clutch is combined with the solenoid brake and centrifugal brake and face coupling, for connection to worm or spur gearing. The centrifugal brake is to prevent excessive speed of the armature when lowering an extra heavy load. This brake only comes into action at well below the safe speed of the armature, and it thus prevents the armature running above this safe speed under any circumstances. The centrifugal brake, being mechanical and not electrical, is invariable in its action, and is not affected by the rather complicated electrical effects that can be obtained by the varying conditions of motoring and generating which may occur in the handling of cargo, etc.

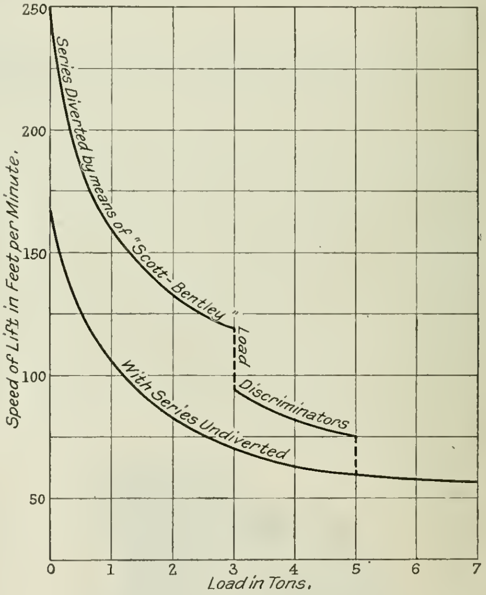


Fig. 5.—Deck Winch Electrical Equipment.

Series wound motor with speed-limiting coils and centrifugal brake Contactor Controller in Deck House or below and Fool-proof Master Controller with Reverser or Winch.

In addition to plant for operating winches Messrs. Laurence, Scott & Co. have made a large number of electrical equipments for warping capstans. The one shown in the illustration (Fig. 6) is a series-parallel equipment for giving a maximum pull of 18 tons at 100 ft. per min., with a light-rope hauling-in speed of 300 ft. per min. The voltage in this case was 110 volts, and each motor was capable of doing 75 b.h.p. at 375 revs. per min. for one hour with a maximum temperature rise of 80° F. The full excitation speed with the motors in parallel was 265 revs. per min., and with the motors in series 120 revs. per min.. The current required to give 18 tons pull at 120 revs. per min. on the motor, representing 32 ft. per min. on the hawser, is 480 amperes, while the current required to give the same pull at 100 ft. per min., which is 375 revs. per min. of the motor, is 1,300 amperes, with the motors in parallel, as shown in Fig. 7.

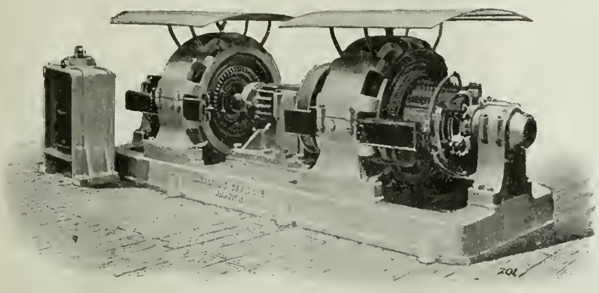


Fig. 6.—Electrical Equipment for Use with Warping Capstans.

The motors are controlled by a main contactor controller, which is placed in a special compartment, and is worked from a small "master" controller placed in any convenient position on the deck, this being connected to the main contactor controller by means of a multiple cable of small wires. A diagram of connection is given in Fig. 8. The "master" controller has only four steps in either direction. The first step puts in the starting resistances with the motors in series. The second step cuts out this resistance, and the motors run in series with full excitation and at full voltage. On the third step the motors are changed from series to parallel with full excitation, and on the fourth step the excitation is reduced and the motors speed up to 375 revs. per min. when fully loaded, running up to 1,125 revs. per min. for the light hauling speed. The "master" controller can be thrown right over to the full speed position, each step being timed at the contactor controller so that the contactors cannot close faster than is safe. Taking the worst condition, if the "master" controller is put full on, with the motors in parallel, the speed will run up to its maximum, which is under the control of speed-limiting shunt coils. Now if the load comes on the speed will fall owing to the series effect, until a pull of 18 tons is on the hawser. If this is exceeded, the load-discriminator operates to put on full field and the speed will come down to 77 ft. per min., and if the motors are still overloaded the time overload will act and put the motors in series. This will bring the speed down very much, and if the overload still continues, the resistance will remain inserted and the motors may be stalled altogether. The motors being in series, the amount of stalled current is very much reduced, so that a resistance of moderate size can deal with it. As soon as the pull on the hawser eases off somewhat, the contactors atuomatically cut out the resistance; but it has to be reduced considerably before the contactors for paralleling can come in. This is effected by the discriminator, which will only allow the parelleling contactors to operate when the load is reduced below a certain amount. The arrangement, in fact, gives the ideal capstan drive for warping, slowing down automatically to a standstill when the load is excessive, and automatically running up to speed when the load is reduced, The series-parallel system was adopted in this case because the voltage (110) involved such very big amperage.

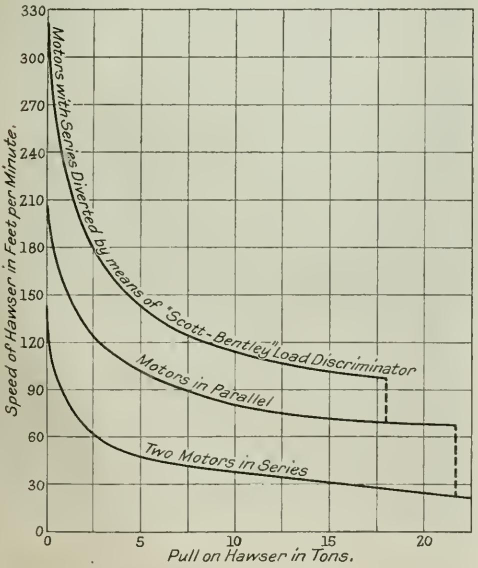


Fig. 7.—150 b.h.p. Warping Capstan Electrical Equipment.

Two motors, each 75 b.h.p., 110 volts. Contactor Controller in Deck-House or below and Fool-proof Master Controller on Deck.

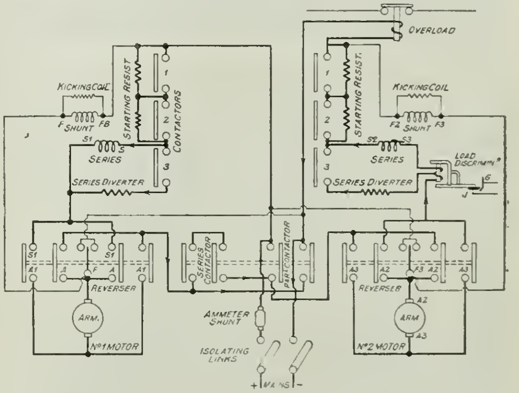


Fig. 8.—Connections for Warping Capstan Motors.

Battery Locomotives for Mine Work.

When the Ebbw Vale Mining Company were considering problems connected with the opening up of their new mine at Irthlingborough they decided to eliminate ponies altogether as a means of underground haulage and to substitute electric locomotives. As the outcome of their inquiry the British Electric Vehicles, Ltd., designed their standard 10-ton locomotive, the first two of which were delivered in April last. These locomotives, which have been working every day since delivery, are designed to deal with a load of 220 tons and run about 15 miles per day. Statistics go to show that they do 50 per cent. more work than two ponies, and thus save about three guineas per day.

The motor on these locomotives has double wound fields, so that series parallel control is possible and every running shaft is fitted with ball bearings. The controller is of the drum type and the battery, which is manufactured by the Chloride Electrical Storage Company, consists of 24 Ironclad Exide Cells and has a capacity of 193 ampere-hours. The rated speed is about 6 miles per hour light and 5 miles per hour when loaded.

An Electrically-Driven Wagon Hoist in a Steel Works.

SOME time ago there was installed at the Acklam Works, Middlesborough, an equipment of electrically-driven hoisting machinery for the handling of wagons up to 35 tons gross. At the present time, when transporting and conveying problems are so very much in the foreground, a description of an electrically-driven installation of this kind will not be without interest, especially in view of the fact that it takes the place of hydraulic plant of the same kind. In order to avoid interference with the work, a new steel structure and motor house was built close to the old hoist, so that handling of the wagons was not interfered with during installation of the new electrical hoisting plant and new wagon table.

Fig. 1 shows a view of the new structure, the height of which is 60 ft. from rail to rail. The hoist is of the usual table type, with four sets of hoisting ropes in parallel, each set being directly connected to each corner. This arrangement enables the winding drum diameter to be kept within very reasonable limits, as the drum diameter must be increased with every increase in the rope diameter. The wagons are lowered to ground level at the far end of the store bin platform by means of a gravity hoist of the usual type. In order to equalise the cycle of operations, a tank type of counter weight is suspended by means of two pairs of ropes from the winding drums, and is so adjusted as regards its weight that the unbalanced load actually hoisted is similar on the average to the net load being hoisted as the table descends on the return or empty journey. The out-of-balance load, either up or down, should be equal in weight to half the loaded wagon, and the counter-balance weight should be equal to the table and half the loaded wagon. In practice, a certain amount of variation in the load to be lifted is always met with, and the weight is so arranged as to average out correctly over a number of winds. The two winding drums are 6 ft. diameter and are spirally grooved to take the four pairs of winding ropes and the two pairs of balance weight ropes. The guide pulleys which spread the two pairs of ropes to the distant side of platform are of an improved type, and consist of drums of a diameter equal to the main drums (instead of sheaves as are usually employed), and they are also spirally grooved on the rope treads. This arrangement makes, it is claimed, an ideal guide for the rope and eliminates all "angling" of the rope on the horizontal, and almost all the less material "angling" in the vertical planes.

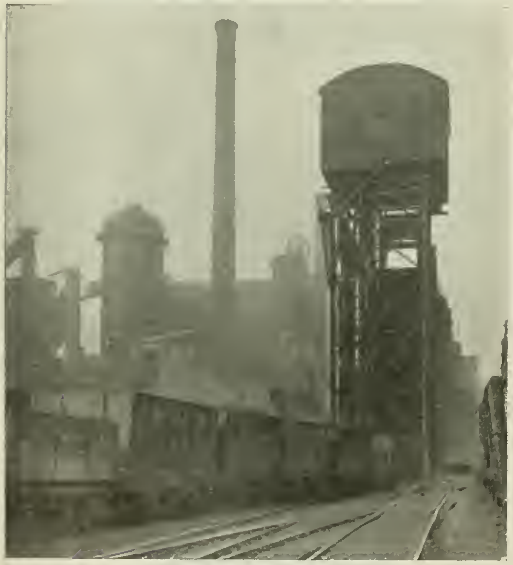


Fig. 1.—View of Structure of Metropolitan-Vickers Electricall driven Wagon Hoist.

The drive from the motor shaft is made through double reduction gear, a counter-shaft carrying the two pinions of the second train running in front of the drums. The gear wheels are of cast steel, the pinions of wrought steel, and the teeth are machined cut double helical in both trains, a very ample width of face and strength of tooth being provided for. The result is that noise and vibration are altogether eliminated. It is necessary that in a wagon hoist the table should stop precisely at the rail level, both at the top platform and also at the lower loading level; and this accuracy must be maintained under all conditions, that is, with light wagons, and also with wagons fully loaded up or at any intermediate state of loading. To meet these conditions a Ward Leonard type of electrical equipment combined with a carefully designed electrically-controlled brake is ideal, and it has been applied in this case. A motor generator set, consisting of a 250-volt, 775 revs. per min. shunt-wound generator coupled to a 200 H.P., two-phase 40 periods 250-volt induction motor, and also a separate exciter is mounted as one unit on a self-contained cast-iron bedplate, and supplies energy to the hoisting motor. Two switchboard panels, one for the alternating current and one for the direct-current side, are mounted in the motor house and are fitted with the usual switchgear and instruments for the control of the equipment.

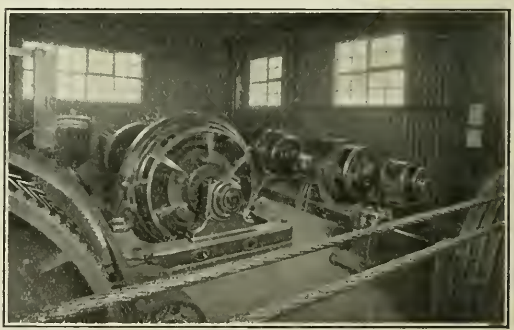


Fig. 2.—Metropolitan-Vickers Hoist Motor and Motor-generator set for Driving 35-ton Wagon Hoist.

The motor is a shunt-wound machine of 175 B.H.P. continuous rating, running at a speed of 150 revs. per min., mounted on a heavy cast all-round bedplate, with the main shaft and pinion extension shaft carried in low set pedestal bearings, and a large flexible coupling is fitted connecting the two shafts. A specially large and powerful type of brake is built as an integral portion of the bedplate of the machine, which has been moulded with bosses and facings to receive the brake parts. The brake is applied by means of a solenoid connected to the automatic controller, so that the timing of the application of the brake is accurate in relation to the travel of the hoist during deceleration, thus ensuring dead level decking of the table. The hoisting time is somewhat under 60 seconds, so that the average speed is about 1 ft. per second, and acceleration and deceleration are accomplished smoothly without shock or jar. The moving masses in a hoist of this type are very great, being in this instance nearly 2,000,000 kgm. when referred to the drum diameter. The accelerating torque, owing to the low velocity, amounts to an equivalent of only a fraction of the static torque, and, consequently, should the driving torque be suddenly removed when working the moving parts would come to a stop and reverse by gravity within less than one second's time. It is therefore necessary to maintain somewhat less than full load torque until the end of each wind when the brake finally determines the exact stopping point, the forward torque being removed at the same moment as the brake takes over the duty of holding the load. It is generally found convenient, for mechanical reasons, to extend the retarding period and also accelerating period to about 4 or 5 seconds, which is the time requisite to move automatically the controller rheostat the distance necessary to increase or decrease the motor torque to the required figure. If the time or distance from the end of the travel at which the power could be cut off to enable the hoist to run to rest at the correct level were the only consideration, then such an interval (0·82 second) would be extremely small. Still no shock would result, as the rate of retardation would be slightly over 1 ft. per second, and higher rates are common with other types of hoists. For the reasons given above, however, the time is generally extended as stated.

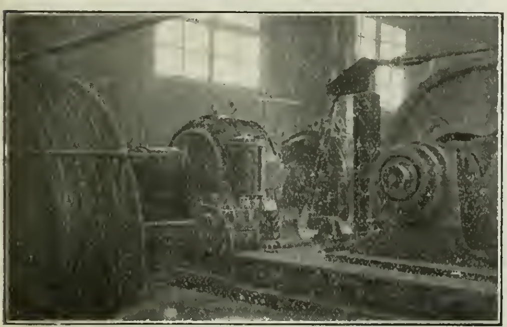


Fig. 3.—Brake Magnet and Part of the Brake Pulley, 4 ft. 6 in. in Diameter.

The automatic controller is of a type specially developed for this class of work, and is motor operated as regards the movement of the rheostst fingers and switches required during acceleration. The motor is started by means of a master switch which is under the control of the operator by means of hand levers placed at both top and bottom levels. The deceleration and stopping of the hoist is automatically accomplished by means of two sets of racks and pinions operated by the upward movement of the table or counter weight. This gear restores the rheostat through the medium of quick pitch screwed spindles and travelling nuts to the neutral or "off" position. Overwind limit switches are fitted so that, in the event of an overwind from whatever cause, the hoist is brought to a standstill and the power shut off. It may be mentioned that the type of limit switch employed in this instance does not depend for resetting (as in the case with most designs) on the reverse movement of the hoist, but it is always capable of dealing with repeated overwinds, should these occur through carelessness or flurry when restarting the hoist. Should necessity arise, the hoist may be brought to a standstill by means of push-button trip switches, which are mounted together with a set of drivers' indicating instruments in cast-iron watertight cases situated on the upper and lower levels.

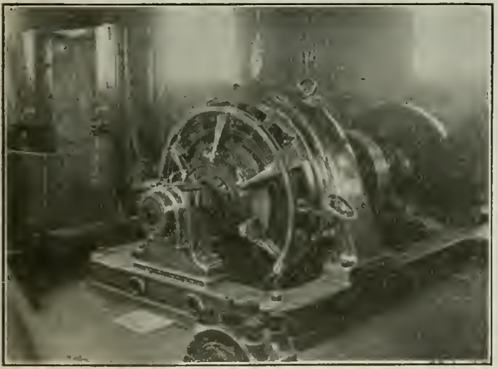


Fig. 4.—Metropolitan-Vickers Hoist Motor and Post Brakes; also the Friction Driven Limit Switches on the Left.

The Metropolitan-Vickers Electrical Company, Ltd. (formerly the British Westinghouse Electric & Manufacturing Company, Ltd.), has equipped a large number of steel works hoists with alternating current and direct-current drives, as well as with a type of equipment and control as described above. From the wide experience which has been gained, the Company are of opinion that the Ward Leonard type of electrical equipment is very desirable from every point of view. As regards the installation we have just described, the Metropolitan-Vickers Electrical Company, Ltd., then the British Westinghouse Company, were responsible for the electrical equipment throughout, and the North Eastern Railway Company's engineers carried out the design and equipment of the mechanical parts of the hoist.

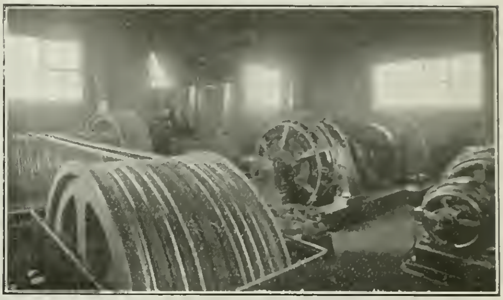


Fig. 5.—Metropolitan-Vickers Hoist Motor and Post Brakes also the Spirally Grooved Sheaves and Drums.

A Large Gantry Crane.

An interesting gantry crane of a particularly large size has recently been installed by the Ateliers des Construction Oerlikon at the works of the Schweizerische Industrie-Gesellschaft at Neuhausen, in Switzerland, for handling great quantities of timber in the rough. This installation has a total lifting capacity of 6 tons, the span from centre to centre of the running track being 55·5 m. (152·5ft.) with a lifting height of 7·5 m. (24·75 ft.) and a total clearance to the under part of the structure of 8·3 m. (27·4 ft.). The total breadth of the gantry is 67 m. (221 ft.) and the total length of the rails on which it runs is 95 m. (312·5 ft.), giving it a run of that length. The gantry is fitted with three motors with horse-powers of 38, 22 and 6 respectively. These give a travelling speed of 30 m. (100 ft.) per minute, a lifting speed of 11 m. (36·3 ft.) per minute, and a traversing speed of 60 m. (198 ft.) per minute. One of the portals is built in as a fixed support, while the other can be moved inwards if required. The gantry rollers are carried in the lower members of the structure. Current is supplied to the gantry as well as to the grab through bare copper wires, the current being taken off by means of trolley arms. The hoisting gear consists of two hoisting hooks kept apart by a separating piece which holds them at a distance of 3·5 m. (11·5 ft.), while lifting. The weight of the whole gantry and auxiliary apparatus is about 75 tons.

If any further particulars are required about this interesting installation reference should be made to Mr. G. Wuthrich, London representative of the Oerlikon Company, 34, Norfolk-street, London, W.C. 2.

New Form of Hand Lamp.—We notice that a new form of hand lamp which is used neither with a dry cell nor an accumulator, has been brought out in Germany, and is the subject of reference in "Licht und Lampe." The cell is of the wet type, zinc forming one pole and lead oxide the other, the electrolyte being dilute sulphuric acid. A feature is the arrangement by which, when the apparatus is in its normal position, the liquid is removed from the active pole so that no wastage takes place. By turning the lamp over through a right angle, however, the cell is put into operation. It is stated that 2·4-2·5 volts is obtained across the terminals and that the cell will keep a lamp burning for 20 to 25 hours. In the present circumstances the cost is said to be relatively low.

An Interesting Grain Handling Equipment.

THE adaptability of electric power to the driving of grain-handling equipment, especially at the dockside, is admirably exemplified in an installation recently completed at the grain warehouse of the Mersey Dock and Harbour Board, Waterloo Dock, Liverpool. The installation comprises one telescopic elevator, external to the warehouse, two elevators inside the warehouse, two automatic weighing machines, one loading-out shoot from the warehouse and one loading-out shoot from the elevator head. A general idea of the elevator equipment will be gathered from the adjoining photographs and drawing. The whole of the plant is electrically operated, and it is interesting to note how the motors have been introduced for the driving of the elevator buckets and for the raising and lowering gear. It will be seen from Fig. 2 that the elevator is fitted with a telescopic arrangement whereby the delivery buckets can be raised or lowered in accordance with the depth of the barge or vessel to be unloaded. The whole elevator is also so supported that further limits of travel up and down are obtainable by the movement of the latticed girder supporting arm which is pivoted at its outer end at the elevator head and its inner end on the wall of the building. Fig. 3 is a near view of the elevator during course of construction at the maker's works. The elevator is 45 ft. long and can be extended to 77 ft. by means of an electric winch.

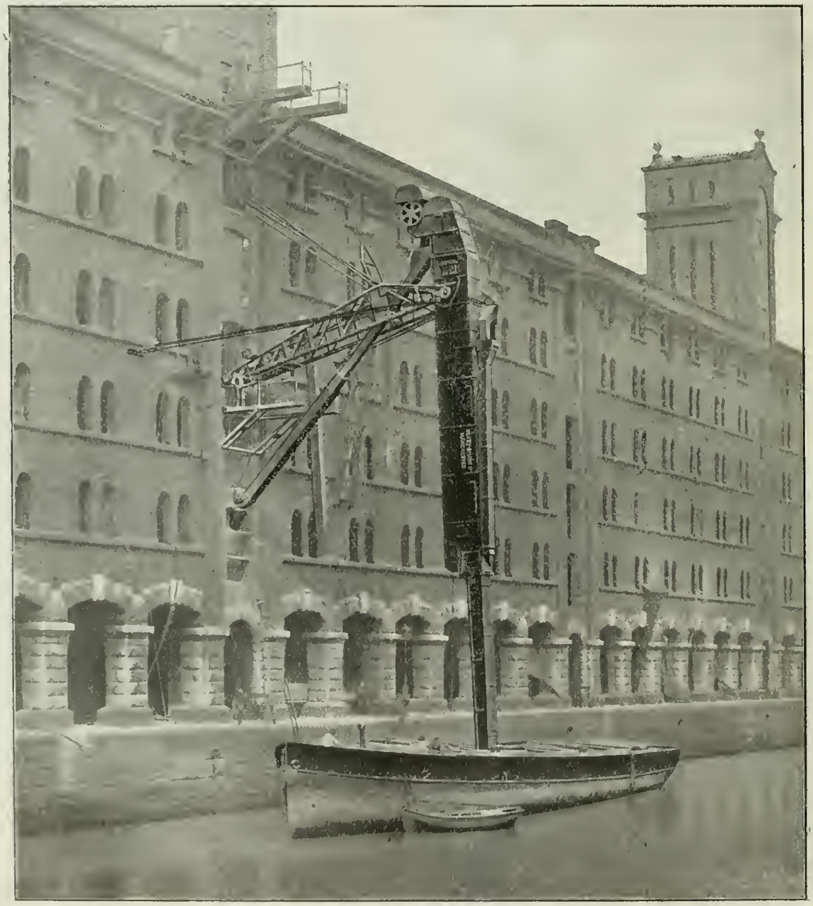


Fig. 1.—Side View of Elevator in Position.

Fig. 1, which is a side view of the elevator, will make its construction clear. It will also be noticed that the telescopic elevator is provided with three motors. One of 22 h.p. crane rated capacity is carried on a suitable support at the elevator head, whence it drives the chain of buckets through gearing. The second motor of 13 h.p. (crane rating) is fixed at the warehouse end of the movable girder arm, supporting the elevator proper and drives a small winch which serves to raise and lower the telescopic leg of the elevator. The third motor, crane rated for 10 h.p., which drives a winch through gearing is used for raising and lowering the latticed girder arm. To maintain an even load on this motor the arm, carrying the telescopic elevator, is provided with a counterpoise system in which is included a method of balancing which ingeniously adjusts the balance weights according to the particular position of the telescopic elevator. It is clear that at the lowest limit of its travel the elevator will require full balance weights and the opposite will be the case for the upper limit. Fig. 2 shows that in the former case the full number of balance weights will have been picked up. When less counter balance is necessary the weights concertina together. The side elevation shows how the grain, after being raised to the elevator head is discharged through a chute into a small receiving hopper in the wall of the building which communi-

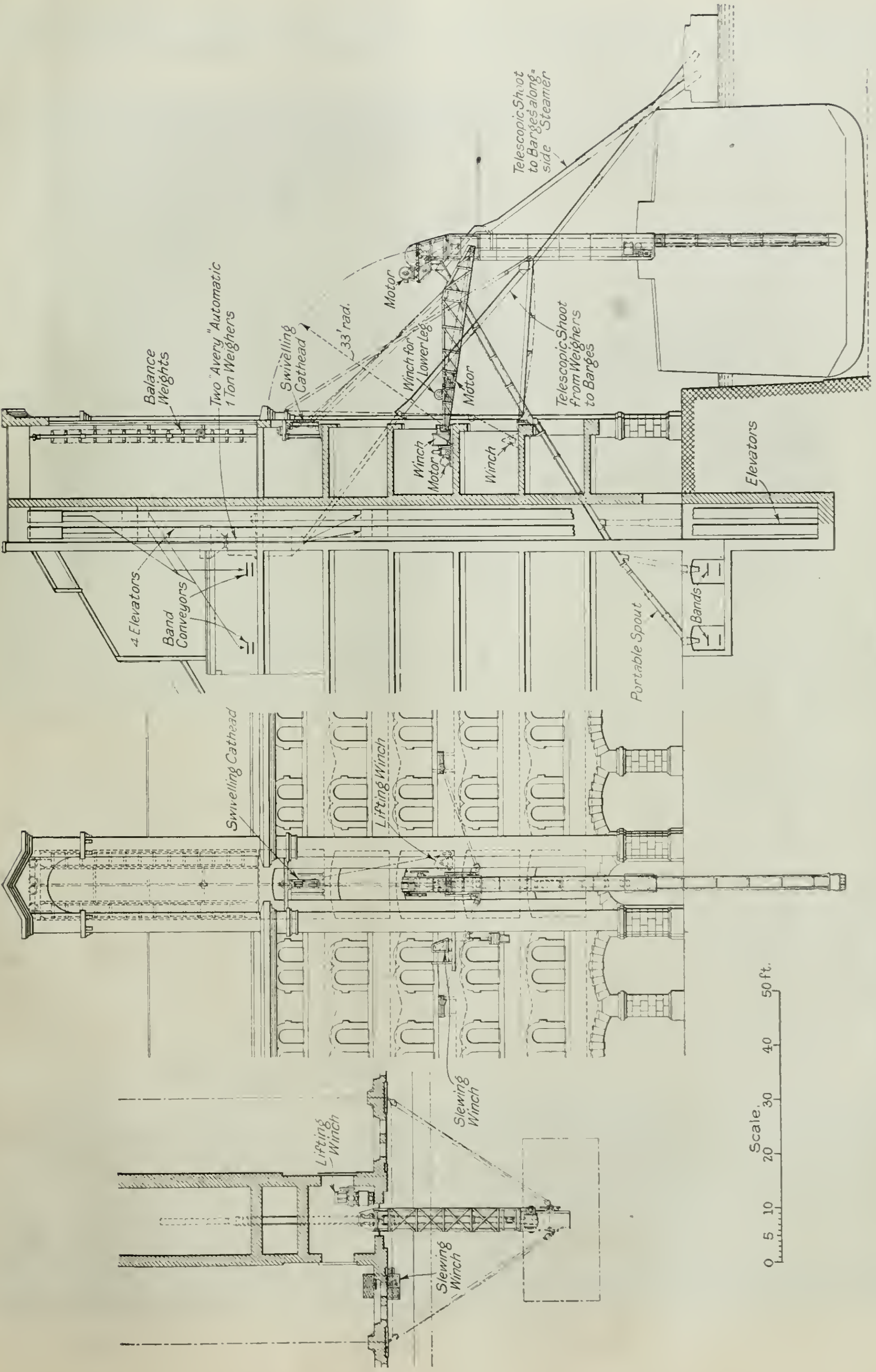


Fig. 2.—General Arrangement of Telescopic Elevator, Mersey Docks and Harbour Board, Liverpool.

eates by a chute inside the warehouse to portable spouters delivering to plants and thence to the main elevators. This is the function of the gear for discharging from barges or large vessels. Conversely the equipment provides telescopic chutes which admit of the loading of barges either from the building itself or by means of the telescopic elevator from one barge to another or from a large vessel or to a barge alongside. The designers of the equipment have provided a slewing machine which is operated by hand and which admits of the travel of the telescopic head towards the building in either direction so as to bring the elevator closer in for operation from vessels close against the dockside. This slewing gear is actuated by a separate winch, and as it is only occasionally used this winch is designed for hand movement.

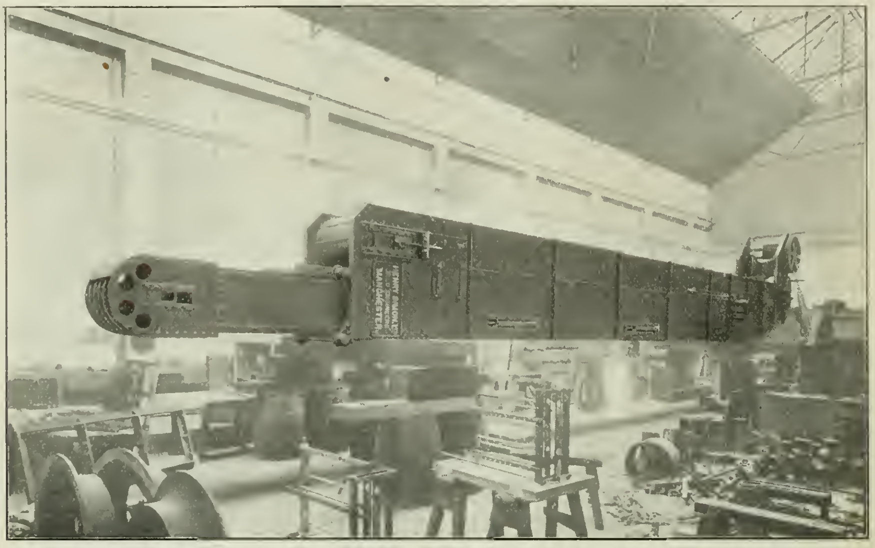


Fig. 3.—The Elevator in Course of Construction.

The equipment has been attached to an existing warehouse without structural alterations, and it has a grain-handling capacity of 120 tons per hour. It has been installed by Messrs. Henry Simon, Ltd., of Manchester, to whose engineers we are indebted for the foregoing particulars.

Modern Belt Conveyor and Grab Transporter Plant.

Plant for the rapid, safe and economical handling of all kinds of material from coal and iron ore for shiploading and unloading in iron and steel works, &c., down to cardboard boxes and packages of fragile goods is manufactured within the organisation of the General Electric Company. The ensuing particulars and illustrations will serve to give an idea of what has been accomplished and will act as a guide to some of the directions in which modern material handling plant may be adopted with the idea of speeding

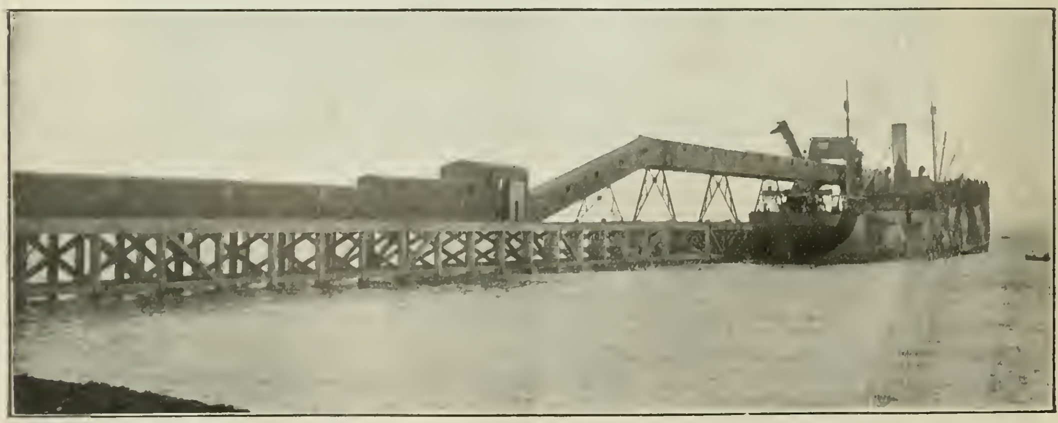


Fig. 1.—Ore Handling Plant of the Bairds Mining Company, Almeria. General View of Plant, showing Vessel being Loaded.

up the process and relieving congestion, saving labour and supervision, reducing breakages and total costs.

The extent to which belt conveyors have been developed and are in most satisfactory operation in factories, mines and boiler houses for handling material in bulk, such as coal, ore and grain, is well known. In addition, this system has proved highly successful for the shipment of bulk material in large quantities. The process of loading ships is comparatively an easy question when belt conveyors are employed as well constructed plant with belts, designed with the proper thickness of rubber covering and disposition of cotton duck plies for the material being handled, has proved satisfactory. The range of this method of loading is practically unlimited. The greater the capacity the less is the tendency to any mechanical difficulties, it being possible to produce plant that will ship at the highest rate boats can take the material. The most efficient method of conducting unloading operations in shipping is certainly that in which grabs and transporters are used, as these have a large capacity range. Many plants which have been erected for the more important railways and dock companies are dealing with large quantities of coal or ore, and in combination with conveyors delivering the material to distant storage entirely without the intervention of hand labour.

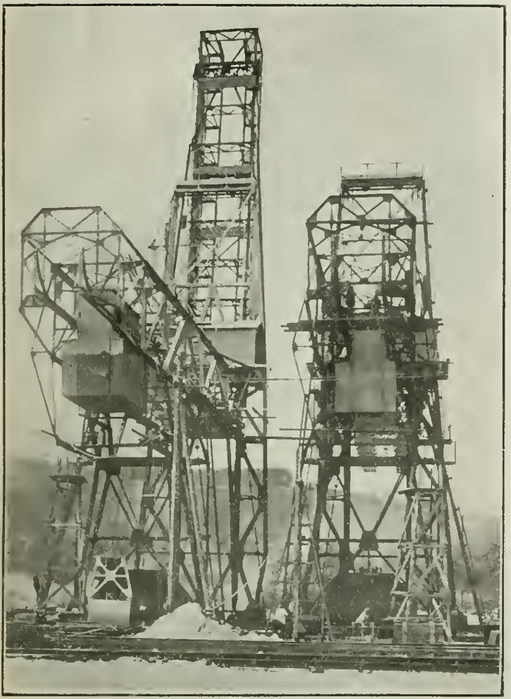


Fig. 2.—Inshore End of Transporter under Erection at Rouen.

We may mention two typical plants on these lines which were constructed by Fraser & Chalmers Engineering Works for the French Government during the war, one for the Port of Dunkirk, and one at the new quay L'Ile, Rouen (*see* Figs. 2 and 3). In the former four, and in the latter two electrically-driven grab transporters are employed, each grab having a capacity of 2 tons, which is designed to handle coal or ore in the following manner:—Unloading: (1) From the boat to lighters and barges moored alongside; (2) From the boat to railway trucks standing on three sets of tracks between the transporter legs; (3) From the boats in any position along the quay front direct to a belt conveyor running alongside and discharging to store bunkers, from which wagon can be loaded through the chutes provided. The grabs are also designed to undertake loading operations from railway trucks to the ships' holds.

In the Rouen plant the transporters travel the whole length of the quay front and have a working reach of 72 ft. from the quay wall. They are fitted with hinged jibs, which can be raised vertically when travelling, thus decreasing the resistance and increasing the speed of travel to considerable advantage. Each transporter is capable of dealing with 150 tons of coal per hour in the first case, and approximately 100 tons per hour in the second, corresponding to the working distance between boat and lighter. When discharging to storage bunkers the grab delivers into a fixed hopper situated at the end of the transporter structure, through which a No. 1 belt conveyor is loaded. This belt has a capacity of 200 tons per hour. It is run the entire length of the quay, over which the transporters operate, to the storage bin. At this point a bucket elevator is employed to raise the material to the No. 2 conveyor which runs the length of the bunkers, and from which an automatic tripper evenly distributes the material throughout the bin. The bunkers are of ferro-concrete construction with a capacity of 2,000 tons of coal, and are arranged to feed by gravity through valves on four lines of rail track, each line being provided with four valves operated by hand. The operation of the grabs and the travelling of the transporters is of course entirely electrical, and is controlled by one man in a cabin provided level with the grab so that full view of manipulation can at all times be obtained. Another interesting plant is shown in Fig. 1, which illustrates a belt conveying plant which has recently been installed at Almeria. This plant has a capacity of 700 tons of iron ore per hour.

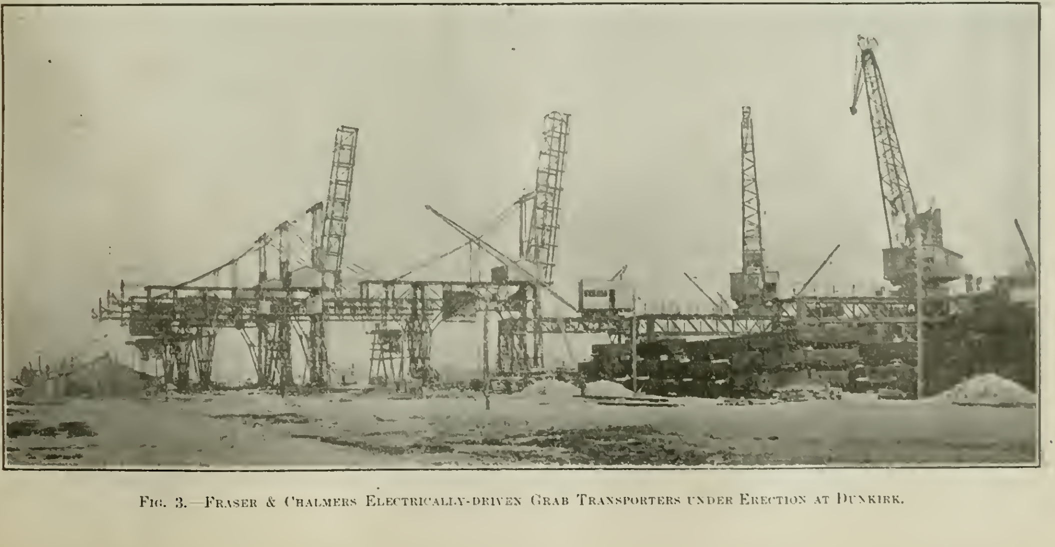


Fig. 3.—Fraser & Chalmers Electrically-driven Grab Transporters under Erection at Dunkirk.

A New Design of Ball Bearing.

By L. E. LITTLE.

The author, who has been known for many years as being interested in F. and S. Ball Bearings, and latterly in connection with "The Coventry" Chain Company, Ltd., whose London manager and chief representative he was for the past nine years, has been instrumental in helping to put on the market a ball bearing and a disc bearing, both of which are most interesting from the point of view of design and construction and from the quality of steel from which they are made. A large company will shortly be registered under the title of The Northern Ball Bearings, Ltd., with its registered offices at 115, Great Portland-street, London, W.1, from which the entire sale organisation will be conducted under the management and sole control of the author.

Below is appended an article in which the chief points of interest in connection with these bearings are set out, and these should be of great interest to readers of the "Electrician."

The term ball bearings is a commonplace designation conferred by engineers on a component introduced into their designs to support the load of revolving parts and to eliminate friction; that, in brief, sums up the objects in life of a ball bearing. Fortunately the designers and manufacturers of ball bearings are continually striving to attain greater perfection of their productions, and for the purpose of this article the writer will endeavour to show to what extent the designers of the N.K.A. ball bearing have achieved that object. Allowing that the tolerances for the inner and outer rings and the sphcrity of the balls are within the finest limits that human element can control, aided by and vouchsafed for by the use of world-renowned and celebrated Johannsen gauges and other elaborate measuring appliances which ensure the interchangeability of one type of ball bearing with any other, it now remains to be shown how the ball bearing which we have mentioned above fulfils the conditions we have laid down and has greater claims to the premier position of all ball bearings over others. Here then is the reason:—The designers of the N.K.A. ball bearing have set out to construct a ball bearing that shall for a given size have a greater load carrying capacity than any other ball bearing, and they have achieved this object by employing a ball cage or seperator of special design. This is constructed from a selected steel wire formed by a special rolling process and dies to the exact shape of the ball, and is looped so that the points of the balls just take a light bedding in the loop, and are therefore prevented from touching each other. At the same time the separator is firmly held against the possibility of coming adrift (*see* Fig. 1). It will be noticed that there is an entire absence of rivets, pins and other cage-fastening devices in the construction of the cage. These devices have in fact frequently brought about the early destruction of a bearing, whereas in the cage under review, owing to the flexibility of the wire, it is immune from the possibility of distortion, and thus has nothing in its construction to impair the longevity of the bearing.

It is therefore possible by reason of this ball cage to introduce the maximum number of balls into the race, or in other words, the equivalent of a full-ball type bearing (*see* Fig. 2) with the entire elimination of its inherent defects. Further, by the use of the very highest grade chrome steel, and by subjecting it to exhaustive mechanical, chemical and metallographical examination and tests, the race sections can be of a lighter construction than is possible by use of other grades of steel, and by the employment of most accurate heat-treatment and hardening process regulated by the aid of self-registering pyrometer gauges, uniformity of hardness of the ball tracks is guaranteed—but without the danger of brittleness being existent. Therefore, this fact is of the utmost significance, and together with the patent cage construction, allows the diameter of the balls for a given size of bearing to be much greater than in any other make (the advantage being that the load carrying capacity depends entirely on the number of balls supporting the race and their diameter). By shortening of the utmost minimum of the bridge—which is formed by separating the balls wide apart, a fault common to many bearings where the cage is of a cast type, and which must be considered a serious defect and weakness in the design of a ball bearing is avoided.

One other point to be noted in connection with this type of ball separator is its extreme lightness resulting in the almost entire elimination of the vagaries of centrifugal force which in many other types of cages of heavy construction is very self-evident, and which in almost every instance of rapid ball-bearing slackness is the primary cause of trouble. The designers have not been content to allow their activities to rest in having achieved such an advance in ball-bearing design, but have also produced what is known as a disc bearing. This is described below.

The advantages which have followed on the introduction of ball and roller bearings have been of such a nature as rapidly to expand the field of application of this type of equipment. The ball bearings especially have had a very large and varied field of usefulness, whereas the roller bearings have been applied mostly in special cases where the loads to be carried have been severe and the speed of rotation slow. In spite of their property of high-carrying capacity the ordinary roller bearings possess several disadvantages, such as increased frictional resistance as compared with ball bearings, inability to resist a thrust load, etc. All the good features of the ball bearings have not been realised in the existing roller bearings. With the above conditions in mind the scientific department of the Northern Ball Bearing Company have for some time past conducted extensive experiments in order to develop a new and improved type of bearing. The result of those experiments is the design, which has been termed a "crowned disc bearing." This can be regarded as an improved roller bearing, possessing all the advantages of both the ball and roller bearings, but eliminating their fundamental disadvantages.

The new disc bearing consists of two rings, like the ball bearings, these rings having raceways in their cylindrical surfaces. Instead of balls, however, the rolling elements consist of rollers having plane sides and a spheroidal bearing surfaces. As will be seen in Fig. 3 each roller consists of a disc cut out of a spool or barrel-shaped body. By employing this shape of roller it is possible to obtain the same area of contact as that of a considerably larger ball, without increasing the diameter of the roller. By a certain proportioning of the two radii of curvature of the roller in the axial and the radial plane, there is obtained the great advantage of a self-aligning roller, *i.e.*, the roller when working in the bearing will automatically assume such a position that the resultant of the external forces acting on the roller will coincide with the radial plane through its centre. At high speeds of rotation there is, further, a stabilisation of the motion by virtue of the dynamical forces. On

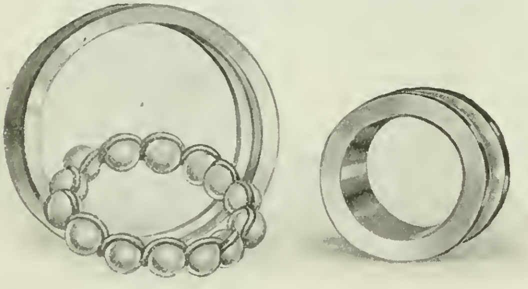


Fig. 1.

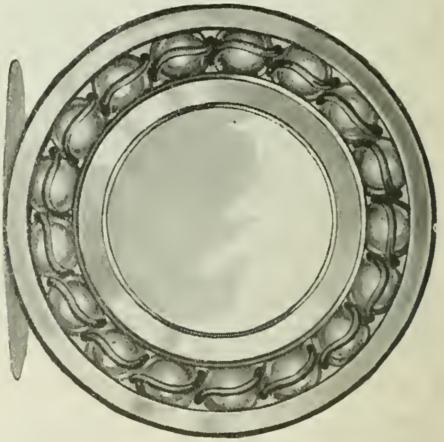


Fig. 2.

account of the peculiar shape of the rollers it is possible to insert a full number of them between the rings of the bearing without resorting to any special arrangements. The rollers are then turned round when fitted into the raceways. The roller cage is so constructed as to permit the above-mentioned self-aligning action of the roller to take place.

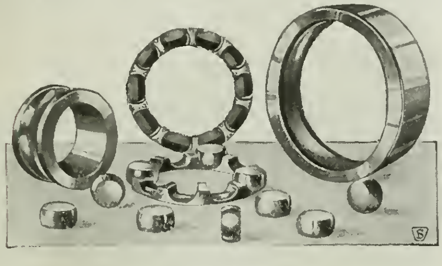
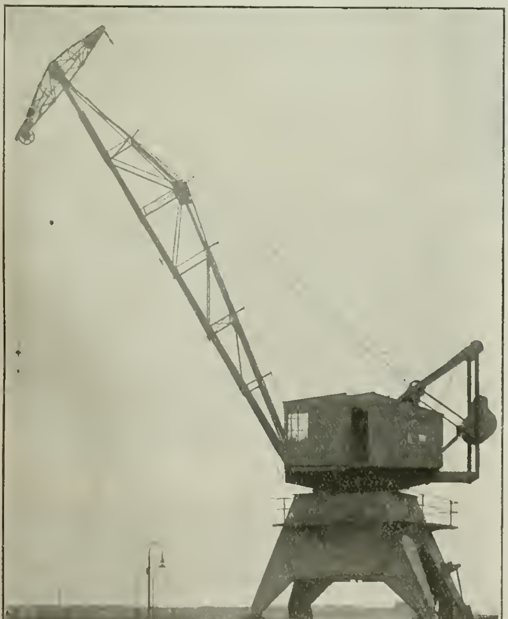


Fig. 3.

The advantages over roller bearings of the self-aligning rollers may be stated as follows: In all ordinary roller bearings it is necessary forcibly to guide the rollers by means of the cage or other arrangement. This necessity introduces additional pressure and friction, which naturally increases the resistance in the bearing as well as the wear, and thus shortens the useful life of the bearing. In the N.K.A. new disc bearing these undesirable features are non-existent, as its rollers are self-aligning. The purpose of the roller cage in an ordinary bearing is, therefore, the same as that of the ball cage in the ball bearings, namely, to keep the rolling elements apart so as to prevent each from gliding against its neighbours. As is well known, a ball bearing has a considerably lower frictional resistance than the ordinary roller bearings. In this new type the rollers act in much the same way as the balls in a ball bearing, and the friction in this bearing is therefore directly comparable with that in a ball bearing. Ordinary roller bearings cannot be subjected to a high rotative speed, as their comparatively high internal friction will cause an undue heating. In this respect also the new discbearing is directly comparable with the ball bearings, but will have an advantage even over these in the fact that the mass of its rollers is less than the mass of the balls of an equal strength, so that the action of the centrifugal forces will be even less in the N.K.A. disc-bearings. Ordinary roller-bearings have generally no capacity for carrying a thrust. In the new disc bearing, as has been explained above, the rollers always move in such a way that the resultant of the applied forces coincides with their central plane. Therefore, when a thrust load is put on this bearing its rollers instantly align themselves at an angle to the plane of rotation of the bearing so as to resist this thrust load. From the extent of the deviation of the rollers the angle of reaction is determined by the amount of the thrust load. Thus it will be seen that this bearing can carry not only a radial load but an axial load too. In a ball bearing the radial load carrying capacity is proportional to the square of the diameter of the ball. By examining Fig. 3 it will be seen that the bearing surface of a roller can be considered as consisting of a part of the spherical surface of a ball, the diameter of which is greater than the distance between the raceways in the bearing rings. Thus if the carrying capacity of the roller is in proportion to the square of this increased diameter, this new disc bearing will be able to carry a load considerably greater than that of a ball bearing of the same size. On account of the shape of the rollers it is possible to make the new bearings narrower than the corresponding ball or roller bearings.

A 30 cwt. Low Portal Gantry Crane.

It is desirable when erecting cranes for quayside work that the front leg of the crane should be as near as possible to the side of the basin or dock to avoid an abnormal length of jib and to permit as great a stability as possible. In order, however, that the crane may not interfere with other traffic to a greater extent than is absolutely necessary its base must be so arranged that railway wagons and other vehicles may pass beneath it. This condition has given rise to the well-known Portal type of crane. An interesting type of crane of this kind has recently been designed by Messrs. Craven Brothers, Ltd., and is shown in the accompanying illustration. The crane is of an electrically-driven low portal gantry wharf crane with a normal load of 30 cwt. It is fitted with the Craven patent derricking motion, a large number of which have, we understand, recently been supplied for docks at home and abroad. The special feature of this motion is that the rope passes from the barrel directly over a single jib sheave, exactly in the same manner as in a crane with ordinary derricking motion. This jib sheave is carried by a special compensating beam at the jib head. This beam is pivoted at about its middle and at the end opposite to that fitted with the jib sheave is attached to a point on the revolving superstructure by a radius rope or rod. The effect of this radius rope is to give such movement to the beam, relative to the jib structure, as to cause the sheave to move in approximately a parabolic path, so that the sum of the distances from the hoisting barrel to the sheave, and from the sheave to the lifting hook in all positions of the jib is constant. This ensures a level path being taken by the hook whilst derricking, and consequently, whilst derricking, a complete balance is maintained as far as the effect of the load is concerned. The power taken to derrick is, therefore, reduced to that required to overcome friction only, apart, of course, from raising the weight of the jib. This latter amount, when so desired, can be balanced by a separate gear, such as is shown at the tail end of the superstructure on the accompanying photograph. This consists of ropes passing off from the derricking barrel round a rising and falling counterweight. It should be noted in this gear that, in contradistinction from nearly all other motions which give a level path of hook whilst derricking, the rope does not pass round any additional sheaves whatever, and a maximum of efficiency is, therefore, claimed for the Craven system. As is well known, passing the hoisting rope round sheaves very considerably reduces its life, and further, and more important, seriously reduces its efficiency.



View of the Low Portal Gantry Crane.

Whilst the fact of obtaining a constant path of hook by any system of sheaves will certainly reduce the power required to derrick, this is of small moment when the period of time in which the derricking motion is in operation is taken into consideration and is compared with the loss of efficiency in hoisting, this latter motion being by far the one most constantly used.

The "Orwell" Electric Lorry.

As Mr. Conradi shows in his Paper (*see* page 682), the electric vehicle has in recent years come to its own, and in its particular sphere has shown itself reliable, cheap and adaptable. That particular field is, of course, the short haul, especially in towns where cleanliness and quietness are of primary importance. In general, it may be said that the efficiency of the combination of the modern storage battery, with an electric motor or motors and a simple transmission system is very high and enables about 60 to 70 per cent. of the energy in the battery to be transmitted to the road wheels. Further, the electric vehicle has no engine to be left running when the car is standing, thus eliminating one source of waste ever present with the petrol-driven combination. On the contrary, regenerative control enables an appreciable amount of energy to be restored to the battery when making trips down hill. Low maintenance cost, the possibility of gradual starting, small type wear and cheap insurance are other factors in favour of the electric vehicle.

One of the most interesting of the modern electric vehicles is the "Orwell," which is manufactured according to the "Mossay" system by Messrs. Ransomes, Sims and Jeffries, Ltd., whose selling agents are Messrs. Mossay & Co.

In this case the chassis is driven by two direct-current motors either geared to the front wheels, or operating on the back wheels by means of chains and sprockets. It is usual to fit the front wheel drive on vehicles up to 2½ tons capacity, and the rear wheel drive on the larger sizes. In cases where the roads are particularly bad, the rear wheel drive may be fitted to vehicles of the lower capacity. The motors are totally enclosed and are provided with aluminium end-shields and watertight covers which can be easily removed for inspection of the commutators. In the front wheel drive the motors are bolted to the swivel axles, and the motors drive the front wheels by helical gears on the armature shafts which mesh with internal helical spur-rings on the wheel hubs. These rings and the pinions are made of high grade steel and run in dust-proof and water-proof casings filled with grease. In the rear wheel drive the motors are bolted on to each side of the chassis frame, and firmly secured to the longitudinal and transverse members.

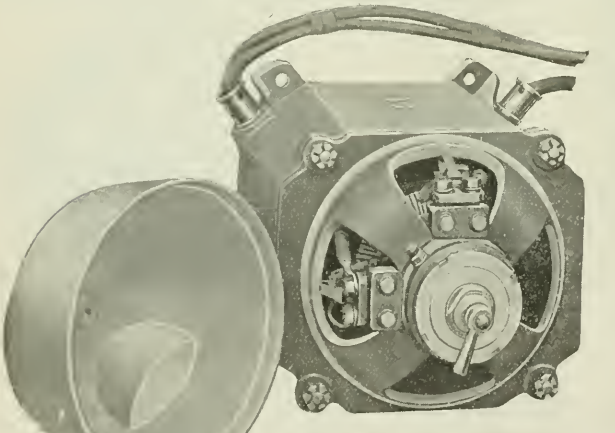


Fig 1 Motor of 2½ ton "Orwell" Vehicle from Commutator End with Cover removed.

The power of each motor is transmitted by enclosed helical gear to an independent countershaft carrying a chain sprocket, which in turn transmits to a rear road wheel by a roller chain. Ball bearings are used throughout. This adds to the first cost, but is absolutely essential if the overall efficiency of the battery is to be sustained. Fig. 1 shows the motor of a 2½ ton "Orwell" vehicle with the cover removed.

An important point in the design of electric vehicles is the battery suspension, so that the shocks which are often very great on our present roads are not communicated to this relatively delicate apparatus. The battery of the "Orwell" vehicle is slung under the chassis in two boxes, each box being arranged to slide sideways by pulling a handle-bar, thus ensuring easy handling. Fig. 2 shows the battery pulled out for examination. The operation of raising the handle-bar lifts the battery box a fraction of an inch, throwing its weight on to rollers. By pulling the handle the battery slides out and is thus readily accessible for examination. When the boxes are pushed back into position the handle-bars are dropped, releasing the weight from the rollers and locking the battery in position.

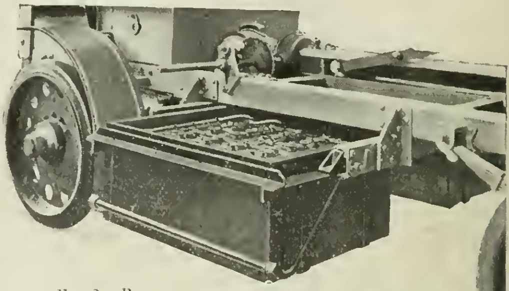


Fig. 2.—Battery pulled out for examination.

The electrical control equipment (Fig. 3) is located under the driver's seat. There are two controller drums. The main drum is operated by a gate change lever mounted on the side of the driver's seat. It has four running positions for the forward direction, and one position for reversing. The auxiliary or rheostatic drums are controlled by a pedal. In its normal position the two resistance steps are short-circuited. Before passing from one position to another on the main controller the pedal must be depressed; this inserts the two resistance steps into the circuit and then interrupts the current when the pedal is fully depressed. In this position the passage to the next position of the main drum takes place without sparking. By releasing the pedal the circuit is re-established through the two steps of the resistance that are successively cut out as the pedal is released. Thus no sparking can take place on the main drum, all the wear being taken up by the starting drum, which is protected by a magnetic blow-out, and is quite inexpensive to renew. It is obvious that the repeated insertion of the resistance steps causes the passage from step to step of the main controller to be extremely gradual and free from current rushes. The operation of the rheostatic drum by means of the foot pedal is exactly analogous to the operation of the clutch on a petrol vehicle. It enables the driver to coast in traffic and to ease off when turning sharp corners without interfering with the main controller and leaving both hands free for steering and signalling purposes, which everyone will agree is very desirable in the crowded streets of a town. In this design every effort has been made to assure great strength and reliability. No combustible material is used in the construction, while the finger tips and segments are all renewable and may be reversed so as to double their life. The cam on the rheostatic drum is arranged so as to give a "quick break" when passing from any position to the next, and so as to prevent the drum from remaining between the

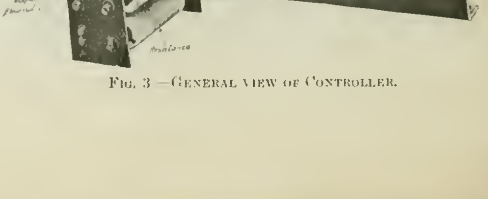


Fig. 3—General view of Controller.

running positions. The provision of a magnetic blow-out prevents arcing between the finger tips and the drum segments. Accessibility is ensured by the provision of hinged doors both at the front and the top of the controller so that all contacts can be easily reached.

The steering is by worm and segment with adjustable step-bearing for taking up any play. It operates through two ball-socket joints on to a bell-crank lever pivoted at the centre of the front axle. This bell-crank lever acts on the wheels by two short tie-rods. By this construction the stresses in the steering rods and links are reduced to a minimum. The axes of the pivots, about which the wheels turn when steering, pass through the points of contact of the wheels with the road. As a consequence of this arrangement shocks are not transmitted to the steering wheel which is, therefore, particularly easy to manipulate. Further, it is claimed there is no tendency for the front wheels to deviate from the set course by unevenness of the road, and, in case of emergency, the car can be driven by one motor alone without strain on the steering mechanism.

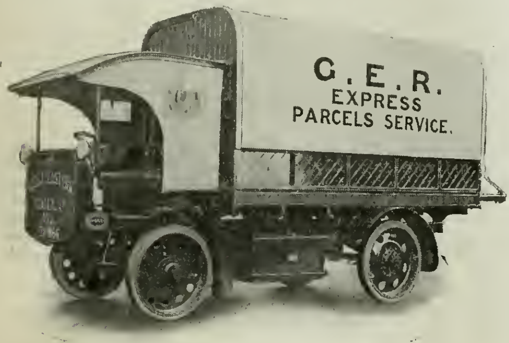


Fig. 4.—The "Orwell" Van applied to Railway Service.

In all electric vehicles some easy method of changing is essential. In the "Orwell" vehicle the chassis is fitted with the standard charging-plug approved by the Electrical Vehicle Committee, the socket being provided with a cover that is so interlocked with the controller drum that the charging plug cannot be inserted unless the controller is in the "off" position. In this position the controller parts are "dead." Furthermore, the controller is locked by the charging plug so that the vehicle cannot be started until the charging plug is withdrawn.

Turning to mechanical details the two independent mechanical brakes with which the "Orwell" is fitted, are of exceptional power and reliability. They both act upon the back wheels and are of the internal expanding type. The service brake is actuated by a foot-pedal and the emergency brake is actuated by a lever that can be held on by a ratchet. Both brakes are compensated so that equal pressures are produced on both rear wheels. All joints in the transmission of the braking action are provided with lubricators. The frame consists of pressed steel girders supported on springs over each axle, and all the bolts in the springs are enclosed in brass bushes and fitted with lubricators. The centres and rims are of wrought steel pressed to shape and riveted together. The hubs are of cast steel.

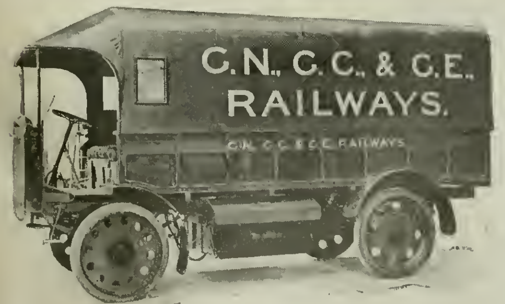


Fig. 5.—Another on the Same Duty.

Various advantages besides high efficiency in the transmission of power are claimed for the two motor drive used on the "Orwell." For instance, it renders unnecessary the use of a complicated change-speed gear box, differential gear, cardan and universal joint, while it is claimed the motors are more accessible than in other types, and daily inspection is possible by the simple operation of removing the end-covers. The electrical connection of the motor sensures an excellent differential action without the intervention of any mechanical parts. With the front-wheel drive the absence of all propelling mechanism from the back axle makes it possible to sweep the frame downwards when it is desirable to have the platform at the back very near to the ground, as is often required for ambulances, fire engines, tower wagons and other special vehicles.

Figs. 4, 5 and 6 are examples of the "Orwell" electric vehicle. Fig. 6 shows one fitted with end-tipping gear. This can be arranged for working by hand power or by electric power controlled from the driver's seat in the following way: A protected powerful horizontal square-threaded shaft working through a heavy bronze crosshead is connected by links and rollers to the channel framework to which the body is secured, and is driven by a cross-shaft through enclosed bevel gearing. The cross-shaft is fitted with winch handles for hand power, or, if desired, it can be driven by an independent electric motor through chain reduction gear. The motion is a compound one, the vertical movement of the body being preceded by a horizontal movement of the body towards the rear of the chassis.

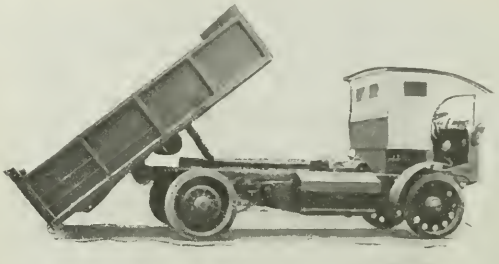


Fig. 6.—"Orwell" Vehicle showing Tipping Gear in Action.

Table I.—*Approximate Running Cost of a 2½-ton Orwell Electric Lorry. Total Cost, £1,100. Energy Consumption, 0·85 unit per mile at 110 volts.*

Annual mileage	6,000	8,000	10,000	12,000
Current (at 1½d. a unit)	£31	£42	£53	£65
Battery maintenance (18,000 miles life)	70	93	117	140
Tyres (12,000 miles life)	22	30	37	45
Chassis maintenance	10	13	17	20
Running cost	£133	£178	£224	£270
Driver	£150	£150	£150	£150
Interest at 5 per cent. (averaged on diminishing value)	28	28	28	28
Depreciation of vehicle, less battery and tyres 10 per cent. per annum	85	85	85	85
Insurance, &c.	15	15	15	15
Total operating cost	£411	£456	£502	£548
Total operating cost in pence per mile	16·5	13·7	12·1	11·0

Table II.—*Approximate Running Cost of a 3½-ton Orwell Electric Lorry. Total Cost, £1,300. Energy consumption, 1·1 units per mile at 110 volts.*

Annual mileage	6,000	8,000	10,000	12,000
Current (at 1½d. a unit)	£40	£55	£69	£82
Battery maintenance (18,000 miles life)	78	104	139	156
Tyres (12,000 miles life)	28	37	47	56
Chassis maintenance	13	17	21	24
	£159	£213	£267	£318
Driver	150	150	150	150
Interest at 5 per cent. per annum (averaged on diminishing value)	32	32	32	32
Depreciation of vehicle, less battery and tyres 10 per cent. per annum	100	100	100	100
Insurance, &c.	15	15	15	15
	£456	£510	£564	£615
Total operating cost in pence per mile	18·2	15·3	13·5	12·3

After all, however, the value of any vehicle, electric or otherwise, depends on what it is going to cost to run. It is, therefore, of interest to be able to reproduce the figures in the above tables which refer to the 2½-ton and 3½-ton "Orwell" vehicle respectively. It will be agreed that the showing is exceedingly good.

G.E.C. Electric Vehicle Equipment.

The manufacture of electric vehicle and trucks for urban delivery services and for use in and about railway stations, factories, stores, &c., is undertaken at the Witton Works of the General Electric Company. These appliances need very special attention in manufacture, and all parts must be easily accessible, strong and correctly designed, and in addition the electrical gear must be "fool-proof." Two details of the G.E.C. vehicles will be considered here. The first is the electric motor, and the second the controller. A typical illustration of the former is given in Fig. 2, and of the latter in Fig. 1, from which the details of construction can be seen. G.E.C. "Witton" motors for electromobiles are made in several sizes, according to the output required. For ½-ton lorries the motors run at 1,500 r.p.m., taking 18 amps. at 60 volts. For 1-ton lorries the speed is the same, the current taken being 25 amps. at 60 volts. For the 3-5 ton vehicles the speed is 1,200 r.p.m., and the current 35 amps. at 60 volts; while for the trucks the speed is 1,000 r.p.m., and the current 40-45 amps. at 24 volts. Two ratings of motor are supplied according to the use to which the motor is to be put; (1) Intermittent rating for trucks. This is based on the one hour full load taken with the top cover off. The temperature rise of the windings does not then exceed 75° C. measured by thermometer or 100° C. when measured by resistance, the motors running at full load current at normal speed. (2) Motors for vehicles are run continuously for four hours at full load current at normal speed and with the covers off. The temperature rise must not exceed 50° C. by the thermometer. No artificial ventilation is used during the tests.

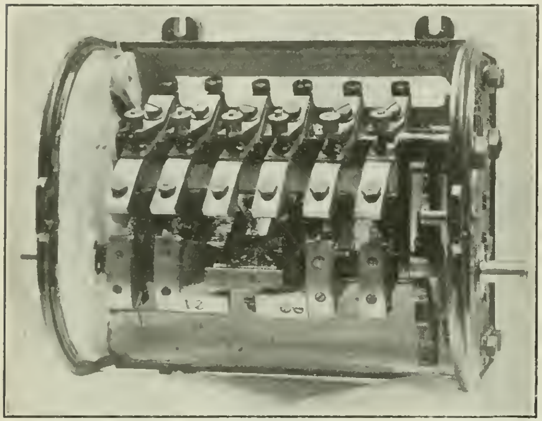


Fig. 1. G.E.C. Controller for Electromobiles with Cover Removed.

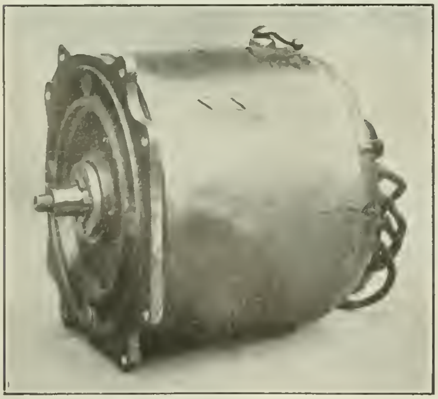
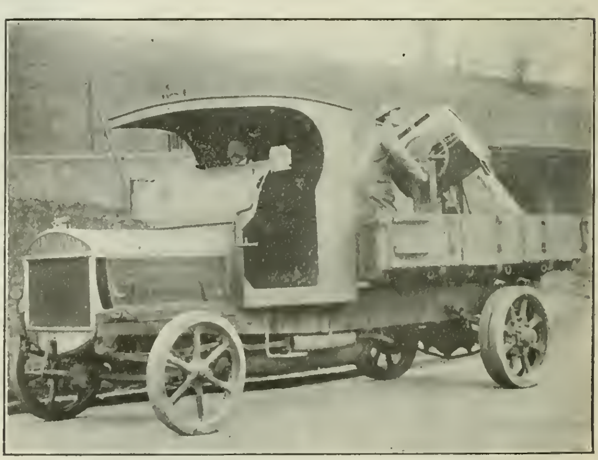


Fig. 2.—"Witton" Series Motor for Automobiles.

The following are some of the principal particulars of the motors:— The frame is of cast steel, and the whole machine is of the totally enclosed type, access to the inside being obtained by a hinged aluminium door. The armature is of the drum slot type and is carefully balanced to run perfectly true, and is set in the magnetic field in such a way as to obviate any tendency to end thrust on the shaft. The commutator is built up of hard drawn copper bars, insulated by pure mica. These bars are forced by means of hydraulic pressure into a cast-iron clamp ring, and whilst held in this position the V in the ends of the segments for receiving the micanite insulating rings is turned. The micanite insulating rings are moulded from carefully manufactured micanite sheets in steam-heated moulds, under powerful pressure, by which means a practically solid mica cone is obtained. The commutator is then assembled in a strong cast-iron spider, and thoroughly baked in order to drive out all moisture. Each commutator is tested both for insulation against the frame, as well as for insulation against adjacent bars. Although the armatures have to work at voltages up to 100 volts only, they are tested with an alternating current of 1,500 volts to frame, after the armature is wound and in a hot condition. The brushes are adjusted to the correct position when the machine is tested, and no shifting of the brushes is afterwards required for any conditions of load between no load and overload. Only two rows of brushes are used, which are placed on the upper portion of the commutator where they are easily accessible by opening the inspection door. Ball bearings are used. The leads are taken off the brush gear and carried through the frame in bushed holes, so no separate terminals are needed.

The Tilling-Stevens "Petrol Electric."

A system which attempts to make the best of two possible worlds in traction problems, and to a great extent succeeds, is the petrol-electric, in which it will be remembered those characteristics of the petrol engine, which are undesirable for this class of work, are eliminated by the introduction of what is really electric gearing between the prime mover and the road wheels. An example of this feature of traction practice is the Tilling-Stevens vehicle; an example of one of which engaged on war work we give in the accompanying illustration. In this case it is interesting to note the dynamo which is used for driving the vehicle also supplies current for operating the searchlight.



Tilling-Stevens Lorry on Military Work.

The principle on which the Tilling-Stevens petrol-electric is propelled is the utilisation of electric energy transmitted from a dynamo driven by a petrol internal combustion engine to a motor, which drives the back axle through the medium of a cardan shaft and worm gearing. The current from the electric generator is governed by means of the engine throttle and a variable resistance, which is introduced, increased or decreased at will by the operation of a resistance lever; this makes the control and driving of the vehicle as simple as possible. It should be noted that there are no gears to change or clutches to operate, and therefore starting or stopping, increasing or decreasing speed is, it is claimed, effected without any jar or jerk whatever, and running under all conditions is always even and sweet. This feature alone makes the Tilling-Stevens petrol-electric a favourite for passenger conveyance, and its suitability for this purpose when compared with gear-driven vehicles cannot be too strongly emphasised, while the same characteristic is also advantageous when the question of conveying goods comes to be considered. To stop the Tilling-Stevens petrol-electric vehicle it is only necessary to throttle down the engine and apply the brakes, the slow speed of the dynamo not then being sufficient to generate enough current to move the vehicle. To start the vehicle again, the brakes are taken off and the throttle opened, and speed from rest is gathered with far greater facility than in the case of the gear-driven vehicle, owing to the elimination of gear changing, clutching and de-clutching.

The utility of the petrol-electric system is, however, by no means confined to passenger conveyance; in fact, this is only one sphere of work in which it is being used with distinction. The fact that the power of the dynamo can be used for auxiliary purposes when the vehicle is at rest in itself places the petrol-electric vehicle as the premier vehicle for quite a number of commercial and municipal purposes. As an instance, we might quote that the Tilling-Stevens petrol-electric chassis forms the basis of portable arc welding sets, and by this means welders are able not only to save time by the quick transportation of the welding set to where the work is required, but also save money by the utilisation of the power normally to propel the chassis to operate the welding set. Further instances where this dual utility of the dynamo is taken advantage of can be found in fire appliances, where power for the pump or ladder extension is supplied from dynamo-tower vehicles for repairing electric tramway wires and vacuum cleaning outfits—all of which have been used with success.

Regarding running costs we are informed that these compare very favourably with gear-driven vehicles, while in maintenance charges the advantage is decidedly in favour of the petrol-electric. The smoothness of running, elimination of gear changing and entire absence of mechanical connection between engine and back axle are reflected in longer engine life and reduced tyre depreciation.

Switchgear for Materials Handling Plant.

As regards the driving of plant and equipment for materials handling by modern methods the electric motor reigns supreme. This position of pre-eminence carries with it, however, certain problems, among them being the design and manufacture of suitable control gear in order that full advantage may be taken of the employment of remote control methods and automatic fool-proof and safety devices. Among the firms which have given this question close attention for some years are Electric Control, Ltd., and in what follows we give some account of their activities in this direction.

We may first deal with the "Empire" continuous current single solenoid starter which is shown in Fig. 1. This type of controller is built in three sizes and will operate motors up to 50 H.P. heavy duty (40 starts per hour, not exceeding 150 per cent. full load torque) and 200 H.P. light duty (5 starts per hour, not exceeding 50 per cent. full load torque) at 500 volts and correspondingly smaller motors at lower voltages.

There are four levers carrying solid copper butt contacts. The two larger sizes have in addition a short-circuiting laminated copper brush. The levers are hinged to the lower pole piece of the solenoid, the lower ends of the levers passing through a brass frame, which is attached to the plunger or core of the magnet. The frame acts as a mechanical interlock when the starter is in the open position, as it is then impossible to close any of the levers by hand. On energising the solenoid, by means of a control switch, tappet switch or pressure regulator, the plunger, with frame, is lifted and the rate of lifting is regulated by means of the oil-dashpot, which is designed so as to splash no oil and to be easily adjusted from the outside. At the lower end, on the inside of each lever, is a cam device which is struck by a roller on the frame; when struck the lever is then in a position free of the frame, so that it can close. Each lever has a different shape of cam so that they close one after the other with a proper time interval between them. The levers are made of malleable iron and form part of the magnetic circuit of the solenoid. When released, therefore, by the upward motion of the frame, they are pulled into the magnet pole and held there firmly by the strong magnetic pull. When the solenoid is de-energised the plunger and frame in dropping knock the levers off. The copper contacts have a quick make-and-break action on to solid carbon blocks. Above 250 volts the first lever is fitted with a magnetic blow-out, as it always ruptures the arc. The starter is usually mounted on an enamelled slab panel, and is designed so as to be easily removable from the front. It can also be mounted on mica-insulated steel bars. Owing to the complete absence of sliding contacts, this design has, we understand, proved capable of operating under continuous and heavy service. It is especially suited for controlling lifts, printing presses, pumps and machine tools. It is supplied as a separate unit, in "open," "protected" and "totally-enclosed" types, and also in combination with reversing switches, automatic contactor type or hand operated, with shunt regulators, automatic or hand operated, and with contactor type circuit breaker with

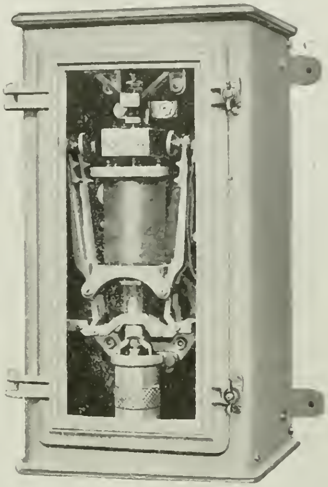


FIG. 1.—"TOTALLY-ENCLOSED" TYPE. 35 H.P., 500 VOLTS (HEAVY DUTY).

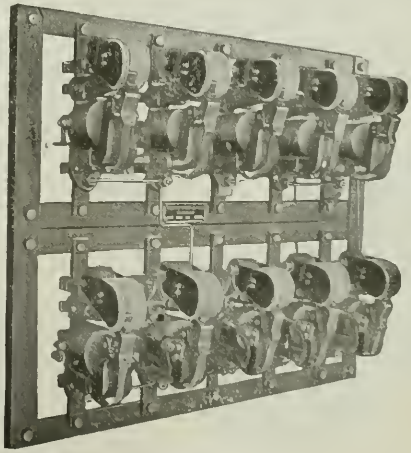


FIG. 2.—HOISTING CONTROLLER (OPEN TYPE). 50 H.P., 220 VOLTS DIRECT CURRENT.

overload relays and safety disconnecting switch of the "totally-enclosed-fool-proof" type.

Fig. 2 shows a contactor controller with seven hoisting speeds and seven lowering speeds, which include four "rheostatic braking" points. The series current relays prevent too rapid acceleration. The ease of operation of the master controller, which is of small size even for the largest motors, reduces the chance of accidents due to faulty operation. By installing it beside the motor the main copper connections between the motor and the operator's cabin are saved, the only cable required being a multi cored control cable. For modern large shipyard and dockyard cranes it is practically essential to have contactor control, so that the numerous small master controllers can be within easy reach of the operator. For controlling the "cross travel" or "traverse," and "long-travel" or "slewing" motors the same number of control points is not required as in "hoisting," and consequently the controller is smaller and simpler, but it has the same safety features and advantages. Very similar control gear with the same general type of master controller as illustrated and described above is suitable for the control of movable cantilever and swing bridges, and large mining hoists and haulages.

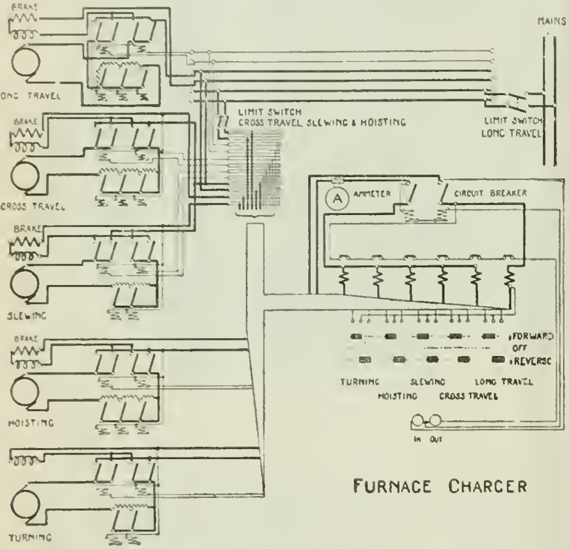


Fig. 3.—Diagram showing Complete Contactor Control for Charging Machine.

A master controller for use in steel mills is shown in Fig. 4. This controller is very strong, as can be seen from the illustration, so as to withstand the worst usage. It is made in the three and also in the single point designs.

By using contactor controllers with small crane type master controllers greater ease of operation is gained, due to the fact of the closer proximity to the operator of all the various controllers. As this duty is exceptionally severe, contactors will stand it much better than ordinary drum controllers, and the series-relay affords a protection to the motors and equipment, which is non-existent in the older form of control. It is also possible to save many of the main connections as can be seen by referring to the diagram (Fig. 3).

The blast furnace hoist controllers made by this firm are of the contactor type and go through a complete cycle of operations automatically. When loaded they are usually started by a push-button. The controller then accelerates the motor to full speed until it reaches near the top of the furnace, when the speed is decreased to a creeping speed, after which the load is automatically tipped, the motor stopped at a definite point by a dynamic brake and then reversed and the cage lowered at normal speed. On nearing the bottom it is again slowed down and stopped at a definite point. The slowing down, stopping and reversing is controlled by tappet switches placed at top or bottom or by a switch geared to the winding drum and driven by it. While the controller has all the features of a lift controller it is stated to be much more automatic in its operation. The above type of control is also suitable for conveyors in which the trucks or buckets do not travel on an endless rope, but have the rope reversed when the truck is emptied.

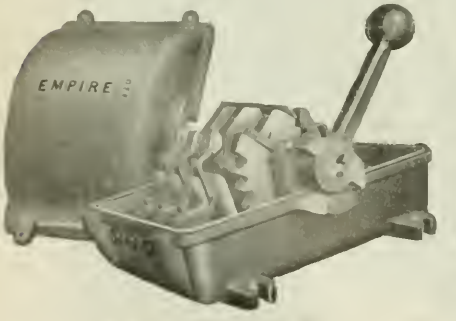


Fig. 4.—Master Controller (Steel Mill Type).

Progress in Edison Vehicles.

It is becoming a truism to say that the development of the electric vehicle and its employment for all sorts of purposes are increasing by leaps and bounds. As some confirmation of this we may say that we have learned from the Edison Accumulators, Ltd., that the number of orders received by them has considerably increased recently, and that they have now a waiting list for various classes of vehicles amounting to at least 600. This development has necessitated a large increase in the size of their works, with the result that their present factory at Marylebone is being converted into offices, showrooms and stores for spare parts and in their stead very large premises in Landor-street, Birmingham, are being fitted up with machines of the most up-to-date character. This development, however, has been to some extent retarded by a number of unfortunate strikes and other similar troubles. It is hoped, however, that these difficulties will shortly be overcome and that the ideal of the Company to obtain a weekly output of 15 chassis will be realised.

Our illustrations show two typical types of Edison vehicles, and these are, we understand, meeting the requirements of the customers of the firm for such work as local deliveries for which the electric is especially suitable. Modifications in the original design have, however, been necessitated when it comes to their employment for municipal work. In this connection a vehicle has recently been put on the market which is fitted with an electrically-operated tipping body with a very low loading line of 4 ft. 11 in. The chassis of these vehicles have been designed for carrying water tanks for street watering to accommodate as much as 750 to 1,000 gallons of water. As these vehicles are only required for a relatively short season in the summer, the tank has been made easily removable and the chassis can then be fitted with either a tipping or flat body, so that it can be used for other purposes and thus be kept in employment throughout the year. In provincial towns where the drainage

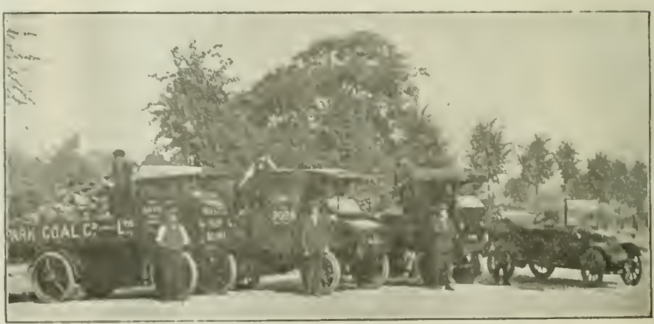


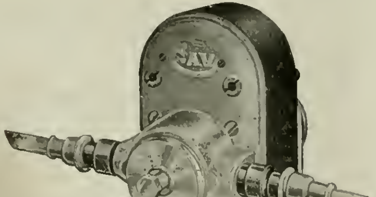
Fig. 1.—Types of Modern Edison Vehicles.

system is not perhaps on quite so up-to-date lines as it might be there is a demand for vehicles capable of proceeding through back lanes for the removal of house refuse, night soil, &c. As, however, many of these lanes are narrow and frequently have sharp angles and awkward corners, it has been found necessary to provide a vehicle which is capable of carrying out this work, and a design for this purpose is now under consideration. The building of platform trucks of which a large number have been brought from America for workshop, dock and railway working is now proceeding at the Birmingham factory of the Edison Accumulators.

An Edison Delivery Van.

The Victory Magneto.

On Stand 166 of the Cycle Motor Cycle and Cycle Car Exhibition at Olympia, the well-known Acton firm of Messrs. C. A. Vandervell & Company, Ltd., exhibited their new light-weight magneto, models K.U.1 and K.U.2, and also lighting sets for motor cycles. The new magneto, which has been adopted by most of the leading motor cycle manufacturers, is made in two types, viz., for single cylinder engines up to about 3 h.p. and for horizontally opposed twins of the same power. The principal features of previous C.A.V. models are incorporated, including the contact breaker which works without a rocker arm. All working parts are entirely protected from dust, mud, &c. These magnetos can, in fact, be immersed in water and will even then work perfectly. The company have also issued a leaflet which gives an illustrated description of the magnetos, and this should be in the hands of all those interested in the use of this type of electrical apparatus.



View of the Victory Magneto.

The lighting dynamo, although primarily intended for small cars, has been found to be admirably suited for motor cycle work, and owing to the great advantage of its being able to run at engine speed, complicated gearing is done away with. The usual method of driving the dynamo is by means of a pulley on the engine shaft, which takes the place of the fixing nut. C.A.V. batteries have already been proved for their excellent properties of withstanding the extra vibration experienced on motor cycles, and give the most satisfactory service when used for battery lighting only, viz., without dynamo. A varied assortment of lamps to suit all types of machines will also be on exhibition.

The Industrial Outlook.

Sir Auckland Geddes, lecturing on this subject at a meeting of the Industrial League and Council last week, said we were employing in industry over 300,000 more men and women than we employed before the war. In consequence of the stoppage of emigration during the war, which had added 1,600,000 to our population, of the fall in the value of money, which had made it necessary for an increased number of people to go out to work, of the increasingly independent spirit of women, and of the fact that men formerly engaged on the land or in domestic work now sought work in the industrial world, we should require in future to employ 15¼ million persons. Employment in industry presupposed production, and to absorb the products we had to find markets. We had lost some of our best customers, Germany, Austria-Hungary and Russia, and the purchasing capacity of France, Italy and Belgium was greatly reduced. At present we had only two serious competitors—the United States and Japan—supplying goods to those markets in other parts of the world which were able to pay in products which we could not produce, but there were indications that, apart from anything the U.S.A. and Japan were able to supply, there was an enormous demand to be fulfilled. But the things those markets required were not the sort of things the European markets took from us before the war. So we had not only to increase production, but to change the type of things produced. It was not impossible to do this if we approached the matter with a spirit of determination. Changes in wages and working hours made consequential adjustments necessary. There was a dislocation in the flow of industry which was raising the cost of all sorts of goods. The fact that the daily average of work fell necessitated an increase in the cost of everything in the country. Ships were not getting the same work, and the result was the price of our goods for export and our own cost of living was up. The fall in the usage of railway wagons and ships affected the prospective absorptive power of the markets we supplied. Our industries were resting upon an artificial basis. We were selling coal for industrial and private purposes below the cost of production, and recouping ourselves out of the price of coal exported or sold for bunker purposes. In so far as coal was being supplied for bunker purposes, this procedure had a direct effect on freights for raw material and for our manufactured goods. If the industrial demand for coal rose sharply the price of coal must inevitably rise. As we pushed forward the development of industry we were bringing nearer the moment when a check would come to industry on the fuel side. The fuel difficulty arose partly as the result of the reduced number of hours worked in the mines, partly from transport difficulties, and partly from the difficulty of replacing plant in mines. Unless more coal were produced or unless some other fuel could be got to take its place, pushing forward our industry would be like pushing it into a noose. There was a great development in the use of oil fuel. In a few weeks the greatest liners would go to sea with oil The use of oil brought a new set of factors into the industrial outlook It meant that the ships which formerly carried coal on their outward journeys would go empty, and the goods coming back would therefore have to pay double freight. We had to get a higher level of skill in industry, and if the population was to stay here we must be more highly industrialised than ever before. Our output must be greater, and there must be a far greater willingness to adapt our products to the requirements of the markets we hoped to secure. The goods we produced must possess a higher work value than hitherto, and that meant technical education. The great adjustments necessary could only be made if those engaged in industry—employers and employed—understood what was passing on around us. The Government could not take over the whole of industry and run it themselves. They could only provide the opportunities for effective instruction and be ready to help at any moment. Anything such a body as the Industrial League and Council could do to promote co-operation, mitigate strife and increase the understanding of the problems by which industry was governed would be beneficial to the wage earners and the country as a whole.

Patents and Designs Bill.

This Bill has now been passed by the House of Lords. On the Committee stage, an amendment to clause 1, which contains provisions for the prevention of abuse of monopoly rights, was rejected.

On clause 6, which increases the duration of patents from 14 to 16 years, Earl Grey moved an amendment providing that the period from Aug. 4, 1914, to the official date for the termination of the war shall not be taken into account, but after discussion the amendment was withdrawn.

Lord Parmoor moved the insertion of a new clause to provide that where by reason of national service in connection with the war a patentee had been wholly or partially prevented from dealing with or developing his invention, he might apply to the Comptroller in the prescribed manner for an extension of the term of his patent.

Viscount Peel pointed out that the duration of all patents had under the Bill been extended by two years. In addition, patentees would have an opportunity of obtaining a further extension if they could show that they had suffered loss or damage in consequence of hostilities.

The new clause was rejected by 33 to 12, and the Bill reported to the House.

Electricity (Supply) Bill.

The adjourned debate on the Second Reading of this Bill was concluded by the House of Lords on Monday.

On the 4th inst., on the motion for the Second Reading, the Lord Chancellor stated that unusual care and deliberation had been exercised in recommending the proposals to the House. In the past there had been an extraordinary and most inconvenient variety of pressures and frequencies of supply, which had prevented those concerned from acting together, and had enormously increased charges.

Lord Downham expressed the opinion that the setting up of some department to supervise and regulate electricity was long overdue: but what grounds were there for the hope, so often expressed, that the Bill would provide "a cheap and abundant supply of electricity"? The cost of putting up each station he estimated at £6,000,000. Therefore the 16 stations would cost £96,000,000. Add to that another £50,000,000 which would have to be found for equipping the stations, putting up main transmission lines, &c.; that gave a total of nearly £150,000,000. Then there were the maintenance charges. Coal was double the pre-war price, wages were also double, and rates would before long be double also. The supply might be abundant, but what was the use of holding out to the people the idea that it was going to be cheap? If the present undertakers were treated justly, he believed they would be willing to come together to provide schemes by which smaller stations might be scrapped and larger stations provided for combined purposes.

Lord Moulton maintained that the Bill would not only nationalise the industry, but bureaucratise it. If ever there was a moment when we ought to be chary of seeking future benefit on borrowed money it was the present. Surely the policy ought to have been to postpone those grandiose schemes until the normal industry of the country had received what it stood in need of. There had not been the faintest adumbration of what the sums of money required would amount to. To select an industry not specially suitable for Government handling for nationalisation seemed to be a thing that required more defence than it had received. The community found itself hampered as it never expected to be. Why should they seek in those circumstances, without waiting to see how transitory existing troubles were, to make our industrial life more complex? Why should they supply our big towns with the absolute necessaries of light and heat by means of mains hundreds and hundreds of miles long, all of which were subject to destruction by a mere individual fanatic or in pursuance of a policy of hostility to society?

On the resumption of the adjourned debate on Monday, Viscount Haldane reminded the House that he had presided over a Committee of experts appointed to inquire into the great waste that took place in our use of coal, and that the Committee came to unanimous conclusions which had taken shape in the Bill before the House. At present we generated motive power from about 600 stations, and the Committee found that the work could be done far more efficiently by 16 such stations. One of the reproaches against the Bill was that it did not take account of the gas industry. No one had any desire to injure that industry; nor did he feel that the principles of the Bill would injure it. Gas was produced in a costly fashion at present. The purpose of what was proposed under the Bill was very largely to increase productive power in this country. That had been done extensively in the United States, in the Rand and in Westphalia, and the success had been such as to produce unbroken testimony to the enormous increase of output. We had never really thought out the electricity question in this country, and had left it to private enterprise. A system had grown up so antiquated and old-fashioned, and yet on so large a scale, that it was impossible for the private individual to deal with it. The Bill was largely in the interests of the consumer, and unless the consumer was able to get for his works power, lighting and heating it was useless to talk of the conditions of this country as regarded production. The Bill was the only one of a practical kind which had been brought forward for increasing production. With regard to the financial liabilities proposed, he expressed the view that there was not a single penny to be expended which would not almost certainly come back to the State.

Lord Inchcape held that the backbone of the success of this country had been, and would be in the future, not Government control or nationalisation of industry, but individual enterprise and initiative. If the Bill became an Act, our electrical undertakings would eventually be nationalised, and the whole electricity of the country would, in effect, be in the hands of the Government. He viewed with considerable alarm the expenditure which the Bill would entail. The country was being promised cheap electricity, but he did not think that anything provided by the Government so far had been cheap, though perhaps it had been nasty. This scheme meant more Government offices, more jobs, more fat Government appointments at the very time when the country was crying out for reductions.

The Marquess of Salisbury said they were all agreed that some measure was required to co-ordinate the electrical undertakings, but there was a *prima facie* case for the contention that the Bill would entirely press out in electrical development the whole of private enterprise. The power companies and the provisional order companies criticised the Bill on the same lines, and the Association of Municipal Corporations were doubtful about the financial provisions of the Bill.

Lord Ashton of Hyde thought the Bill premature. It would be very much better to let the subject rest for two or three years. He was not sure that those great power houses were absolutely desirable.

Lord Emmott submitted that there was a case for the second reading, but that the whole matter deserved more consideration than it had received. In addition to the danger of current being cut off by any discontented element in the population, there was another danger in the event of our being involved in another war, arising from the fact that the situation of the transmission lines must be widely known, and that they might be made the object of concentrated attack, which, if successful, would seriously affect the carrying on of industry. He was very sceptical as to the alleged enormous saving by the use of electricity. He did not believe that any Government system could supply electricity anything like as cheaply as the existing power undertakings. Time would not be wasted if they simply set up the Commission and got on with the work of surveying the situation.

Lord Parmoor said that were the Bill to become law no private individual or company would be able either to erect or extend a generating station. Had such a Bill been in force in South Africa there would have been no Victoria Falls Company, with its ample electric power for business and other purposes.

The Lord Chancellor having replied, the Bill was then read a second time.

Trade Marks Bill.

The Committee stage of this Bill was taken in the House of Lords on Monday.

An amendment to Clause 2 by Lord Moulton was agreed to, with the object of making it clear that there should be no obligation on the Registrar to make a search in every case.

To Clause 6 an amendment was made providing that "no word which is the only practical name or description of any single chemical element or single chemical compound, as distinguished from a mixture, shall be registered as a trade mark."

At the instance of Lord Moulton, a new clause (in place of Clause 11) dealing with the registration of assignments was agreed to, and an amendment was also made to Clause 13, substituting April 1 for January 1 1920, as the date on which the Bill comes into operation.

The Bill was then reported to the House.

Electricians' Wages.

We are informed that at a meeting of the Electrical Trades Union with the London Section of the National Federated Electrical Association (representing the electrical contractors) on the 3rd inst. the offer of the employers to bring London into the National scheme of standardised wages for the electrical contracting industry by which London men would be paid 2s. per hour from Dec. 1. was unconditionally refused by the London Committee of the E.T.U. The refused offer included certain allowances which, in the opinion of employers would have the effect of increasing the men's earnings on the average considerably above what would have been obtained by the offer of June last which worked out at 2s. 0¾d. The rate in the London area as a result of the refusal therefore remains unaltered at 1s. 7d. per hour, plus 12½ per cent. on earnings, whereas the rates for the rest of the country have been agreed at 2s., 1s. 11d., 1s. 10d., and 1s. 9d. inclusive for the respective grades into which the country has been divided. Under the circumstances the employers who consider that the deadlock caused by the refusal would operate hardly on the rank and file of the E.T.U., have decided that the inclusive rate of 2s. per hour for London shall be paid forthwith, and the rate for auxiliary workers over 21 shall be 1s. 7d. per hour.

It is reported that a ballot of the E.T.U. has resulted in an overwhelming majority in favour of action. The Executive of the union is now empowered to take whatever action it thinks fit and when it thinks advisable.

The National Joint Industrial Council agreed unanimously on Nov. 27 to recommend to the members of the E.T.U., the N.F.E.A. and the E.C.A. of Scotland the adoption of the following proposals:—

The standard rate of wages for the towns and districts in Great Britain and Ireland to be as follows:—

Grade A, 2s. per hour; towns and districts left open.

Grade B, 1s. 11d., covering Mersey district, Manchester, those towns or districts in Lancs which follow the Manchester rate, and South Wales.

Grade C, 1s. 10d., Belfast, Londonderry, Scotland, N.E. Coast, Northumberland, Durham, Yorkshire, those towns and districts in Lancs and Cheshire not covered by agreement to follow Mersey district or Manchester rate, Carlisle, Eastern Counties (Lincs, Norfolk, Suffolk, and Essex and Herts) outside London area, Nottinghamshire, Leicestershire, Derbyshire and Northamptonshire, Bournemouth, Plymouth, Devonport, Bristol, Birmingham and towns following Birmingham rate, Coventry, Wolverhampton and the Potteries. The grading of Taunton is left over for further consideration.

Grade D, 1s. 9d., remaining towns and districts, other than London, in England and Wales; Luton is left over for local agreement, and the grading of Ireland, other than Belfast and Londonderry, is to be settled locally.

The above, which includes the 12½ per cent. and all past and future awards up to March 1, 1920, are to be standard rates and shall not be altered except in accordance with this agreement. The new rates to take effect as from the pay day in the week ending Saturday, Dec. 6, 1919, provided that (*a*) where earlier dates have been agreed locally such earlier dates shall be substituted for that given, and (*b*) where the increase in any district exceeds 3d. per hour, the increase payable as above shall be 3d. only, and the balance of such increase shall come into effect six months later. Any variation in the above general rates to be a national variation and to be applied to all grades. A town or district may only alter its grade by local agreement, or by decisions of the N.J.I.C. failing local agreement.

After March 31, 1920, there shall be a review of wages in February and July of each year. Any application for increase or reduction must be in the hands of the Joint Secretaries of the N.J.I.C. not later than January 1 and June 1 for consideration at the following meeting. Any application for regrading of towns shall be considered by the D.J.I.C.'s during December and May, and mutual recommendations or failure to agree shall be submitted to the National Joint Secretaries not later than Jan. 1 or June 1 of each year.

The agreement applies to all qualified journeymen being members of the E.T.U. who are employed by electrical contractors, except employees engaged for full time on manufacturing work under agreed engineering conditions.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

133,342 Western Electric Co. & Polinkowsky. (Western Electric Co. partly). Machine switching telephone exchange systems. (17/1/18.)
133,343 Western Electric Co. & Polinkowsky. Western Electric Co. partly). Machine switching telephone systems. (25/1/18.)
133,361 Revel & Boldorini. Electric steam generators. (19/6/18.)
133,365 Pridham & Jensen. Method of and apparatus for telephonically transmitting speech in an improved manner. (26/6/18.)
133,366 Western Electric Co. (Western Electric Co.) Modulating means for high-frequency oscillations. (28/6/18.)
133,370 Mordey & Hughes. Electrical searchlight and other projectors. (10/7/18.)
133,376 Heape & Grylls. Carbons for electric arc lamps. (2/8/18.)
133,403 Case. Electric resistances. (10/9/18.)
133,404 Case. Light reactive electric resistance elements. (10/9/18.)
133,406 Fletcher. Electrically-heated warming or cooking plates of the enclosed type. (18/3/19.)
133,413 Murray. Electric vacuous bulb thermionic devices. (4/10/18.)
133,422 Gill. (Woods.) Electrically-heated water and like services and systems. (7/10/18.)
133,439 B.T.H. Co. (G.E. Co.) Electric welding. (9/10/18.)
133,453 Shipman. Trolley shoes or collectors for electricity. (11/10/18.)
133,483 Oldham & Oldham. Gas exits for galvanic batteries. (25/10/18.)
133,485 Kent. Electric furnaces. (28/10/18.)
133,499 Pickard & Dobson. Electrical ignition for internal combustion engines and the like. (5/11/18.)
133,510 Grylls & Heape. Electric arc lamps. (11/11/18.) (Addition to 4,866/17.) (Cognate Application 20,965/18.)
133,513 Ewen. Inductance coils. (13/11/18.)
133,521 Jowett & Wilkinson. Shuttles for weaving in electrically-stopped looms. (20/11/18.)
133,541 M..vor & Coulson & Moore. Electric alternating-current slip-ring motors, and short-circuiting and brush-lifting gear therefor. (14/12/18.)
133,545 Lozano. Electrically-heated utensils. (23/12/18.)
133,718 Hope. Electric lighting of machines driven by electric motors. (21/3/18.)
133,724 Imray. (Bosch Akt.-Ges. R.) Regulating device for electric machines. (11/6/18.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

September 30, 1919.

23,928 Stirling. Motor and dynamos.
23,940 Murray. Trolley adjuster.
23,949 Boorne. Electrodes.
23,952 Hanman. Terminals and connections for electric cables, &c.
23,955 Tedeschi. Insulators for fixing cables to walls, &c. (5/12/18, Italy.)
23,956 Tedeschi. Insulators for fixing cables to walls, &c. (18/2/19, Italy.)
23,976 Eckersley & Prince. Means for regulating voltages of self-excited generators.
23,977 Anzani. Contact breakers for high-tension magnetos. (2/10/18, France.)
23,978 Anzani. Contact breakers for high-tension magnetos. (9/10/18, France.)
23,979 Douvry. Wireless telephone apparatus.
23,981 Eayres-Gardner. Directional wireless installations.

October 1, 1919.

24,027 Marks. (Koehler Mfg. Co.) Electric storage batteries.
24,028 Marks. (Macfarlane Communications Corpn.) Electrical system of train communication.

October 2, 1919.

24,064 Royston. (Chadburns Ship Telegraph Co.) Sound increasing apparatus for telephone receivers.
24,074 Donaldson. Electric appliance for heating electric irons.
24,080 Barbour. Starters and controllers for alternating-current induction motors.
24,103 Thomson. Mechanism for operation of electric switches.
24,105 B. T.-H. Co. & Taylor. Alternating current dynamo electric machines.
24,106 B. T.-H. Co. & Clinker. Static electrical condensers.
24,114 Marks. (Koehler Mfg. Co.) Electric lamps.
24,115 Marks. (Macfarlane Communications Corpn.) Electrical system of communication.
24,121 American Bosch Magneto Corpn. Ignition apparatus. (1/10/18, U.S.)
24,130 American Bosch Magneto Corpn. Brush holders for magnetos. (26/10/18, U.S.)

October 3, 1919.

24,164 Morgan, Shepherd & Shannon. Fitment for attaching magneto to engine.
24,190 Quain. Electric heating and lighting.
24,197 Mascarenhas. Electric lamps.
24,173 Western Electric Co. Electric transmission signalling systems.
24,214 Resonance, Ltd., Diboin & Glover. Sound reproducers for telephones, &c.
24,224 Mellersh-Jackson. (American Bosch Magneto Corpn.) Magnetos.
24,225 Borel. Apparatus for operation of receiver with plurality of separate elements by a transmitter with comparatively few elements and conversely.

October 4, 1919.

24,243 Shanks. Magnetically operated friction clutches.
24,246 Automatic Telephone Mfg. Co. & Archer. Electric heating apparatus.
24,267 Pilgrim. Electric cooker and heater.
24,290 Graham. Telephone apparatus.

Commercial Topics.

An Industrial Court.

In pursuance of the new Industrial Courts Act the Minister of Labour has constituted a standing Industrial Court for dealing with trade disputes which, with the consent of the parties thereto, may be referred for settlement by arbitration. The first members of the Court are Sir William W. Mackenzie, K.C., K.B.E. (President); Mr. F. H. McLeod, C.B. (chairman); Messrs. D. C. Cummings, C.B.E., J. McKie Bryce, Ernest J. Brown and F. S. Button, with Miss Violet Markham (Mrs. James Carruthers) and Miss Cecilie Matheson. The secretary of the Court is Mr. G. T. Reid. Other chairmen and other members will be available to form additional divisions of the Court if necessary.

The first case to come before the Court is the dispute between the employees and directors of the Army & Navy Stores and the result will be watched with some interest.

* * * *

Double Income Tax.

The Royal Commission on the Income Tax has completed the hearing of evidence. Among the last witnesses heard was Sir Arthur Steel-Maitland, who gave evidence on the important subject of double income tax. As an illustration he took the case of the Rio Tinto Company. He expressed the opinion that double taxation would not only cause existing companies whose operations were mainly carried on abroad to transfer the control abroad, but that enterprises which may be projected in the future would be so arranged that they were not subject to the disadvantages arising out of the control being in the United Kingdom.

The subject is of particular interest to the electrical industry, as there are many colonial and foreign electric supply and tramways undertakings with head offices in London who are adversely affected by the present arrangement, and it is to be hoped that the Commission will suggest a suitable remedy in the report which is now under consideration.

* * * *

Progress of the Marconi Company.

It was recently decided to increase the capital of Marconi's Wireless Telegraph Company, Ltd., by the creation of 1,500,000 new ordinary shares of £1 each in order to provide capital for many important extensions and developments of the Company's business. A number of valuable contracts have been secured for the erection of wireless telegraph stations in all parts of the world, including China and South America, and negotiations are proceeding in regard to several others, while the Company also desires to be ready to carry out the offer, if and when called upon to do so, which it has made to the Government to construct and organise a thorough and efficient wireless telegraph service between all distant parts of the Empire and the mother country. The distribution of a cash bonus to the shareholders was considered inexpedient, but it has been decided to issue the whole of the new shares at a premium of only £2. As the present quotation for the shares is £4 the issue is being made at an attractive price and in view of this and of the excellent prospects of the company no doubt the present issue, which is being offered to shareholders on the register on 4th inst. will be taken up promptly.

* * * *

Australian Trade Marks Legislation

A Bill to amend the law relating to Trade Marks (which has been introduced into the Commonwealth Parliament) will prevent the use of such words as "Anzac," "Aussie," and similar words as trade marks. Power is given to the Governor-General to proclaim any prohibited word or mark, and to declare that the word prohibited shall not be used as a trade mark or part of a trade mark either at all or after a date to be specified in the proclamation. It is proposed to prevent injury to trade by any person who claims to own a trade mark threatening any other person with legal proceedings or liability for infringement, unless the person making the threat commences and prosecutes an action for infringement with due diligence.

By the Trade Marks Act of 1905 it is within the power of a State to authorise the use of the Arms of the Commonwealth in connection with a trade, business, calling or profession, but under the Bill this power will be confined to the Government of the Commonwealth or some department of it, the King, or some member of the Royal Family, or the Governor-General.

* * * *

Norway's Industrial Progress.

Norway has made remarkable commercial and industrial progress in recent years, but particularly during the war, and attempts are being made to make the country self-supporting. During the period 1897-1915 the number of industrial undertakings grew by 75 per cent., and the number of industrial workers by 95 per cent. A number of new industrial enterprises were launched during the war. In the electrical industry the country was formerly practically dependent on outside supplies. Generators, cables, lamps, insulators, engines and transformers, etc., had to be imported; but a great change has been made in this respect during the past four years. A number of large Norwegian companies have taken up various branches of these manufactures. The chemical and electro-chemical industries have developed greatly: there have also been developments in the manufacture of aluminium sulphate, labrador stone, and ferro-mangan (used in the manufacture of tool steel) and of graphite crucibles. In 1917 the A.S. Sodium Works were established at Trondhjem for the production of chlorine and alkali products by the electrolytic separation of salt.

Electricity Supply.

The salary of the borough electrical engineer (Mr. H. Woods) has been increased to £500 by TORQUAY Corporation.

At ST. ANNE'S-ON-SEA the electrical engineer (Mr. J. H. Clothier) reports an exceptional demand for electric fires.

At a conference of delegates from Scottish electric supply undertakings and of trade union representatives it has been decided to form a DISTRICT COUNCIL for Scotland.

For the purpose of extending the RAWTENSTALL Corporation electricity undertaking application has been made for sanction to a loan of £117,000, of which £87,000 is required for immediate purposes.

We regret to learn that the health of Mr. F. H. Rudd, borough electrical engineer of ROCHDALE has broken down, and the Electricity Committee have granted him a month's leave of absence.

MARYLEBONE (London) Borough Council has been granted a loan of £6,200 by the London County Council. Of this sum £2,750 is for mains and is repayable within 25 years and the balance for house services repayable in 12 years.

It has been decided to increase the salary of the BOLTON electrical engineer (Mr. W. J. H. Wood) from £800 to £900 a year, that of the tramways manager (Mr. John Barnard) from £700 to £800, and that of the chief tramway traffic assistant (Mr. C. Ormrod) from £200 to £250.

PETERBOROUGH Corporation has decided to reorganise its electric supply undertaking in accordance with the recommendations of the consulting engineer, Mr. Wm. Selvey. The present low tension system is to be replaced by high tension at an estimated cost of £40,000. Changes are also suggested in the staff and management, and further developments, involving an expenditure of probably £1 00,000, are contemplated.

An inquiry has been held at PLYMOUTH into the application of the Corporation for sanction to borrow £69,750 for the electric supply department, including extensions of plant at Prince Rock station and for extensions of mains. Compared with March, 1915, the present demand represents an increase of 4,282 kw., and the committee has been forced to appeal to consumers to economise in the use of electricity during certain hours.

The GRIMSBY Lighting Committee has been informed by the electrical engineer (Lieut.-Col. W. A. Vignoles, D.S.O.) that his estimate of 2,000 kw. as the load on the plant at the electricity station this winter had been exceeded by 200 kw. on more than one occasion during the "peak" hours, and in order to deal with that load the spare plant had to be employed temporarily. He had made efforts to keep down the "peak" load, but the next few weeks would be an anxious period. The Committee has decided not to use the public lamps until 5 p.m., in order to relieve the situation.

The GLASGOW Electricity Committee, which has been considering the effect of the recent reduction in the price of coal on the cost of electricity supply, states that the quantity of electricity sold for domestic purposes is a very small proportion of the total consumption, and for the half-year ended May 31 the reduction was equal to £1,425. This would only permit of a reduction of one-fifth of a penny per unit, or an average of 2s. 6d. to each consumer. The electricity department did not increase the rates when the price of coal went up 6s. per ton, and the present rates are only 50 per cent. over the pre-war scale. The 6s. per ton on coal represents £68,000 additional expenditure to the department per annum.

On the occasion of his leaving the ABERDEEN Corporation Electricity Department, to take up duty as assistant mains superintendent with the Dundee Corporation, Mr. George Troup was made the recipient on the 28th ult. of a watch and chain and pendant, slide rule and a copy of Dick & Fernie's "Electric Mains and Distributing Systems." Mr. McKay, who (in the unavoidable absence of Mr. J. A. Bell) made the presentation, congratulated Mr. Troup on his well-earned appointment and wished him every success.

On Friday night the staff and employees of the ABERDEEN Corporation electricity works entertained some 30 of the Ex-Service men who had returned to the works at an "At Home and Dance." The company totalled nearly 130, over which the city electrical engineer (Mr. J. Alex. Bell) presided. Songs were rendered during the evening. After supper, the toast of "The King" having been honoured, Mr. Bell asked the company to stand while he read the names of the three men whose loss they mourned and whose memory they honoured. These were Leading Seaman William Smith, Corpl. James B. Thomson and Private Charles McDonald. Fifty-nine men in all left the department, representing approximately 50 per cent. of the average working staff during the war. The four prisoners of war (Messrs. R. Aitken, F. McDonald, F. Glass and J. C. Aiken) were released at the Armistice, and he was glad to see them present. He congratulated Major Webster on winning the Military Cross, Corpl. Geo. Troup and A. M. B. Ross on gaining the Military Medal, and Sergt. W. Ogg on having received the M.S.M. In calling on the convener to address the meeting, Mr. Bell pointed out that of the 210 hospital trains which arrived at Aberdeen, Mr. Gibb had met 205, at all hours of the night and day. That represented some 30,000 patients. Mrs. Gibb also worked very hard for the Red Cross and had given every one of the men cigarettes.

Mr. Gibb briefly addressed the meeting and was followed by Mr. Fyfe on behalf of the rank and file. Lieut. W. Hodson, replying for the guests, called on the Ex-service men to give three hearty cheers for those who had provided them with such an enjoyable entertainment.

A vote of thanks to Mr. Bell for presiding was heartily given on the call of Mr. Knox, chairman of the Sports and Works Committee.

Electric Traction.

The BELFAST tramway employees have been granted an advance of 4s. in war wages.

NELSON Council has increased the salary of the Electrical and Tramways Manager from £425 to £480.

Wigan Corporation have appointed Mr. Benjamin Hall manager of their tramways at a salary of £450, rising by £25 annually to £600.

The Minister of Transport has extended by one year from Aug. 18, 1920, the period limited by the Halifax Corporation Act, 1911, for the completion of 23 lengths of tramway.

For the past half-year there was a loss of £14,000 on the HULL tramways, and owing to the high cost of materials, &c., the Tramways Committee hesitates to embark upon the proposed extension to Stoneferry.

The LANCASTER Corporation tramways have never been a financia success and a consulting engineer is to be engaged to report upon the subject and also upon the advisability of running motor omnibuses.

The Minister of Transport has recently confirmed the LIVERPOOL and PRESCOT Light Railway (Amendment) Order, 1919, amending the Liverpool and Prescot Light Railway Order, 1898, and authorising the Liverpool Corporation to purchase the undertaking authorised by that Order.

For the year ended March 31 last the total revenue of the PRESTON Corporation tramways was £77,930, working expenses and war service allowances were £52,876, and gross profit was £25,053, against which was charged interest (£5,889), income tax (£3,291), sinking fund (£6,291), and old tramway debt (£1,290), leaving a profit of £8,229.

The accounts of the IPSWICH tramways department for the year ended March 31 last show revenue £38,775 (against £34,817 in previous year, and net profit £2,294 (£1,478). Revenue per car-mile was 19·637d. (13·365d.), and working expenses, including power, were 1·481d. (1·359d.). Passengers carried were 6,224,608 (6,069,777), and car-miles run 473,893 (625,224).

STOKE-ON-TRENT has decided to proceed with the Bill to authorise the purchase of the tramway undertakings in North Staffordshire and to work and run tramways, light railways and omnibuses. A recommendation of the Special Tramways Committee not to purchase the tramways but to promote a bill for power to purchase and run omnibuses was rejected.

The preliminary arrangements in connection with the formation of the INSTITUTE OF TRANSPORT are now well advanced, and it is hoped that the work of the Institute may commence early in the new year. Office accommodation has been acquired at No. 2, The Sanctuary, Westminster, and pending the appointment of a permanent secretary Mr. H. E. Blain is acting as honorary secretary to the Council.

The tracks of the LONDON ELECTRIC and METROPOLITAN DISTRICT RAILWAYS will be rearranged west of Baron's Court and Hammersmith. It is proposed to rearrange the westward tracks and to carry four lines of metals from just east of Hammersmith to join the lines of the L. & S.W. Railway at Ravenscourt Park. The Piccadilly Tube trains will then be able to run direct to Richmond, Acton Town and Ealing.

In a report on proposed extensions of the tramways the YORK Tramways Committee recommend that it is unwise to embark on an expensive scheme at present owing to the high cost of materials. It would be better to construct the suggested lines, including those in Poppleton-road, Leman-road, Clifton, and Burton-lane gradually, and to aim at a general policy in the completion of the system. The total cost of the extensions will be about £143,000.

SHEFFIELD City Council is recommended to increase the tramway fares from 1½d. to 2d. An increase from 1d. to 1½d. was made last February, but the tramways manager estimates that if income is not increased there will be a loss of £36,900 at the end of the current year, and of at least £72,500 by the end of next year. The increase of fare will bring an increased revenue of £115,908 per annum, which will be only sufficient to cover increased expenditure.

The LONDON County Council has authorised the expenditure on capital account of £11,725 for the provision of new junction lines between the tramways in Stockwell-road and Clapham-road and in Tooting High-street and Mitcham-road.

On Tuesday the County Council approved the Tramways and Improvements Bill of 1920 and ordered the Council's seal to be affixed to the petition for leave to bring in the Bill. An estimate of £33,000 on capital account for the installation of coal conveying plant at the Greenwich generating station was also passed.

The official report on the accident to a light railway car on the BURTON & ASHBY LIGHT RAILWAY on October 8 has been issued, and the inspector (Major G. L. Hall, R.E.) states that the slipping of the wheels immediately prior to the run-back was caused by the exceptionally bad condition of the rails, and from the fact that the motorman was unable to release the sand before his car had come to a stand, owing to the collapse of his sand pedal. He failed to control the run-back immediately, as his brakes would not hold without sand. This was not supplied by the conductress, who at the time was on the top deck. He failed to regain control of the car by injudiciously relinquishing his magnetic brake. If he had retained the magnetic brake in use he would at least have kept the speed of the car below the limit of danger. He did not consider the motorman acted with that degree of judgment which might reasonably have been expected of him, but both driver and conductress deserved credit for remaining at their posts.

Imperial and Foreign Notes.

The directors of the Dominion Steel Corporation and its constituent companies had decided that the Dominion Iron & Steel Company, a subsidiary, shall sell to a syndicate of prominent British capitalists 50,000 shares of the ordinary stock of the Dominion Steel Corporation, which the Iron & Steel Company will acquire from the parent corporation.

Two years ago Moorabbin Council entered into an agreement with the Melbourne Electric Supply Company to carry their mains into the shire, and to light the streets within the district. This work has not yet been undertaken owing to the high cost of copper, but the Company has promised to carry out its agreement as soon as cables are procurable at a reasonable price.

Preparations have been made for the erection of a great weir on the Murray, 9 miles from Albury (N.S.W.), where it is proposed to erect hydro-electric works. Electric current will be supplied for pumping and irrigation purposes on farms, &c. Already motors are in use on some farms, and their many advantages have created a great demand for their extension in the district.

Works for the manufacture of sulphate of lead are being erected at Launceston, Northern Tasmania. The first unit, which will require 400-h.p. of electric current, will produce 100 tons a month, but the completed plant will require about 10,000 h.p. of electric current. The additions are to be made as soon as the Government Hydro-Electric Department can supply the power.

Telephone communication has been established between Germany and Sweden. There is a submarine telephone cable of 87 miles, which is the longest of its kind in the world.

The Compania Telefonica y Luz Electrica del Chubut has been formed in Buenos Ayres to acquire the undertakings of the Empresa Telefonica del Chubut Rechelet y Cia, the Empresa de Luz Electrica de Trelew, &c.

Miscellaneous.

It has been decided to abolish the order requiring licences for retail traders as and from the 31st inst.

According to the Ministry of Labour there are now 51 Whitley Councils in existence, representing over 4,000,000 workers, and that negotiations are proceeding with regard to 16 other professions and industries, representing over 765,000 workers.

A complete Inter-Departmental Telephone installation has been recently erected at the works of Messrs. Jas. Mackie & Sons, of Belfast, by the Automatic Telephone Mfg. Company. The equipment is designed to accommodate 100 lines, and is entirely automatic in action.

In the House of Commons on Friday, the Workmen's Compensation (War Addition) Amendment Bill was read a second time. The object of the Bill is to increase the percentage of workmen's compensation from 25 to 75 per cent. over the rate payable by the 1906 Act, in order to meet the increased cost of living. The Bill will operate during the period of the war and six months afterwards.

The Executive Council of the Imperial Institute of Patentees have elected Sir Harry S. Foster, D.L., President of the Institute in place of the late Sir Joseph Lawrence. An Administrative Committee has been created for advising and assisting poor inventors in protecting his interests. Communications to the Organising Secretary, Mr. Godfrey Cheesman, 6, Holborn Viaduct, London, E.C.1.

Non-manual workers, whose remuneration is between £160 and £250, a year, and who desire to claim exemption under the National Health Insurance Act, 1919, should make their claims not later than the 31st inst. The appropriate form of application is obtainable at any post office. Until exemption has been granted the weekly contributions are at the ordinary rate (7d. for men, 6d. for women), and if exemption is not claimed within the time allowed the person will thereafter remain subject to compulsory insurance under the normal conditions.

The National Union of Manufacturers have published a revised list of their members. We are informed that every name in it is that of a purely British manufacturing firm, and that it can be alluded to as a "white" list. No merchants are admitted to full membership of the Union. The list has been published in order to meet the desire of many that members should trade with one another as far as possible. It is stated that the list will be freely circulated throughout the whole of the Dominions and other countries with whom the Empire enjoys friendly relationship.

On Friday last a large gathering of employees of the Western Electric Company took place at the Drill Hall, Woolwich, when gold service badges were presented to over 250 employees of the company who had been on the pay roll for 10 years or more. Musical selections having been performed by the Royal Artillery band, Mr. H. M. Pease, managing director, gave a brief account of the method of operation of the pension system. This system ensures that every employee on reaching the age of 60 years, and who has had continuous service of 20 years or more with the firm, becomes eligible for a pension amounting to 1 per cent. for each year of service of the average salary of his last 10 years. It should be pointed out that this pension scheme is entirely non-contributory. At the same time, it applies to all employees, without distinction of rank, and all pensions throughout the firm are computed in exactly the same way. The speeches being over, the programme was concluded by an enjoyable dance, for which the Royal Artillery band again provided music. The attendance was about 2,000.

Educational.

A bequest of £4,000 has been made to Manchester University by the late Mr. Wm. Kirtley for founding a scholarship to be called "The William Kirtley Scholarship," for the promotion of the study of mechanical engineering.

The Council of the Institution of Electrical Engineers has awarded a David Hughes scholarship of the value of £50 to Mr. Bernard Cronin, who is studying at the University College of S. Wales and Monmouthshire for the degree of B.Sc. in electrical engineering.

The prizes and certificates at the Northampton Polytechnic Institute were presented on Friday last by the Marquis of Northampton. The principal (Dr. R. Mullineux Walmsley) reported that the classes in the current year were full, and he gave a most creditable record of war work. Naturally the ranks of the students were rapidly thinned; but the institute was able to employ its staff and equipment in the training of artillerists for Kitchener's Army; in the actual manufacture of mechanical and notably optical munitions; and the training both of munition workers and of disabled sailors and soldiers on their return to civil life. It also trained many ambulance war workers.

Mr. William Oliver, B.Sc., A.M.I.C.E., has recently been appointed lecturer in the organisation of industry and commerce by the Edinburgh University Court, after consultation with representatives of the Edinburgh Merchant Company, the Edinburgh and the Leith Chambers of Commerce, the Institute of Bankers in Scotland and the Leith Shipowners' Society. Mr. Oliver, who was educated at George Watson's College, Edinburgh, and at the Edinburgh University (graduating in Science with distinction) has been in the employment of Messrs. Bruce Peebles & Company, Ltd., Edinburgh, since he left school, and he now holds the position of contract engineer to that Company, which position he will still hold in addition to the new lectureship. As he has had experience in all the chief departments of Messrs. Bruce Peebles' works and offices, and some time past has been intimately connected with the commercial side of the business, first as chief of the sales department and now as chief of the contract department. Mr. Oliver's experience will stand him in good stead in connection with the new lectureship in the important subject of the organisation of industry and commerce. There were over 50 applicants for the lectureship.

Tenders Invited and Accepted.

The Victorian Railway Commissioners require tenders by 11 a.m., Jan. 7, for the supply of steel strand g.-i. wire (contract 32,718).

Johannesburg (Transvaal) Council require tenders for copper wire cable insulators and steel poles (contract 548). Tenders to the Town Clerk by noon Jan. 8.

Tenders are required by noon, Dec. 18, for three months' electrical and engineers' supplies, ironmongery, &c., for the Toxteth Park Guardians. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

Halifax Corporation want tenders by Jan. 5 for 13 months' supply of tramway stores, including lighting fittings, insulating materials, v.r cable, wires, trolley and overhead line materials, castings, &c. Forms of tender from the Tramways Engineer.

Palmerston North (New Zealand) Council require tenders by 4 p.m. March 2 for the supply of two 400 h.p. pressure producers and auxiliaries, 3,000-volt generating sets, converters, battery switchboards, &c. Specifications can be inspected at the Department of Overseas Trade (Room 40), 35, Old Queen-street, London, S.W.1.

Belfast Corporation invite tenders for the manufacture and erection at the new harbour power station of steam, water and other pipework. Specifications from Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's Gate, S.W.1.; or Mr. T. W. Bloxam, M.I.E.E., city electrical engineer. Tenders to Town Clerk by Monday Dec. 22.

The Electric Supply Committee of the City of Sheffield invite tenders for the supply of materials and works required in connection with the supply and laying of 6-core e.h.t. split conductor cable. Specifications, &c., from the general manager and engineer, Mr. S. E. Fedden, Commercial-street, Sheffield, where tenders are to be delivered by Jan. 2.

Barnes Urban District Council invite tender for the supply of water-tube boilers, economisers, draught plant, turbo-alternators, condensers, air and circulating pumps, transformers and rotary converters. Specifications from the engineer and manager, Mr. C. S. Davidson, M.I.M.E., M.I.E.E., Electricity Works, High-street, Mortlake, S.W.14. Tenders by noon of Jan. 12.

Southport Electricity Committee has accepted the tender of the General Electric Company for the supply of a switchboard, at £3,538.

Sunderland Tramways Committee has accepted the tender of the English Electric Company, Ltd., for six double-deck, covered-in single truck cars.

The following tenders have been accepted by Grimsby Corporation :—Metropolitan-Vickers Electrical Company, converting plant, £12,693; Stothert & Pitt, 30 ton electric travelling crane, £2,185; Smith & Son, well boring, £694; New Switchgear Construction Company, extra high tension switchgear, £4,773.

Stepney (London) Borough Council has accepted the tender of the Sloan Electrical Company for the supply of 10,000 pairs of carbons at £175. The General Electric Company tendered at £196 and Messrs. Wm. White & Company at £257. 10s. The Council has also purchased 200 demand indicators at 15s. each.

Appointments Vacant.

A shift engineer and a jointer are required at the Aldershot electricity works. Applications to the Electrical Engineer, Laburnum-road, Aldershot.

Two assistant lecturers in physics are required at the University of Birmingham. Stipend £300. Further particulars from the Secretary and applications to be in by Dec. 17.

A senior lecturer in mechanical engineering is required at the Manchester College of Technology. Salary £600 per annum. Conditions of appointment and forms of application from the Registrar, to whom applications by Jan. 15.

Three charge engineers are required by the Shanghai Municipal Council Commencing salary 300 taels, rising to 450 taels per month. Applications to the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's gate, Westminster, S.W. 1, by Jan. 1.

A chief lecturer in electrical engineering (salary £300–£10–£450 per annum) and an assistant lecturer in physics (£250–£10–£350) are required at West Ham Municipal Technical Institute. Applications to the Principal, Romford-road, Stratford, E.15, by Dec. 15.

Applications are invited for the position of assistant in the electrical engineering department of the Sunderland Technical College. Commencing salary £250-£370, with annual increments of £15 to £400, and of £10 to £450. Applications to the chief education officer by Dec. 17.

An additional assistant lecturer and demonstrator is required in the civil and mechanical engineering department and also in the electrical engineering and applied physics department of the Northampton Polytechnic Institute. Commencing salary £225-£315, rising to £400 or £450. Particulars and forms of application from the Principal, Dr. R. Mullineux Walmsley.

Business Items.

Victor Gascoigne and Herbert Geo. Hoad, electrical and mechanical engineers, 36, St. Martin's-court, Charing Cross-road, London, W.C., have dissolved partnership. Debts by Mr. Hoad.

The partnership between Hy. G. and Matthew R. Scarth (trading as Taylor & Scarths), electrical and mechanical engineers, Bridge Works, Fountain-street, Morley, Yorks, has been dissolved. Debts by Mr. H. G. Scarth, who continues as H. G. Scarth at the same address.

Mr. F. Peake Sexton, A.R.C.S., A.M.I.E.E., who has during the war been assisting Mr. S. G. Brown in the development of his gyro-compass has resigned his position to resume his consulting practice, and will devote special attention to gyroscopic compasses and their installation. Until a London office is open his address will be 16, Market-place, Kingston-on-Thames.

By direction of the Disposal Board there will be an important sale by auction of machinery, electrical plant (including dynamos and motors) and miscellaneous engineering stores at Watford on the 21st prox. Catalogues and particulars may be obtained from the auctioneers, Messrs. Hunter & Flint, 11, Serle-street, Lincoln's Inn, London, W.C., and Watford.

The Simoon Engineering Company, Ltd., of Bramber-road, West Kensington, W.14, has issued the first part of its new catalogue, which deals with the "Simoon" d.c. motors. The catalogue contains a specification, tables of approximate speeds for 110, 220 and 440 volts, dimensions and other particulars. Copies will be supplied to those interested.

Mr. W. Hope Wilson, M.I.Mech.E., for many years general manager of the H.S. engine and turbine department of Messrs. Jame Howden & Company, Ltd. (and who formerly held a responsible position with Messrs. Willans & Robinson), has commenced business as a consulting engineer at 29, St. Vincent-place, Glasgow. In addition to consulting work generally, he will specialise in steam turbines, engines, boilers and electrical power plant.

Messrs. C. A. Vandervell & Company, Ltd., achieved a remarkable record at the Motor Show and again at the Motor Cycle Show at Olympia. Upon cars fitted with the now almost universal lighting and starting sets the Acton firm was easily first, having their sets upon 128 cars, or 32 per cent. of the number of entire exhibits. At the Motor Cycle Show, 148 machines were fitted with C.A.V. magnetos, practically the same large percentage.

Messrs. R. W. Winfield & Company, Cambridge-street Works, Birmingham, gave an exhibition of electric lighting early this week in one of their showrooms. The room had been arranged as a drawing room, and was lighted by means of a Crompton arc lamp placed in a large opal glass bowl, supported on a pedestal in the middle of the room, the light from which was reflected on the ceiling, and so diffused throughout the room. The remainder of the works were also lighted by means of Crompton arc and Swan incandescent lamps, the current being generated by Burgin machines. Mining lamps, table lamps and brackets and fittings of all kinds manufactured by Messrs. Winfield were also shown.

In list No. 31, which has just been issued by the India Rubber, Gutta Percha & Telegraph Works Company, Ltd., of Silvertown, E. 16, particulars are given of the various types of primary batteries and cells, battery zincs, carbons, chemicals, &c., manufactured by them. The list, which is well illustrated, includes descriptions of the numerous forms of Leclanché, Grove, Bichromate, Bunsen, Daniell, Minotto, dry and inert cells, with details of the E.M.F., internal resistance, weight of cell and size of container, &c. The Company has a very long experience in the manufacture of cells for all purposes, including telegraphy and telephony, signalling and domestic bell work, and great care is exercised in the manufacture and testing of all batteries manufactured by them.

Companies' Reports, &c.

The directors of the Lancashire Dynamo & Motor Company, Ltd., have decided not to make an interim distribution at present.

The directors of Messrs. Ferranti Limited have declared a dividend of 6 per cent. on the preference shares.

The directors of the Pernambuco Tramways & Power Company are making an issue of £200,000 8 per cent. 10-year notes at par.

The Canadian General Electric Company has declared a dividend of 2 per cent. for the quarter ending Dec. 31 on the common stock.

The directors of the Consolidated Signal Company, Ltd., recommend a dividend on the ordinary shares of 2s. per share (less tax) for the past year.

The receipts of the Charlton (Victoria) Electric Light and Power Company, Ltd., for the year ended June 30 were £1,066 (increase £177). A dividend of 6 per cent. has been declared.

The accounts of Electric Welding Company, Ltd., ended Nov. 30, 1918, show a loss, after charging debenture interest, of £1,056, thus increasing the debit balance to £44,456, which includes £17,491 unpaid debenture interest.

The London Electric Wire Company & Smiths, Ltd., is making an issue of 350,000 7½ per cent. cumulative preference shares of £1 each in order to provide capital for enlarging the Anaconda works at Manchester, erecting a new rolling mill in Trafford Park, and equipping additional shops at the Leyton works.

The capital of the Electro-Bleach & By-Products Company, Ltd., was recently increased to £480,000 by the creation of a further 200,000 preference and 200,000 ordinary shares, of which 80,000 preference and 80,000 ordinary shares have been agreed to be purchased by George Clare & Company, and are offered for sale, the preference shares at par and the ordinary at 17s. per share. The proceeds are to be applied to the repayment of a Government loan, for the extension of the works at Middlewich and for the purchase of machinery, &c.

The profit of the Venezuela Telephone & Electrical Appliances Company, Ltd., for the year ended June 30 last was £21,540. After paying £7,340 for interest on debentures and loans, £1,547 for income tax, and £2,258 for excess profits duty, the balance is £10,395. It is proposed to pay the dividend of 8 per cent. on the cumulative preference shares for the year, to provide £700 for first debenture sinking fund, to add £6,000 to reserve for renewals and depreciation, and to carry £3,213 to undivided profits account. The sum of £9,907 has been spent on capital account during the year. The number of subscribers shows an increase of 254, compared with 1917-18.

The report of the India Rubber, Gutta Percha and Telegraph Works Company, Ltd., for the year ended Sept. 30 last states that, after making provision for doubtful debts and excess profits duty, there is a net profit of £71,913, and the disposable balance, after deducting the preference dividend and the interim dividend on the ordinary shares, is £137,868. The directors recommend a final dividend of 15s. per share (tax free) on the ordinary shares, making 10 per cent. for the year, absorbing £37,500, and leaving £100,368 to be carried forward. The various difficulties arising out of the reconstruction period, in connection with labour, supplies, &c., have had the anticipated effect of reducing the output below the War standard, with a corresponding reduction of profit.

The report of the Manaos Tramways and Light Company, Ltd., for the year ended 30th April last states that trade depression and the severe influenza epidemic affected the financial results. The returns since April show an increase of approximately 28 per cent. in net revenue compared with the same period under review. Remittances were received at an average rate of 12·81d., the loss in exchange amounting to £7,952. Gross receipts decreased to £111,276, against £122,495, the decrease being almost entirely in the tramway earnings. Operating expenses were £83,921, against £84,003, the net operating revenue being £27,355, against £38,492. After deducting debenture interest and sinking fund, interest on loan, etc., there remains, £558, which wtih £11,856 brought forward, makes £12,414 to be carried forward.

The report of the Western Telegraph Company, Ltd., for the year ended June 30, 1919, states that the revenue amounted to £1,963,780. 8s. 5d. and the working expenses to £663,390. 9s. 9d. After providing £32,747 for debenture stock interest, and £536,625. 15s. 6d. for income tax and excess profits duty, there remains £731,017. 3s. 2d.; to this is added £33,129. 18s. 11d. brought forward, making a total of £764,147 2s. 1d. The directors have transferred £450,000 to general reserve fund, £30,000 in further reduction of the amount of capital expenditure in excess of the share capital and debenture stock issued, £50,000 to maintenance ships reserve fund, and £30,000 to land and buildings depreciation fund. Three interim dividends of 1½ per cent. each and a final dividend of 1½ per cent., also a bonus of 2 per cent. have been paid, amounting together to £166,344, making a total distribution of 8 per cent., tax free, for the year, leaving £37,803. 2s. 1d. to be carried forward.

The report of the directors of the Eastern Telegraph Company, Ltd., for the year ended Dec. 31, 1918, states that the revenue amounted to £3,365,049. 11s. 4d., from which are deducted £889,232. 15s. 5d. for ordinary expenses, and £664,358. 10s. 11d. for expenditure relating to maintenance of cables, sundry differences in exchange, income and war taxes payable abroad, share of contribution to the pension and superannuation funds towards depreciation of investments, and payments to staff and other expenses in connection with the war, leaving a balance of £1,811,458. 5s. After providing for income tax and excess profits duty payable in England, interest on mortgage debenture stock and dividends on the preference stock, which in all absorb £1,011,303. 0s. 10d., there remains £800,155. 4s. 2d., to which is added £64,369. 15s. 2d. brought forward, making a total available balance of £864,524. 19s. 4d. The directors have placed £500,000 to the general reserve fund. Three interim dividends of 1½ per cent. each, a final dividend of 1½ per cent. and a bonus of 2 per cent. have been paid on the ordinary stock, amounting together to £320,000, making a total distribution of 8 per cent. tax free) for the year 1918. These appropriations absorb £820,000 and leave £44,524. 19s. 4d. to be carried forward.

The revenue of the Eastern Extension, Australasia & China Telegraph Company, Ltd., for the year 1918 amounted to £2,070,118. 18s. 9d., from which are deducted £406,347. 10s. 10d. for ordinary expenses, and £214,009. 6s. 2d. for maintenance of cables, and other special expenditure, leaving a balance of £1,449,762. 1s. 9d. After providing £860,611. 4s. 2d. for income tax and excess profits duty payable in England, and £30,096 for interest on the mortgage debenture stock, there remains £559,054. 17s. 7d., to which is added £72,261. 13s. brought forward, making a total available balance of £631,316. 10s. 7d., out of which the directors have placed £350,000 to general reserve fund. Four dividends of 1½ per cent. each and a bonus of 2 per cent. have been paid, amounting together to £240,000, making a total distribution for the year of 8 per cent., tax free. These appropriations absorb £590,000 and leave a balance of £41,316. 10s. 7d. to be carried forward. The directors record, with deep regret, the death of Mr. Francis A. Bevan, who had been a member of the Board since the formation of the Company in 1873. The vacancy in the directorate occasioned by the death of Sir John Wolfe Barry has been filled by the appointment of Mr. John H. Wilson, C.B.E.

The annual meeting of the Alby United Carbide Factories, Ltd., was held last week when Major C. H. Campbell, who presided, gave particulars of the progress of the company. He said they had made excellent progress at the electrode works at Hebburn-on-Tyne. After termination of the war many of the electric steel furnaces in England were closed down owing to the lack of demand for special steels in the manufacture of which they had been employed during the war. That meant a temporarily decreased demand for our electrodes. They utilised the opportunity to carry out further experimental work in various directions, and the result of that had been very satisfactory in the extreme. The quality of the electrodes had been enormously improved. It was highly gratifying to be able to record progress of that nature in an entirely new branch of industry, and the effect should be of very great importance to their works in Norway, where they consume several thousand of tons of electrodes per annum.

The report and accounts were adopted, and at a subsequent extraordinary meeting it was resolved to approve the proposed amalgamation with the Nitrogen Products and Carbide Company, Ltd., but the matter has had to be postponed in order that negotiations with the Norwegian Government could be concluded. It is proposed to increase the capital of the company to £2,332,916 by the creation of 1,607,916 new ordinary shares of £1 each, which will rank pari passu with the existing ordinary shares. The total capital will then be £2,332,916.—Preference shares in issue, £82,916 ; ordinary shares, £2,250,000.

At the recent extraordinary general meeting of Sir W. G. Armstrong, Whitworth & Company, Ltd., the Chairman (Mr. J. M. Falkner) gave some particulars of recent developments of the company's business. They had turned such portions of their heavy gun and carriage shops at Elswick, as were not to be reserved for national needs, into marine engine works on a very large scale ; and the old shipyard site at Elswick was now partly covered by a large boiler shop. They had also converted the ammunition works at Scotswood into locomotive works. Many orders had been received at adequate prices. Another portion of their works had been converted for the production of brass and aluminium castings of all types and qualities on a commercial scale, of brass sheets, and of bronze and aluminium powders. During the war their drop-stamping department at Elswick was greatly expanded, and they had taken steps to increase further the department in order to meet the growing demand. It had also been thought expedient to expand further the capacity for the production of pneumatic tools. They had been making carriages and equipments for the Government at the Close Works, Gateshead, and had now bought both site and shops from the Government. They were extending the place and turning it into an immense iron foundry for commercial purposes.

In their great works at Manchester many changes were being made. New steel works had been erected there on a very complete scale for the production of high-class steel by the most improved processes. They were satisfied that the manufacture of motor cars on a large scale was a paying proposition, and they had arranged for a fusion of interests with the well-known Siddeley-Deasy Motor Car Company at Coventry.

They had purchased a controlling interest in the electrical works of Messrs. Crompton & Company (Ltd), of Chelmsford. The products of that company had an excellent reputation, and their quality was of the highest. By that connection they should be able to equip with electric motors the machine tools manufactured at their Manchester works, and to obtain on satisfactory terms their other requirements of electrical machinery. In addition they expected to use Messrs. Crompton & Company as a base for preparing large electrification schemes. They had also bought a controlling interest in the business of the constructional engineers, Messrs. A. and J. Main & Company, Ltd.

The resolution to increase the capital to £11,012,500 by the creation of 1,500,000 new ordinary shares of £1 each was passed.

Marconi's Wireless Telegraph Company.

The following circular has been issued by the directors of Marconi's Wireless Telegraph Company, Ltd., Marconi House, Strand, London, W.C.2, to its shareholders :—

On the 13th ultimo, at an extraordinary general meeting of the company, a resolution was passed authorising the increase of the company's capital by £1,500,000. The "Times" report of the proceedings of this meeting was duly forwarded to you. On the 28th ultimo the confirmatory meeting was held, and a copy of the "Times" report of the proceedings of that meeting is enclosed herewith. At these meetings the chairman informed you of the important and extensive developments of the company's business and the necessity for the substantial increase of the company's capital in order to provide for the commitments already entered into and to be ready to carry out the offer, if and when called upon to do so, which the company has made to the Government to construct and organise a thorough and efficient wireless telegraph service between all distant parts of the Empire and the Mother Country.

In these circumstances, and for the reason which has already been given at the extraordinary general meeting on Nov. 13, it was regarded as inexpedient to distribute a cash bonus to the shareholders, but a promise was made that this should be compensated for by the terms of the issue of the new capital. The directors have pleasure in informing you that, in fulfilment of this promise, they have decided to issue the whole of the increased capital to shareholders only at £2 per share premium. This will entitle every shareholder, whether he holds preference or ordinary shares, to secure one new share at the price of £3 for every share he may hold on Dec. 4, 1919, when the register will be closed. Letters of allotment and renunciation will be posted to both classes of shareholders, and due provision will be made for the holders of share warrants upon fulfilment of the necessary formalities. The new shares will rank for dividends declared in respect of the period commencing Jan. 1, 1920 ; but in all other respects will rank pari passu with the existing 1,250,000 ordinary shares of £1 each. The transfer books will be closed from Thursday, Dec. 4, to Tuesday, Dec. 9, inclusive, for the preparation of allotment letters, which will be posted to the shareholders on or about the 8th instant.

It will be remembered that the profit and loss account for the year ending Dec. 31, 1918, showed a net profit of £597,938. 9s., which, together with the amount brought forward, left the sum of £974,698 14s. 8d. to the credit of profit and loss account. After payment of dividends amounting to 25 per cent. for the year on the ordinary shares and 22 per cent. upon the preference shares, and transferring £150,000 to general reserve account (making a total to the credit of general reserve of £1,250,000), a balance of £463,786 14s. 8d. was carried forward to the current year's account. With the considerable additional capital which this issue will provide, and having regard to the immense development of wireless telegraphic and telephonic business throughout the world, the earning powers of the company should be greatly enhanced. The directors are confident that the profits of the current year will justify them in maintaining the rate of dividend, and there is every reason to hope that the increase in the capital of the company should at least produce a proportionate increase of profits in future years.

In a subsequent circular by the company (dated the 8th inst.) it is stated that—

The directors now offer 1,500,000 new ordinary shares of £1 each at the price of £3 per share, pursuant to the memorandum and articles of association of the company, to persons appearing on the register of members on Dec. 4, 1919, and to holders of share warrants to bearer, issued on or prior to that date in proportion to their respective holdings—namely—one new share for each ordinary and/or preference share held by them respectively.

The shares now offered will rank for dividends declared in respect of the period commencing Jan. 1, 1920, but in all other respect will rank *pari passu* with the existing 1,250,000 ordinary shares of £1 each.

Acceptances must be received by the London County, Westminster & Parr's Bank, Ltd., 21, Lombard-street, London, E.C.3, on or before December 19, 1919, together with a payment of 5s. per share (which includes 3s. on account of premium), being the amount of the first instalment.

The balance of £2 15s. per share will be payable as follows : 10s. per share (which includes 6s. on account of premium) on Jan. 30, 1920, 20s. per share (which includes 12s. on account of premium) on March 31, 1920, and 25s. per share (which includes 19s. on account of premium) on May 31, 1920. Failure to pay any of these instalments on its due date will render all previous payments liable to forfeiture.

Payment in full may be made upon acceptance (but not otherwise), in which event interest at 5 per cent. per annum will accrue from that date on the amount prepaid. Interest at the same rate will be chargeable on overdue instalments.

Share certificates will be ready on Jan. 15, 1920, and will be issued on or after that date at the company's office, Marconi House, Strand, London, W.C.2, in exchange for the banker's receipt for the first instalment.

Shareholders may transfer the whole or a part of their rights to the new shares.

Application will be made for the special permission of the London Stock Exchange for dealing in these shares.

If the conditions as to acceptance and payment are not duly observed, the right to participate in the above-mentioned issue will be absolutely forfeited, and the directors will deal with the shares for the benefit of the company at their discretion.

New Companies.

COX ENGINEERING COMPANY (BIRMINGHAM), LTD. (160.380)—Private company. Reg. Nov. 7. capital £5.000 in £1 shares, to carry on the business of general, motor and electrical engineers, &c. First directors are T. J. Priestman, P. Wright and E. Cox. Sec.: P. Wright. Reg. office: 27, Newtown-row, Birmingham.

EWART & COLLIS, LTD. (160.605)—Reg. Nov. 14, capital £425,000 in 200,000 8 per cent. cumulative preference shares and 225,000 ordinary shares of £1 each. Objects: To acquire all or part of the business, assets and liabilities of Ewart & Son and J. Collis & Sons, or either of them, and to carry on the business of geyser manufacturers, ventilating and hot water engineers, electrical and general engineers, &c. First directors are Sir Hy. O. Bax-Ironside, K.C.M.G., Sir Robert W. Carlyle, K.C.S.I., C.I.E., A. Collis, S. Ewart, G. H. Ewart, J. W. Ewart, A. Sainsbury, A. Wardell and W. Harrison. Reg. office: 350, Euston-road, N.W

GEORGE McGHEE & COMPANY, LTD. (10.747)—Private company. Reg. in Edinburgh Nov. 13, capital £2,000 in £1 shares. Objects: To take over the business carried on as George McGhee & Company at Glasgow as mechanical and electrical engineers, gas engine makers, &c. Agreement with G. McGhee. First directors are G. McGhee, J. Soye and R. Soye. Reg. office: 30, Easterhill-street, Glasgow.

HYDE & THOMSON, LTD. (160,322)—Private company. Reg. Nov. 5, capital £2,000 in £1 shares. Objects: To carry on the business of electrical engineers, manufacturers of and dealers in machinery for use in connection with the generation, distribution, supply and employment of electricity, indiarubber manufacturers, &c. First directors are A. W. Hyde (Queen's Dock Chambers, Hull) and N. K. Thomson (both permanent).

JACKSON BROS. (SHEFFIELD, LTD. (160.424)—Private company. Reg. Nov. 8, capital £5.000 in £1 shares. Objects: to carry on the business of toolmakers, jig and gauge makers, electricians, &c. First directors are J. C., A. H. and W. L. Jackson.

MIDLAND ARC ELECTRIC WELDING COMPANY, LTD. (160.429)—Private company. Reg. Nov. 8. capital £10,000 in £1 shares. Objects: To take over the business of electric welders and boiler repairers carried on by L. Falconer and P. H. Rich at Mansfield, Notts, as the Midland Arc Welding Company. First directors are H. H. Bradford, J. Falconer, P. H. Rich and R. W. Smith. Sec.: W. G. Milton. Reg. office: Bishops Chambers, West Gate, Mansfield, Notts.

MIDLAND FARM SERVICE COMPANY, LTD. (160,561)—Private company. Reg. Nov. 13. capital £30.225 in 30,000 ordinary shares of £1 each and 4,500 deferred shares of 1s. each, to acquire a sole licence under the Wolfryn patents for the electrification of seeds in the counties of Leicester, Warwick and Worcester and elsewhere, &c. Directors: H. Sturmey (managing director) and J. Hewitt. Reg. office: 2, Radford-villas, Coventry.

SCIENTIFIC & PROJECTIONS, LTD. (160,273)—Private company. Reg. Nov. 3, capital £10,000 in £1 shares. Objects: To carry on the business of manufacturers of and dealers in cinematograph, photographic, scientific, philosophical, electrical and optical instruments, &c., and to enter into an agreement with F. W. Larkins and T. R. Bailey. First directors are C. Fairweather (chairman), A. S. March and F. W. Larkins. Reg. office: 5, Crawford-passage, Farringdon-road, E.C.

Prices of Metals, Chemicals, &c.

Tuesday, Dec. 9.

		Price.	Inc	Dec.
Copper—				
Best selected.........	per ton	£111 0 0	£6 0 0	—
Electrolytic bars ...	,,	£111 0 0	£4 0 0	—
H.C. wire basis......	per lb.	1s. 2⅞d.	7/16d.	—
Sheet	,,	1s. 3¾d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 6⅞d.	7/16d.	—
Brass 60/40—				
Rod, basis	,,	0s. 11½d.	½d.	—
Sheet, basis	,,	1s. 2⅜d.	—	—
Wire, basis	,,	1s. 2¼d.	—	—
Iron—				
Cleveland Warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis	,,	£34 10 0	£2 0 0	—
Lead Pig—				
English	,,	41 10 0	£2 10 0	—
Foreign or colonial	,,	40 10 0	£2 10 0	—
Tin—Ingot	,,	304 10 0	£9 5 0	—
Wire, basis	per lb.	0 3 9	1½d.	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £22 10s.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40.

Boric Acid (Crystals)—Per ton. £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d

Sodium Chlorate—Per lb. 6d.

Shellac.—610s.-615s.

Rubber.—Para fine, 2s. 6d.; plantation 1st. latex 2s. 5¾d. lb.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W. T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From The Electrician, Dec. 9, 1882.]

A Cheap Battery.—It is stated that Dr. Brard has devised a cheap battery by turning to account the action of nitrates in igneous fusion on incandescent charcoal.

Students of Electricity in Glasgow.—The number of members of the Glasgow College of Science and Arts Classes is—in electricity 103, and in electrical engineering 76.

New Company.—The Incandescent Electric Lighting Company has been formed with a capital of £250.000 in £1 shares. Mr. R. E. B. Crompton is one of the first subscribers.

Electric Lighting of a Town Hall.—The new Town Hall, West Brighton, which is to be opened on the 13th inst., will be lighted by Swan lamps. The work is being carried out by Mr. Magnus Volk, of Brighton.

Electricity and the Evaporation of Fluids.—Prof. Freeman, of the John Hopkins University of Baltimore, concludes from a long series of experiments that electricity is not demonstrably disengaged by the evaporation of fluids.

Life of the Edison Lamp.—It has been stated recently that, out of 130 Edison lamps used to light a factory in the United Kingdom for some time past, only nine have broken since they were first put in, and that the remainder have been burning over 2.400 hours.

The Telephone in Germany.—It appears that the telephone exchanges in 18 German cities comprise no less than 3,788 different stations. The total length of telegraph lines utilised by the telephonic service is 540 miles, giving a length of single wire equal to 4,017 miles.

The Bradford Technical Exhibition, 1882.—This exhibition, which was brought to a close last week, has been lighted since its commencement by the Yorkshire Brush Electric Light & Power Company, of Leeds, who have been awarded a gold medal for their exhibit of electrical apparatus at the above place.

Electric Light at Jarrow.—Messrs. Palmer & Company, shipbuilders, of Jarrow, who have been lighting their works for some time past with Brush lamps, have now requested the Hammond Electric Light Company to put in a 40-light machine and more lamps. Previously they were employing a 16-light machine only.

Electric Lighting in Leeds.—We learn that the Yorkshire Brush Electric Light & Power Company, of 1, East-parade, Leeds, have secured a contract for the lighting up of the market place and principal streets of Dewsbury, Yorkshire, during the forthcoming Christmas holidays, and this Company is now putting down machines and erecting wire and lamps for running about 16 2,000 candle-power Brush arc lights.

Electric Lighting in Sheffield.—The large premises of Mr. Davy, provision merchant, Fargate, Sheffield, have been lighted by 120 Swan incandescent lamps, which are fed by one of Siemens's W_2 alternate-current machines. The local press, in commenting upon the installation, state that "Messrs. Tasker Sons & Company, by whom the whole of the arrangements have been carried out, are to be congratulated upon a success which has no parallel in this neighbourhood."

Illness of the Postmaster-General.—At the request of Mrs. Fawcett, the Secretary of the Post Office has issued a notice conveying her grateful thanks for the expressions of sympathy which she has received from the postal and telegraph staff in different parts of the United Kingdom. It is impossible for her at present to individually acknowledge their kindness, but she is confident that they will not doubt that she heartily appreciates it. At the time of our going to press Mr. Fawcett's condition, though still precarious, was more satisfactory.

Strand District Board of Works.—An influential body of members of this board visited the works of Messrs. Verity & Sons, on Wednesday night, for the purpose of inspecting the Edison electric lighting installation on the premises of the above-named firm, in King-street, Covent-garden. The display was a most brilliant and artistic one, Mr. Edison's incandescent lamp being shown to the utmost advantage in every conceivable situation and pattern. The electrolier manufactured by Messrs. Verity, and exhibited at the Crystal Palace, which we illustrated at the time in these pages, was far excelled in beauty of design and richness of material by some that were shown on this occasion. For every purpose of indoor lighting, whether appended to simple brackets or worked into the design of costly electroliers, the lamps were effective and agreeable. The deputation seemed highly satisfied with the installation.

Thunderstorms at Great Heights.—Being desirous of examining the air at great heights in order to ascertain the proportion of ammonia present, as well as some facts as to atmospheric nitrification, Messrs. Muntz & Aubin recently examined the record of thunderstorms kept at the Pic du Midi Observatory, some 9.590 ft. above the level of the sea. Of the 184 thunderstorms, observed from 1873 to 1882, they found that only 23 had been produced at a height above 7,700 ft. (where the original station of Plantade is situated). In the latter the summit of the Pic was surrounded by clouds, whence the discharges came. It may be said in general that in the Pyrenean region the violent electric phenomena of thunderstorms never exceed a height of 10,000 ft. (3,000 metres) and that, consequently, the formation of nitrates under the influence of electricity is below this limit. Atmospheric nitrification seems to be chiefly produced in the zone between the sea-level and the mean height of clouds. This absence of fine powders of nitrates, the authors also remark, certainly contributes to the remarkable transparence of the air in high regions, and shows that the plants on high mountains and the soil they have formed can only obtain their nitrogenised matter from the ammonia of the air.

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NOTICE.

THE ELECTRICIAN next week will be published on WEDNESDAY instead of on Friday on account of the Christmas Holidays.

Notes.

Science and Industry.

In order that full advantage may be taken of the scientific knowledge at our disposal and lying latent, the organisation of research is a paramount necessity. One of the results of this need has been the formation of the Department of Scientific and Industrial Research, and at a conference of the representatives of the research organisations connected with this Department which was held last week under the presidency of Mr. A. J. Balfour, it was possible to see what progress is being made. At the present time the Department is carrying out its operations in three directions. It is stimulating the production of workers by making grants to men who show ability to do useful research. It has inaugurated a scheme by which industries are to be encouraged to use first-rate men of science for the solution of their special problems and it is organising enquiries into scientific and industrial problems of national importance by means of research councils. This is all to the good. But in dealing with this question of organised research those who are responsible have a difficult course to pursue. On the one hand they must avoid the error of making the research depend too closely on the needs of any particular trade, and at the same time they must not allow the demands of pure science to draw away researchers from the more material character of the work. They must neither allow the cart to draw the horse nor the horse to run away with the cart. At the present time it would seem that of these two errors the former is the most likely to be committed, and that there is a tendency in this research work to neglect the claims of pure science. When the Department was first formed the President of the Royal Society pointed out that the science which is the typical result of university training, rather than that other science which is deliberately tuned to industrial needs, has special claims to consideration, while Mr. Balfour, in his presidential address, thought right to lay stress on the same point. Now, it is interesting to consider why the authorities we have quoted are so concerned with this point of view, especially having in mind that the progress of English industry has not generally been along this path, although there are outstanding examples to the contrary. On the other hand, in Germany, where pure science and industry have been always closely allied, the progress made in the commercial world was for many years at a greater rate than that of our own country, simply owing, as many consider, to the encouragement given to scientists and to the wealth expended on research. *Fas est et ab hoste doceri*, says the old tag. Pure science, Mr. Balfour remarked, is the main engine of human advance, and this dictum will no doubt be taken to heart by the Department of Scientific and Industrial Research. At the same time the other pitfall of making the science too pure must be avoided, though in this case there is always a counteracting commercial tendency at work. We wish the Department of Scientific and Industrial Research all success and hope that in due course they will turn their attention to engineering and electrical problems.

The Electricity (Supply) Bill.

The amendments introduced by the Lord Chancellor in the Electricity (Supply) Bill in the House of Lords on Tuesday are but another example of the workings of the kaleidoscopic Government under which we live. The effect of these amendments is to dispense for the present with the District Boards, round which much controversy has ranged. Incidentally this, of course, removes the powers by which the generating stations of electricity supply undertakings can be compulsorily acquired. The finance of the Bill is materially altered, since the £25,000,000 with which the Commissioners could finance the District Boards is necessarily deleted. The political aspect of this is that the stations, as regards ownership, will remain as at present, and the quasi-nationalisation which the ownership by District Boards would have entailed is completely done away with. The transitory powers, however, which include the grant of £20,000,000 for the development of schemes in the interim period are retained. This alteration should meet the views of most sections of the industry, and is a great score for those who have worked so indefatigably for the private interests all through the long and tortuous career of the Bill. It would be invidious perhaps to attempt to apportion the credit for this change, but we may perhaps mention the name of the Provincial Electric Supply Committee and its chairman, Mr. H. B. Renwick, in this connection, as the only memorandum of views actually sent to the House of Lords emanated from them. At the moment the whole affair has been so rushed, and the effect of the proposed amendments is so uncertain, we prefer to postpone further comment until next week.

Submarine Cable Progress.

A few years ago there were those who were prophesying that with the development of wireless telegraphy the submarine cable would become derelict in the depths of the sea. The annual report of the Eastern Telegraph Company does not, however, lend any confirmation to this idea, as, in spite of the disabilities placed upon submarine cable development by the war, progress has been very satisfactory, not only during the war itself, but since the signing of the armistice. In the year under review the gross revenue was £1,902,205 above the pre-war figure, and £463,470 in excess of that obtained in 1917. Owing to the large amounts which have to be paid out in excess profits duty and income tax, the amount available for reserve and dividend on the ordinary stock is £20,000 less than in 1917, and when £500,000 has been placed to the general reserve fund the amount carried forward to the 1919 account is £20,000 less than in the previous year, the same dividend being paid as before. With this increase in business, however, there has been an increase in the cost of cables and material generally, and the amount expended under this head has increased from £107,021—which was the average in the five years prior to the war—to £257,786.

The Service to be Improved.

In spite of this satisfactory state of things, however, the delays are very great, and we are glad to see that the company recognise that the commercial service still falls short of what it should be, and that they are doing their best to improve matters in this respect. The present unsatisfactory state of things may be said to be due to four causes. The Eastern and Associated Companies recently had to take over the traffic which was formerly dealt with by other companies whose routes passed through Germany and Russia. Owing to the unprecedented increase in traffic due to this and other causes, the previous margin of safety in the network has been reduced to practically nothing, while, owing to the war conditions, no arrangements could be made to manufacture or lay additional cables to meet this emergency. Maintenance also was rendered extremely difficult, in spite of the fact that extra ships were placed at the company's disposal. The last factor was shortage of staff. Added to all these troubles, Government telegrams increased enormously in volume, while a large number of words were sent free in connection with Red Cross and other benevolent institutions. The total number of words sent in 1917 was about 64,000,000. This increased in 1918 to over 180,000,000. It was hoped that the volume of traffic would comparatively diminish with the abolition of censorship, but the reverse has taken place. However, the company is making every effort to get back to normal conditions as soon as possible, and another fast speed cable is shortly to be laid between Porthcurnow and Gibraltar, while extensions between Gibraltar and the Far East, leading to an expenditure of about 7,000 miles of cable, are also contemplated. We hope that these efforts will be crowned with success, and that progress in the future will be equal to that in the past.

The Patent Office Library.

A short time ago we remarked that the hours during which the Patent Office Library is available to the public had been slightly extended since the termination of the war. But these restrictions have not yet been completely removed, and it is very desirable, in our opinion, that the library should now be kept open to the peace-time hour of 10 p.m. We have always held that the curtailment of access to this library, in many respects of unique value to engineers and technical students, was a short-sighted economy. When the expense of collecting and housing a good collection of works and journals has once been incurred, it is obviously a most retrograde step to limit their usefulness to the public, as has been done in this particular instance. In the case of many busy professional men, who are necessarily occupied during the day, the evening is the only time available when they can use the Patent Office library. At a time when so much is being said on the need for encouraging research, invention and scientific study, it is surely an anomaly that this simple step to provide better facilities for study should be deferred. We are glad to note that a movement is on foot to present a petition to the Board of Trade asking for pre-war conditions to be restored. We understand that the request has the backing of leading scientific and technical bodies, and that copies of the petition can be obtained from Mr. Charles Salter, 33, Park Hall-road, East Finchley, N. 2, who is organising this movement. We recommend all our readers to sign the petition and hope it will be successful.

Electricity and the Housing Problem.

The Government method of dealing with the housing problem is not the best that could have been devised if we are to judge by results. For months past attempts have been made by means of legislation, subsidies and propaganda to bring about the erection of the houses which are sorely needed in all parts of the country, not only for the accommodation of the working classes, but of the population generally. These efforts have not so far resulted in much that is tangible, though in one or two parts of the country a start has been made. Architects have been hard at work; what has the electrical engineer been doing? For the modern houses one of the most important questions is that the adequate supply of artificial lighting, and hand in hand with that goes the provision of proper means for cooking and heating. Now though many will argue about the cheeriness and comfort of the open fire, it will not be denied that it is perhaps about the least efficient method of heating a dwelling and about the best way of wasting our fuel resources. It is high time something was put in its place, and the opportunity presented therefore to electricity supply engineers by the erection of these houses is one which should be too good to be lost. Every effort should be made to ensure that these new houses are not only wired for electric light, but that suitable provision is made for the employment of electric heating and cooking apparatus. This has already been done on a large scale at the Swanpool Garden Suburb, near Lincoln, and it is an example which should be followed in other parts of the country where housing schemes are being considered. The task is not hard. It will need very little propaganda work to convince people of all classes that in these modern days electric lighting is the only possible source of illuminant, and if hand in hand with this go a tariff and conditions of service which allow employment of electric cooking and heating apparatus, the development of electricity along these lines should be most satisfactory to all concerned. Now is not the time to stand on the rigid letter of the law relating to electricity supply, and all concessions possible should be made in order to obtain this most desirable load. For it is in the domestic field that at the moment the greatest development of electricity supply is possible.

The Cobbler and the Last.

Amongst the pieces of advice which have recently been addressed to engineering institutions on the subject of how to make their meetings more attractive to the majority of their members was one in which the critic expatiated adversely on the growing tendency of presidents to go outside the boundaries of pure engineering for the subject of their address. It is an old, old complaint for which at first sight there seems no remedy. Here is a man, says the critic, who has risen high in his profession by reason of his professional attainments, let him, therefore, tell us how he did it so that we, if we can, may go and do likewise. It is something on that subject we want to hear from him, not his views on education or on the value of literary pursuits to the engineer. So runs the argument. But is it incontrovertible? There certainly is another side to the question. A man who is considered worthy of election to the presidential chair of an engineering institution has not reached that eminence only because of his professional qualifications, but because he possesses in addition other qualities which impress themselves on those he meets. Chief among these must be a certain breadth of view, and such breadth of view cannot accompany a narrowness of vision. Thus it happens that our hypothetical president is forced by the very number of his interests to go outside the usual bounds set by the objects of the institution of which he is temporarily the head, and to range over wider fields in which he, though possibly not all his hearers, can find something that is worth attention. A presidential address, in our opinion, forms an excellent opportunity for considering a material subject from a human point of view. As far as electrical engineering is concerned this is a distinct advantage. There is no reason, moreover, why the address should be non-controversial. By custom it cannot be formally discussed at the meeting, but it may be widely discussed afterwards, and this often is the best type of discussion. It therefore seems to us that it does not so much matter whether the president addresses his audience on a professional or on a non-professional subject so long as the address is interesting and stimulating. That is the crux of the question. Nothing else matters.

Steel Structures.—"Steel Structures" for October contains some interesting photographs of steel work in the devastated areas in France, which illustrate the advantages of steel fragments in building operations. Among other examples we note articles descriptive of the Tay Bridge and the Ferro-Carril Central Argentino-Retiro Station Buildings at Buenos Ayres.

Institution of Electrical Engineers, North-Western Section.—The 14th annual dinner of this centre will be held on Friday, February 6, 1920, at the Grand Hotel, Manchester. This being the first annual dinner to be held for six years the Committee hope there will be a good attendance. Tickets, at 10s. 6d. each, may be obtained from Mr. A. G. Ellis, of Thorncliffe, Lisson Grove, Hale, Cheshire, and all cheques or postal orders should be made payable to Mr. A. L. Green.

"Present Position of the Theory of Ionisation."—We have received from the Faraday Society an account of the general discussion on this subject which was held at the meeting of the Society on January 21, 1919. This is now bound up in book form. It contains the introductory address by Dr. George Senter and the rest of the Papers read on that occasion, together with the discussion thereon. It forms a useful account of the present knowledge on this important subject.

Birmingham and District Electric Club.—The fifteenth annual meeting of this Club was held at the Grand Hotel on Saturday evening. The secretary (Mr. N. Deykin) reported that the past year, under the presidency of Mr. W. H. Vernon, had been the most successful the Club had known, the membership being now well over 100. Mr. H. W. Wolton was elected president for the ensuing year and, for the sixth successive year, Mr. Norman Deykin was elected honorary secretary. Mr. R. A. Chattock headed the poll in the election for the committee.

Electrocution of a Radiologist. Considerable uneasiness has been caused by a report from Paris of the death by electrocution of a doctor while using the X-ray apparatus. We understand that the victim was Dr. Jaugeas, and that the equipment consisted of a small high-tension transformer working from an alternating-current circuit without a rotating rectifier, and with a radiator type of Coolidge tube. The high-tension wires from the transformer to the tube were hanging in the form of a loop. The tube stand was not earthed, and during the course of experiments it came into accidental contact with the hanging wire, Dr. Jaugeas, whose hand was on the wheel of the tube stand, thereby receiving a fatal shock. This accident points to the need of proper precautions being taken in the installation of X-ray apparatus, especially with regard to the proper protection of the high-tension wire and the earthing of the apparatus.

Distinctive Marking of Electrical Apparatus.—Mr. F. Beckoff, in the "Electrical World," emphasises the desirability of adopting distinctive marking of all electrical apparatus in factories, so that the nature of transformers, isolated oil and disconnecting switches, starting apparatus, &c., may be clearly indicated. This is more necessary in industrial work than in the case of central stations where workers are familiar with electrical apparatus. Besides being helpful from the safety standpoint this practice facilitates repairs and eliminates errors. The nature of the lettering is specified in some detail The positive and negative terminals or cables for direct current and the numbers of phases for alternating current should be shown, and where different voltages are in operation this should be clearly indicated. Special distinctive marking should be employed for high-tension conductors, steel cross arms on transmission poles, &c.

Obituary.

We regret to record the death of Sir John Jackson, the well-known civil engineer and contractor, who was responsible for the construction of several railways and other public works, including the last section of the Manchester Ship Canal, the foundations of the Tower Bridge, the great Dover Harbour works and the Admiralty docks at Keyham, Devonport.

We also regret to record the death, which took place on Friday last, of Mr. W. G. Conner, eldest son of Mr. J. Conner, O.B.E., manager of Messrs. Dick, Kerr & Co.'s works, Preston. Deceased was 33 years of age. At the outbreak of war he was in Spain on work connected with Spanish ores, but the directors realising the necessity of getting tools and machines for making munitions, sent him to America, where he was very successful. After the armistice he was sent on a business tour through America and Japan, and on his return was appointed to a responsible position at the works.

Personal.

The Home Secretary has appointed Mr. William Walker to be Chief Inpector of Mines, in place of Sir Richard Redmayne, now chairman of the Imperial Mineral Resources Bureau.

On Friday last the administrative staff of the traffic side of the Cardiff tramways department, presented the late manager, Mr. Arthur Ellis, with a silver inkstand and tray. In acknowledging the gift, Mr. Ellis said, although he was leaving the service of the Corporation he should still remain in Cardiff.

Mr. Hector Tabossi, M.Amer.I.E.E., A.M.I.E.E., commercial engineer with the British Thomson-Houston Company, Rugby, is leaving on the 16th prox. per ss. "Andes" for a six months' trip to the Argentine Republic. Mr. Tabossi, who is an Argentine citizen, received his technical training in the U.S.A., and is an M.Sc. of Harvard University. Previous to joining the staff of the B. T.-H. Company, four years ago, he was with Messrs. J. G. White & Company as an assistant engineer. This is Mr. Tabossi's first trip to his home country for a period of 15 years.

Arrangements for the Week.

FRIDAY, Dec. 19th (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At Storey's Gate, St. James's Park, London, S.W. Paper on "Cutting Power of Lathe Turning Tools," by Mr. G. W. Burley.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

6.15 p.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper to be read, "The Application of Geared Turbines to Merchant Ships," by Mr. R. J. Walker.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At the Royal United Service Institution, Whitehall, London, S.W. Presidential Address, "The Influence of the War on Engineering'" by Sir E. H. Tennyson D'Eyncourt, K.C.B.

SOCIETY OF TECHNICAL ENGINEERS.

7.30 p.m. At the Memorial Hall, Albert-square, Manchester. Address on "The Value and Purposes of Organisation," by Mr. E. Murray Wrong.

TUESDAY, Dec. 23rd.

INSTITUTION OF MECHANICAL ENGINEERS.

7 p.m. At the Engineers' Club, Manchester. Paper on "Cutting Power of Lathe Turning Tools," by Mr. G. W. Burley.

Scientific Management: A Solution of the Capital and Labour Problem.[*]

By Capt. J. M. SCOTT MAXWELL, B.Sc.

The first attack of science against rule-of-thumb methods in industry was directed to the problem of finding the true solution of the various factors governing machine-shop practice. The late Dr. F. W. Taylor, of Philadelphia, started his epoch-making experiments in the autumn of 1880, and carried them on over a period of 26 years. While carrying out this work, many ideas were evolved connected with management. The great new fact was elementary-rate-fixing. General recognition of the term "Scientific Management" is not yet 10 years old. Public interest in the subject of efficient management was first aroused by the action of the eastern railroads in the United States, which raised their rates because of increased costs, mainly due to higher wages. A public investigation was ordered which lasted about six months, Mr. Louis D. Brandeis acted as chief counsel in the interest of the traders, and fought the railroads on the plea that if all the railroads adopted a system of management, which he termed "scientific management," a saving of one million dollars a day could be effected. Late in 1910 a conference of American engineers interested in efficient management decided to adopt the designation Scientific Management, after discarding such terms as the Taylor System, Functional Management, Shop Management, Efficiency.

Before the war the term was seldom heard in this country, and there is a still failure to grasp the great significance of the principle of scientific management. The real cause of the strong opposition is that scientific management is the first system to realise that the human factor must come first. This is a revolutionary idea to the capitalist, who still considers that he comes first. Scientific management is revolutionary to the trade unions because it enables work to be accurately measured for the first time in the history of industry. To many socialists and social reformers it is also revolutionary because they think that it is better for the character of the worker that be should use his own initiative as to how the work should be done, even though he has only rule-of-thumb to guide him. The pioneers of the movement, who are all engineers, regard the new mental attitude which makes it obligatory as the very essence of the system. All the devices used in office and shop as means of efficient production they consider in the same light as mechanisms—*i.e.*, of secondary and not primary importance.

The traders' ideal has always been to buy in the cheapest market and sell in the dearest. They risked much capital in the past and employed little labour, while their profits bore no relation to costs, but were regulated entirely by supply and demand, excluding, of course, any misadventure. Engineering advance has changed everything, and now the big men are producers, but the prestige of the merchant is still maintained, and also the prestige of those associated with him, such as the bankers, while the engineering profession, the creator of our modern wealth, does not yet enjoy the prestige that is its due.. Merchants prefer a high profit on a small turnover. Production requires low profits on a large turnover. The merchant system restricted the supply and thus lessened the consumption in order to maintain or increase prices. The production system cheapens the supply in order to maintain or increase the demand, and thus maintain or increase consumption. The merchant system favoured the wealthy, and developed aristocracies. The production system favours the proletariat, and thus develops democracy. The merchant system at the best did not raise the status of the workers. The production system must continually raise their status by continually raising the standard of living. The confusion of these ideals is very great at the present time amongst all classes of the people, and until they are disentangled, and the one set encouraged and the other controlled, we are bound to have continual industrial trouble. It is necessary that our economic conceptions should synchronise with the facts. At present they are entirely out of step.

In applying the principle of cheap production, it must not be confused with the act of buying commodities. Labour must cease to be regarded as a commodity, which is one of the worst legacies of the old system. Labour in the abstract may be a commodity, but in the concrete it is human life. Increased output and payment by result is the sound foundation on which to build, but it ought to include everyone, from the managing director down, and both these aims should be qualified by another—a better life for the worker. Scientific management increases output, and because it can accurately measure the work done in terms of human effort, payment-by-result is the fair and natural sequel. It achieves this greater output by lessening the task and raising the status of the worker. Scientific management affects the individual as a unit worker, the workers as a group, and therefore trade unionism, and it affects all industry in its relation to the Government and to the consumers, and thus involves the whole nation. I do not see how scientific management can progress at all unless the unions are included in its scheme. Progress will only commence in earnest when the labour leaders grasp the full meaning to the worker of the elimination of useless work, which will lessen the total burden of labour; and when they realise that the accurate measuring of work protects the worker from underpayment, and that the greater all round efficiency makes shorter hours and higher wages a just claim on the community.

The author then deals at some length with the well-known principles of motion and time study, which are due to Taylor, discussing the three factors of analysis, execution and environment in their relation to the worker. This study gives the minimum time necessary for the job under the best possible conditions, and the time must be so set that there is no overstrain or loss of interest such as were the disastrous results of excessive overtime during the early part of the war The industry should bear the expense of continual industrial research both in methods of work and fatigue, so that international standards of production can be found. Scientific management is an incentive to steady and efficient work, and removes many of the drawbacks of the present premium and piece-work systems. It makes a study of the man, and selects the best man for the job, which is a reason why trades unions are against it, though it would seem an unsound policy to penalise the best men. It ceases to deal with labour as a commodity, and employers should therefore pay the same amount for the same service done irrespective of the situation of their works. It teaches the man how to do his job. This gives it the same tendency as the introduction of improved machinery. But the shop and office organisation must be specialised on the same functional basis as that of the manual worker.

No firm should attempt the introduction of scientific management, even with the approval of the men and the unions, unless the office and shop organisations have first of all been put into shape. Without this organisation to assist the worker at all points, nothing but disaster will result from the attempt to increase output by means of scientific management in the machine shop and factory.

The present individualist system is more strongly attacked now than it has ever been, and the Government has been the means of greatly discrediting it. The cry of the State Socialists is that the present system is inefficient and a failure. Labour knows very little about the difficulties of production organisation, and nothing about sales and finance, and consequently it assumes there is little or nothing to know. It sees the result of the inefficiency of organisation every day in the daily work, and the agitators do the rest. Remove inefficiency, raise wages, shorten hours, improve conditions, create incentive, and individualism will beat any form of socialism. To quote Dr. Taylor: "Among the risks of a manufacturing business, by far the greatest is bad management. This risk arises not so much from the evident mismanagement, which plainly discloses itself through occasional strikes and similar troubles, as from the daily more insidious and fatal failure on the part of the superintendents to secure anything even approaching the maximum work from their men and machines." This "daily more insidious and fatal failure" is pre-eminent in most Government undertakings. Is it our respect for material things that makes us us accept the great economies in its use that science has made possible? Is it our ignorance and pseudo-respect for man that causes us to refuse the application of science to the economy of human effort, and thus condemns man to perform work of which from 50 to 75 per cent. has been proved to be useless whenever science has been applied? Material things have still a stranglehold on humanity, and to those who live for materialistic aims the economy of labour only appeals from that vicious point of view. That may satisfactorily explain the prejudices of socialist and social reformer to scientific management, but it says very little for the long-distance mental vision of the intellectuals that they think it possible to build up their industrial Utopias while retaining rule-of-thumb methods in the workshop. Guild Socialism seeks to raise the status of the working man by the methods of the politician. The word "committee" has become almost a magic one in these days. Whenever there is a difficult problem to solve the Government appoints a committee to investigate it. What a travesty of the truth it is to think of the late Coal Commission, for example, as a scientific investigation. It was one of the most glaring examples of how investigation should not be carried out It was the negation of the scientific ideal. We are ruled by opinion, and scientific fact is held to be of secondary value. The unscientific opinions of the majority are not the truth. Democracy is a theory of politics founded on payment by results. If the electorate are slack or foolish, they suffer; if wise, they are rewarded. Our politics are very rule-of-thumb, and until the people have knowledge, in place of opinions and prejudices, the demagogue will always score over all who try to lead and not fool the people.

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[*] Abstract of a Paper read before the Institution of Electrical Engineers.

Scientific management is condemned by the Guild Socialists as an industrial bureaucracy which destroys the freedom and responsibility of the workers. How can the endless discussions of innumerable committees gain greater freedom for the workers when the performance of utterly useless work in the shop is considered to be an essential of such freedom? How does the execution of work in the most efficient manner lessen the responsibility of the worker? Unless democracy is able to evolve an expert bureaucracy which it will be able to control as its servant, and not suffer it to become its master as at present, then the payment of democracy will be suffering and that ultimately means revolution. Industry is a simpler field than politics, and it is therefore easier to arrange the necessary safeguards which have been described above and which will ensure that those who carry out scientific management are the servants of an intelligent democracy of labour. Individualism, directed by the scientific knowledge of experts, and recognised as such by the educated intelligence of the workers, will carry civilisation more quickly to a higher plane than socialism based on discursive and rule-of-thumb methods of production. Further advance will be by knowledge gained in the laboratory, and the application of the scientific method throughout the whole realm of human effort.

In 1819, a century ago, and four years after Waterloo, this country reached its lowest point of misery. In spite of that, and due to the invention of machinery, we became the greatest producing country in the world. We shall probably reach our lowest point in less than four years from the armistice, but it is not likely that the invention of machinery will save us this time. Our prosperity a century ago was due to the fact that other countries did not have machinery. Now it is common to the civilised world, and our prosperity will depend on our ability so to organise human effort that we shall be able to produce more with less labour. Material wealth must no longer increase the power and comforts of the few; its justification must be the amelioration of the lives of the many. We fail to distinguish between wealth and our attitude towards it. We cannot have too much wealth if we will only consider it of secondary importance. It is because there is too little wealth and not too much that so many abuses have arisen. The orthodox view of life is that character is developed by means of work, and there is no qualification that it must be efficient work. We must surely agree that some work, even if efficient, cannot by its very nature develop the intelligence and the character to the same extent as other work. Granted this, we must agree that a great amount of manual labour and clerical work is in this category, and once we have the honesty to face this fact, we see that the ideal of raising the workers' outlook by means of his work is very often not possible. The way to raise the social status of these workers is to reduce their working hours and pay them more, and thus give both the opportunity and the means to become better educated and live better lives. The philosophy or religion of work—that work in itself is good for one—belongs to the upper and owning and owning class, and why should we be surprised that the working class does not believe in it? Our present system, being very inefficient, can give leisure and opportunity for culture only to the few. If democracy is to win against anarchy, it must win leisure and opportunity for the many.

Labour leaders emphasise the waste of human life through industrial accidents and bad conditions, but they fail to realise that the waste of human life because of inefficient work is far greater in its total result. They not only fail to see this waste of life, but by their teachings and action do everything to maintain it, actually arguing that the elimination of this waste would be bad for the worker. It is because we are now struggling for something better, that production must be made so much more efficient, so much easier for the workers. It should be possible to produce material wealth so easily that it will cease to have its present inflated value, and the amount of wealth owned will cease to be the measure of the man.

History is not necessarily progressive in its sequence. One system is not displaced by another because the new system is better, but because the old is bad. There is no guarantee that once a system has been destroyed that it will be replaced by something better. The socialists say that because the present system means profits to private individuals the workers will not and should not become more efficient, and they claim similarly that if the nation or the producers, or both, owned everything, the workers would then willingly become more efficient because the profit would go to the whole community. These are expressions of opinion disproved by what experience we have, and as long as opinions have the upper hand of facts, because of the inability to distinguish the one from the other, so long will the unscientific attitude dominate the country, and we must continue to pay for so many mistakes which would never be committed if the scientific attitude were developed in the Government and the people. The war record stares us in the face, and still we continue the same method. The socialists are beginning to realise the significance of scientific management, and are bringing all their batteries to bear on it. This is a time when ideas are being quickly changed all over the world. A great responsibility rests with every member of a scientific profession to see that the truth prevails and that the demagogues, whether they be politicians or labour agitators, do not gain too much advantage from this abnormal state of mental flux, so that prejudice and mere verbal opinion do not triumph over scientific knowledge.

The British people have the traditional habit of belittling themselves by exaggerated accusations of incompetency, which the rest of the world would seem to take at their full face value. This habit of depreciation has a very bad psychological effect on ourselves. It creates a disinclination to tackle boldly a big problem in a big manner. It took us as a nation a long time to visualise the ultimate size of the war, and our time-lag in that respect made it last so much longer. The war is over, and we have a tendency to react again to little things, or the tackling of big things in little ways. We seem to lose again our courage and our vision. Never in all our history have we enjoyed the world prestige that we do now, and never have our responsibilities been so great.

This country is faced with the following dilemma. How is the population of the British Isles, which is less than one-half of the United States and about three-quarters that of Germany, going to produce enough capable young men for the administration of India, Egypt, Mesopotamia? How are we to supply young engineers to execute the endless tasks waiting in these countries, not to speak of the allurements of our self-governing Colonies? How are we to do all this, and at the same time maintain our supremacy at home, which is the foundation of it all? There seems only one way to guarantee the supremacy of the Mother Country, and that is to make industry and life at home greater and more fascinating than it is abroad. Industry must be so organised as to attract the attention and hold the interest of the very best and most efficient amongst us—those with the highest conception of social service. To make industry a very much better means to a higher culture and to give the captains of industry a far greater part in the development of that culture instead of at present being completely immersed in the production of the means is a revolutionary idea which makes a strong appeal to the younger generation.

Scientific management is a higher and more complex type of management and requires greater discipline and intelligence from everyone. We are the most disciplined of peoples, which does not mean the autocratic form that Germany tolerated and suffered under, but the self-discipline of a free democracy. Scientific management is only advisable and possible in a community of free people. Don't let us be afraid of it, and while believing in it, tackle it by small and secret methods. Let us proclaim it widely and fight for it openly by every fair means. We are probably the only people who can tackle it on a national scale. Nothing short of a national movement, involving capital, labour and the Government will achieve what is required. It is a very big thing that we have to do. One of our greatest national assets in the present difficult times is the advanced state of British trade union organisation. Do not let us belittle it or fear it. We lead in this direction, and the most advanced countries follow us. The British working class has produced many men of whom we have every reason to be proud, and, in spite of all we hear to the contrary, the mass of the workers are sound and will respond quickly to an open and honest policy of education and leadership. The war has tried our young men of all classes, and they have not been found wanting. The present situation requires the faith, the courage, the optimism of youth to overcome the forces of reaction, whether on the extreme right or left of the industrial and political army. Give the younger generation more scope, encourage them to think and act in these matters, and the country will win through more quickly. We have in the stable and industrious character of our people a far greater asset than we can ever have in the most ingenious machines. If we realise that fact in time, the history of Great Britain in the twentieth century will eclipse all its previous history in its progress towards a higher culture and a better life for all.

DISCUSSION.

Mr. Ll. B. Atkinson said no progress could be made without the goodwill and co-operation of labour. The difficulty was to convince the worker that he would get more than his present share of the profit if a larger output were secured. It was not true to say everybody would get more if there were a larger profit. He thought it would be possible to devise a scheme by which they could get the co-operation of organised labour in introducing improved methods and to discuss with the labour representatives the legitimate method of dividing the larger profit which might be secured.

Mr. S. Mavor said the waste of time in engineering was greater than most of those in control were aware of. The responsibility for increased production lay less on the workmen than on the employers. The possibility of increased production by the use of properly devised machine tools was much greater than any possibility of increase through increased effort by workmen. The author said that 75 per cent. of the time required for an operation was absorbed in handling tools, 15 per cent. in handling the men, and only 10 per cent. in doing the actual job. That was true of the average machine shop. He disliked the suggestion that the system (scientific management) should be imposed upon them by the Government.

Mr. R. W. Paul was of opinion that the consideration of muscular effort was not their business, but the business of the workman. He should cure himself of the habit of working like an amateur. They wanted to secure good feeling in the shops, and this did not seem likely to be effected by the systems described by the author. The workers felt that overhead charges were unduly high, and said while their wages were measured by tenths of a penny it cost half a crown to get a split pin out of the stores. In the early days the efficient men weeded out the inefficients, and everything went well; but with rapid expansion other men had to be called in, and the trouble began. They had to guard against industrial boredom. Men got bored more quickly than they got tired. He doubted whether this country ought to be engaged largely in repetition work. It was better to make Rolls-Royces than Fords. Welfare work was all bogey. He admired scientific management, but it would take another two generations before they would be ready to use it.

Mr. Stavenhagen (Electrical Trades' Union), who began by aggressively stating that himself and his co-unionists were the opponents of the Institution, went on to say that he was aware that the Electrical Trades' Union was not regarded with great favour by the contracting or technical sides of the industry. The working class feared that if they accepted a payment by results system it would throw them more rapidly out of work. He saw no means of guarding against it.

Mr. J. G. Pearce said industrial conditions in this country were not comparable with those in the United States, which had a huge home market and a vast foreign born population. He did not like the term "scientific management," and there was a tendency to confuse it with mass production. But scientific management was most necessary in works which produced varied products. If the workers were properly educated, it would develop their manipulative skill and the intelligence so vital to the success of the system. If proper safeguards were provided, such as a minimum wage, and protection against so-called fatigue, he thought it probable that scientific management might come from the labour side.

Mr. J. R. Dick said employers were themselves living in a fantastic age with topsy-turvy finance, and his current price was elastic and covered all sorts of sins besides the so-called inefficiency of labour. He was, therefore, not in a position to enthuse on Taylor's system on any large scale. Workmen were not opposed to higher production, but were practically indifferent to it.

Sir George Gibb said the standard of living could not be improved unless the production of wealth was increased, and methods which would serve labour and obtain the maximum production would assist this end. Payment by results must be extended. The English people must abandon their habits of secrecy and approach the workmen with solid arguments. He believed a good case for scientific management could be established.

Major Pells said unless the manufacturers in this country took up some system of scientific management we should be behind other countries in competing in the world's markets. The system could be applied to any kind of work—not only mass production. There was a danger of confusing the two sides of scientific management: (1) Research or study, and (2) application—when putting the matter before manufacturers and employers. He thought it would be a mistake to aim at creating an international link on the research side.

Mr. P. G. Pettifor said there was an implication that factories not run under Taylor's system were non-scientific; but without mass production the full benefit of the system could not be secured. He did not approve of the suggestion that manufacturers in country districts should pay the difference in labour rates into a common fund, as it would encourage manufacturers to come into the congested districts, where they would get free access to labour.

Mr. A. Vines said nearly every works in England had adopted scientific management to a greater or less extent, in spite of what the author said about managers. The difficulty was getting trained rate-fixers who would fix really honest rates that the trade unions would accept.

The Author, in reply, said, in regard to the solution of the capital and labour problem, the whole Paper was meant to explain how to remunerate labour. The Taylor system was an effort to measure human effort. Once it could be measured, they could have a square deal. He thought that in the near future a 40-hours week was a possible thing, and that with scientific management more output could be obtained than they got at present. If adopted on a national basis, with the consent of the employers and employees, it could be controlled. In the United States it was adopted by employers, who exploited their workers, and the Government were compelled to pass legislation making scientific management impossible in any Government factory. He did not want that to happen here. The Government could not impose the system upon them, but they would have to be a party to it. The setting of times or the studying of fatigue would not, however, be done by them. Mr. Paul said under present conditions the efficient men came to the top and the inefficients were weeded out; but scientific management said every man must be found a job. The question had to be looked at from a social and national point of view. If the skilled man trained the unskilled, the intelligence of the less skilled man was developed and his self-respect raised, and he was given more money, which did not, as a rule, conduce to boredom. The crux of Mr. Stavenhagen's argument was suspicion, and the workmen had every justification for suspicion. That was why he advocated that scientific management should be brought about on a broad basis, and not in individual factories. He thought this was the only country sufficiently advanced to attempt to adopt the system in the way he suggested. In America the employers—not the trade unions—were the greatest obstacle. Scientific management was not really a system, but a mental attitude, which was difficult to define. Mr. Vines said decently trained rate-fixers could not be got at present. That was the whole argument for scientific management.

Mr. W. B. Hird on the Influence of Theory on Practice.*

The many inventions and developments which took place during the war were, necessarily, kept secret during the continuation of hostilities, and are now only just becoming generally known and open to discussion. In all the different branches of engineering physics, of chemistry, of military science, new strides were taken with a rapidity which only the great stress and necessity of the times could have brought about, a rapidity utterly impossible in times of peace when every new thing must show at any rate some prospect of commercial success before it can hope to receive encouragement. The particular feature to which I would specially draw your attention is the marked tendency towards an increasingly close connection between pure science and its applications in engineering and practical work generally. An example of this is to be found in the very large use which has been made of the apparatus known as the thermionic valve. For some years the attention of some of our best physicists has been directed to investigations of the electron, but it was scarcely to be expected that investigations which were started and carried on solely from the point of view of pure science, and which were directed to such highly abstract considerations as the constitution of the atom of matter and the changes which might take place in its constitution would in so short a time have developed into an instrument of great practical utility which could be manufactured in quantities by comparatively unskilled labour and required no great amount of training in those who used it to give useful results. The applications of thermionic valves have so far been chiefly in the service of wireless telegraphy, and in the British Navy, Army and Air Forces the progress made in wireless communications was largely due to the introduction of thermionic valves both as amplifiers in the receiver and as generators of high frequency oscillations in the transmitter. In the Air Force, the wonderful improvement in inter-communication made chiefly by the use of the ionic valves is strikingly realised when we learn that of the aircraft originally sent over to France with the Expeditionary Force one only was fitted with wireless apparatus, while at the signing of the Armistice about 500 machines were so fitted, and there were 2,000 wireless stations with the batteries capable of communicating with these machines.

The rapid progress made in the science of aviation itself has resulted from the action and re-action of practical experience and theoretical investigations. At the beginning of the war our knowledge of the laws of pressure on bodies moving through a fluid was of a very elementary character. One of the most useful steps towards increased knowledge was the publication by Lord Rayleigh of the formula for the variation in the air pressure due to change of dimensions of the moving body, and it is entirely due to the application of the law thus formulated that experiments in aviation were kept on sound lines, and that the results have proved the astounding success which we have seen.

Another totally different direction in which we can see science coming into closer contact with practical work is in connection with the methods of shop organisations now being so widely discussed. The up-to-date shop organiser is no longer satisfied merely to observe for himself the effect of fatigue, to time and tabulate the different motions gone through in carrying out any operation, but he calls in the assistance of the physiologist and the psychologist to devise laboratory experiments and to draw on his experience in quite different spheres to advise him as to the proper proportion of work and rest periods, to discuss the different results of nerve and muscle fatigue, and the mental attitude produced in different groups of workers by changes in their environment.

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* Abstract of an address delivered to the Scottish Centre of the Institution of Electrical Engineers.

If, turning from the past, we venture to glance at the future, it is gratifying to find that an increased interest is being taken in societies, such as is this our own Institution, which are the most powerful link between the scientist and the engineer, that we are all increasing our membership, striving to add to our spheres of activity and to organise and fit ourselves for the work before us. And great as has been the work of the engineer in the past century in bringing into our service first steam and then electricity, it may well seem that we may be on the brink of a new era, the possibilities of which are as yet undreamed of. For if each fresh discovery opens up ever vaster fields of inquiry, it is also true that a larger and larger number of workers mentally equipped to carry out the exploration are each year available, and it is part of our work as an Institution to see that the supply of such workers is kept up to the requisite standard, and that their work and efforts are properly appreciated.

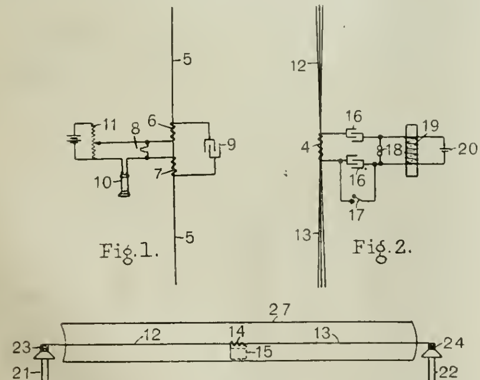
It is only necessary to glance at any technical or scientific journal to see how large a proportion of the time and attention of present-day science is engaged in problems of radio activity and of the constitution of the atom. We still have to learn as to the properties of the electron and how it enters into that combination which we call the atom. There is one point on which there can not be considered to be any doubt, and that is the immense quantity of energy stored up in the atom of matter. At present this energy is entirely out of our control, the atom breaks up spontaneously, and we have no means of either retarding or accelerating the process, nor have we as yet any means of using it. Perhaps we never shall find means of bringing it under control, but the knowledge that such an inexhaustible store of energy is available makes it possible to hope without too great a stretch of the imagination that some means of using it will some day be forthcoming, and we may then anticipate such a revolution in the conditions of living as will absolutely thrown into the shade the changes of the last 100 years brought about by the discovery of the steam engine and the electric telegraph.

The Fessenden Pelorus (Wireless Compass): A Caution as to Its Use.

By REGINALD A. FESSENDEN.

Since the writer's Pelorus, or wireless direction-finder, is now coming into quite general use, it is very necessary that users of this device should be made aware of the fact that the indications given by the original form of the apparatus, which is the type most generally used at the present time, are frequently in error as much as 20 deg., and occasionally as much as 45 deg.

The present note gives a brief description of the various types of the Fessenden Pelorus; indicates the causes of the erroneous readings, and describes the methods which must be used to obtain accurate results.



FIGS. 1 TO 4.

The discovery that the electromagnetic component could be utilised by means of vertical coils of wire with or without magnetic cores was made in 1899, and published in the "Electrical World," August 12, 1899 (see Figs. 1 and 2). The fact that these loops for utilising the magnetic component were peculiarly well adapted for determining the direction of the source of received wireless signals was made a couple of years later.

Two forms were developed, one in which the loops were mounted on a rotating stand, as shown in Figs. 4 and 5 (taken from U.S. application serial No. 167,642, filed July 27, 1903; issued in part as U.S. patent No. 1,020,032. Also German patent 225,256, January 14, 1907 (Fig. 1, and last paragraph of specification). Or by arranging a number of them radially, and connecting them to a commutator as shown in Figs. 6, 7, 8, 9, 10, 11, 12 (taken from U.S. application No. 352,213, filed January 14, 1907, the corresponding French patent being No. 385,897, and the corresponding German patent No. 225,256. Also Fig. 13, taken from U.S. application serial No. 754,058, filed March 8, 1903, and issued as U.S. patent No. 754,058). Also British patents 1710, January 14, 1907, and 28,412, 1907.

The modification subsequently made by Messrs. Bellini and Tosi (British patent specification No. 21,299, September 26, 1907) consisted, as will be noted, in modifying the writer's loop-method by substituting an inductive connection in place of the writer's original conductive connection to the loops.

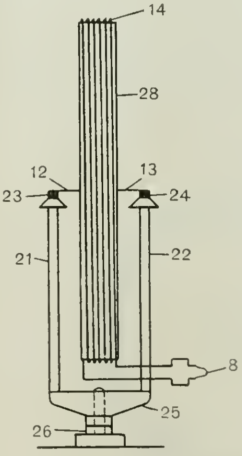


FIG. 5.

This wireless direction-finder was originally designated as the Fessenden Pelorus for the reason that it gives the direction of the source of electromagnetic waves relative to the lubber line of the ship, and has no relation whatever to the points of the compass. Of late years, however, it has been the custom to speak of it as the wireless compass: but for the reasons given above—*i.e.*, that it is not a compass, but a Pelorus—the original designation of Pelorus should be retained, even if the name of the inventor should be dropped.

The first experiments made with this type of apparatus in the years 1899-1901 were made over distances not exceeding 20 miles and gave quite accurate results, and the apparatus was demonstrated and tendered to the U.S. Navy (letter to

U.S. Bureau of Equipment, Navy Department, Washington, D.C., July 8, 1905; also London Electrician, February 22, 1907); but, though the Navy Department was interested at the time there was no demand for apparatus of this character.

rock strata which come to the surface and form a sort of insulating bowl filled with conducting soil, this conducting soil, however, being insulated from the exterior country by the edges of the insulating bowl.

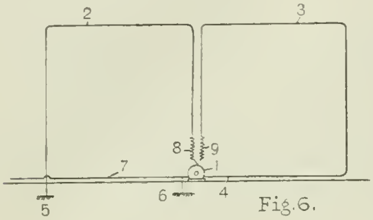


Fig. 6.

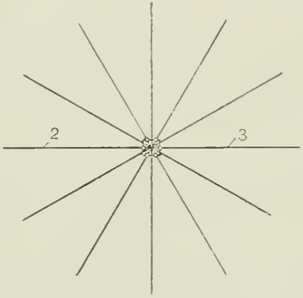


Fig. 7.

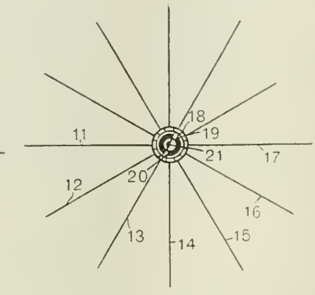


Fig. 8.

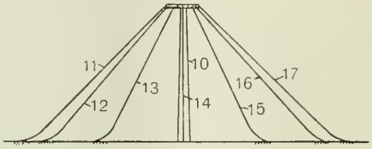


Fig. 9.

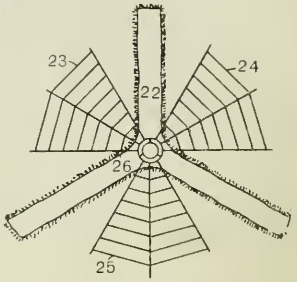


Fig. 10.

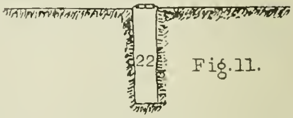


Fig. 11.

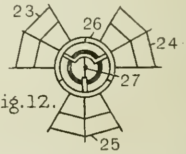


Fig. 12.

Figs. 7 to 12.

Later experiments, 1901–1906, made over distances exceeding 100 miles, showed that the method frequently gave results in error by as much as 20 deg. from the true direction; and in later tests, 1906–1907, errors of as much as 45 deg. were sometimes observed. As the result of numerous experiments, the writer discovered the causes of these erroneous readings and invented a new type of wireless direction finder.

The cause was found to be the existence of regions more or less opaque to the travel of the electromagnetic waves, thereby causing the production of shadows and the bending of the direction of travel of the electromagnetic waves around the edges of the opaque regions.

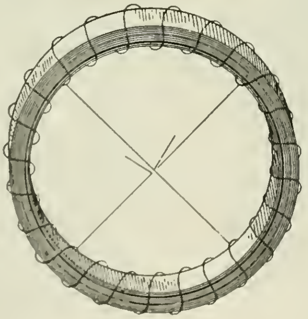


Fig. 13.

Over land these opaque regions were found to be due to—

(*a*) Varying local conductivity of the ground.

Certain sections of the land surface appear to form insulated pockets. Such a pocket exists, for example, just outside of the city of Pittsfield, where the street railway could not operate its system in 1891 until Mr. C. C. Chesney discovered the trouble to be due to the extremely high resistance of the ground return. This pocket appears to be formed of insulating

A similar insulating bowl was described by Dr. Kennelly in the London Electrician at one of the cable landings in the Canadian Maritime Provinces.

(*b*) Varying local and temporal absorption due to vegetation.

As pointed out by the writer in 1903, every tree acts as an antenna and absorbs energy, and the amount of energy absorbed depends on the amount of sap in the trees ("Electrical World and Engineer," November 14, 1903).

Over water and parallel to a coast line, such as that between Cape Henry and Cape Hatteras, the error in direction was found to be due to—

(*c*) The great difference between the resistance of the water and that of the sandy beach, causing the electro magnetic waves to bend in.

Over the sea, and also over the land, directional errors were also found to be due to the presence of the large bodies of ionised air discovered by the writer, through his trans-Atlantic experiments, to exist in the upper regions of the atmosphere, and described by him in the "Electrical Review," March 11-18, 1906.

The third type of direction finder (U.S. application serial No. 356,814, filed February 11, 1907, corresponding British patent No. 2,955/1908) was based on the application of hori-

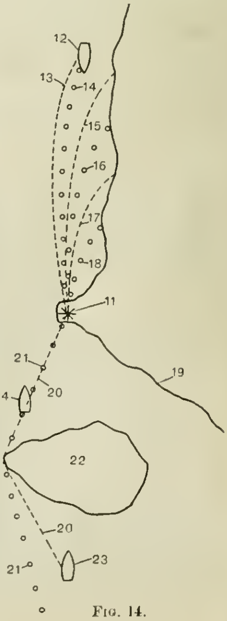


Fig. 14.

zontal electromagnetic waves instead of vertical waves, and was found to give in practice considerably more accurate results up to the limit of its range. Its range was, however, shorter than that of the original Fessenden Pelorus using vertical waves.

The latest type is a modification and an improvement of the original vertical wave Fessenden Pelorus, and is based upon the writer's discovery that the amount of bending—*i.e.*, the amount of directional error—is a function of the wave-length of the electromagnetic waves used for direction-finding. In this method, instead of a single-frequency of electromagnetic waves, two and preferably three frequencies are used, and by means of the readings obtained with these different frequencies of transmission the existence of an error is detected and its amount may be estimated with a fair degree of accuracy.

Fig. 14 illustrates the use of the method. Here 11 is a wireless station arranged to emit signals of a plurality of frequencies; for example, 200,000 per second and 100,000 per second. 12 is a vessel equipped with a Fessenden Pelorus of the type shown in Fig. 5.

Owing to the fact that the waves travelling from the station 11 to the vessel 12 move parallel with the coast, their path of travel is inclined as mentioned above, and the dotted lines 13, 15, 17 may be taken to represent the paths of travel of the waves having a frequency of 200,000 per second, and the lines of small circles 14, 16, 18 the paths of the waves of frequency of 100,000 per second. The observer on the vessel 12 observes the direction as given by the Pelorus, with the Pelorus arranged to receive waves of 200,000 frequency. He then takes a second reading with the Pelorus arranged to receive waves of 100,000 frequency.

If both these readings give the same direction, the observer knows that there has been no bending of the paths of either of the two frequencies of electromagnetic waves, and that the direction is a true one. If, however, there is a difference in the readings for the two frequencies, he knows that the path of the waves has been bent, and by certain formulæ which will be given in a later Paper, or still more simply by empirically observing what differences in the directional reading for the two frequencies correspond to a given angle of bending, he can determine the true direction.

It is preferred to use also a third frequency, because by using three frequencies comparisons may be made between three pairs of frequencies, and the results obtained with each pair may be used as a check on the results obtained with the other pairs.

Fig. 14 also shows in its lower section the effect of a large cloud of ionised air, 22. Here the vessel 24 will obtain the same directional reading on both frequencies, because the path shown by the dotted line 20 of the waves of frequency 200,000 will be the same as the path (shown by the line of circles 21) of the waves of frequency 100,000.

But the vessel 23, lying in the shadow of the mass of ionised air 22, will receive the waves after they have been bent by passing around the edge of 22, and as the amount of bending—as the writer has discovered from his experiments—varies with the wave-length, the paths of 20 and 21 will diverge after passing around the edge of 22, and the readings obtained with the Pelorus on the vessel 23 will be different for the different frequencies as to direction; and will also differ in intensity, which latter phenomenon may also be made use of as a check.

It will be obvious that the use of the writer's Pelorus without means for discovering and estimating the errors due to bending will, in a considerable percentage of cases, result in large errors in navigation. As an illustration, it is understood that on one occasion during the late war a number of German Zeppelins, which had located their course by readings from the German wireless stations and had steered accordingly, found themselves several hundred miles out of their calculated position and over French territory.

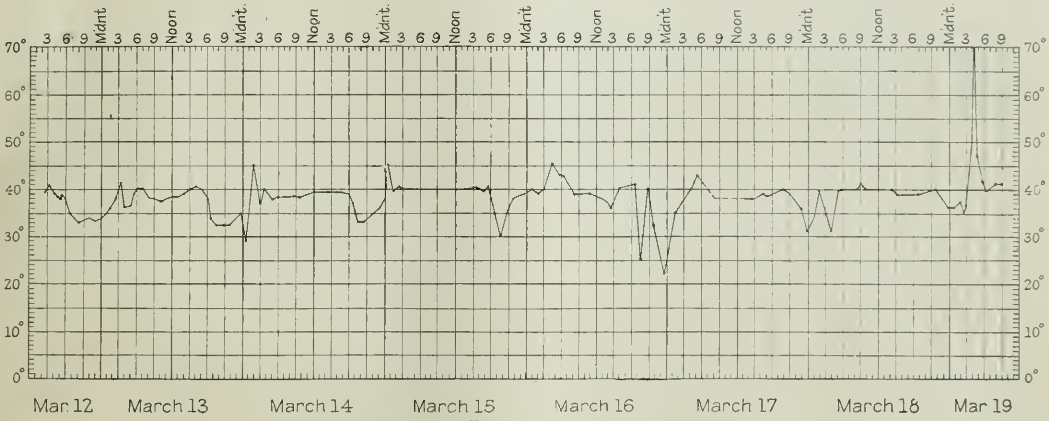


FIG. 15

The apparatus and methods described above were disclosed to the U.S. Army and Navy Departments in December, 1914, but on account of the order of secrecy could not be published before.

Since writing the above I have been furnished, through the kindness of the Navy Department, with a set of readings, Fig. 15, taken between two Navy stations for every hour of the day and night for a complete week.

It will be noted that in this series of tests the errors are greatest during the night, and are mainly in one direction, this being the shore side; but the errors in the other direction, while fewer in number are occasionally much larger in magnitude, which I attribute to their being caused by what I call *ionephs*; *i.e.*, clouds of ionized air.

Society of Technical Engineers. The first general meeting of the present session of this branch was held at Bristol on Dec. 12, when Mr. F. J. Mallett presided over a good muster of members. After routine business had been transacted, an address on the "Aims and Objects" of the Society was given by Mr. A. Davis (Morgan Crucible Company), and this was followed by a discussion, the trend of which emphasised the general apathy amongst engineers to become members of a protective society. It was decided to pursue an active propaganda during the winter months with the aim of enrolling every eligible engineer in the west of England. A hearty vote of thanks was accorded to Mr. Davis for his address, and the date of the next meeting was fixed for Jan. 16.

Mr. W. H. Chamen on the Financial Side of Electricity Supply.[*]

All engineers must be profoundly sorry that considerations of finance have to enter into any of their wonderful schemes; and yet, without the necessity for considering the financial side of any scheme, our usefulness would be largely, if not entirely, gone. For it is economy in the expenditure of money, both in the first cost of the schemes which are propounded and in the maintenance of them, which governs the whole matter. The object of electricity supply for power purposes is economy in the application of power to a great diversity of purposes. If electricity does not enable people to do something at less cost than they did it before, or to do a great deal more for the same money that they previously had to spend, the demand for electricity supply and the development of our schemes cannot continue. In the main, therefore, we come down to the sordid fact that money lies at the root of practically all our work.

In starting out with any scheme if it is to be successful we must consider what economies that scheme is likely to bring about, and, therefore, what chance there is of its succeeding, and, having arrived at some approximate conclusion on that side, we come to the painful consideration where shall we get the money with which to construct our scheme? Now, the money itself comes from the public in one way or another, either from individuals, or from companies, and so it must surely follow that in seeking money for the carrying out of any scheme the scheme must be propounded and explained in such a way as to tempt the individual to put his money into it. Now, there is a difference between Government or Municipal concerns, and Company concerns. In the case of a Government or Municipality the money borrowed is secured by being made a charge upon the taxes of the country or the rates of the Municipality or other local authority as the case may be. That is to say, that if the scheme does not prove a financial success then the deficit is made up by increasing the taxation or the rating of the individual. For this reason the rate of interest on money lent to a Government or a Municipality is low. But with a Company the case is different. The element of enterprise enters in. The individual who lends his money to a Company does so in the hope and expectation of receiving a dividend which, in the first place, on the ordinary shares, is not limited to any fixed rate of interest. The concern may not be successful, and he may get no dividend at all, or, worse than that, he may even lose his capital. It is not difficult to see, therefore, that unless there is a possibility of a shareholder in a Company getting a larger rate of interest than he can do from Government or Municipal investment, not a penny piece will be invested in Companies. This fact is seized upon sometimes to argue that all schemes ought to be carried out by means of loans issued by Government or Municipalities, so as to secure money being borrowed at a low rate of interest and preventing the temptation to what, in these days is called profiteering. This line of argument, however, loses sight of the fact that the Government or Municipality has to repay the loan, and consequently the price charged for electricity must be sufficient to cover annual payments into a sinking fund, while, on the other hand, there is no obligation on a Company to put by a sinking fund for repayment of capital subscribed for ordinary shares or even for preference shares. Again, there is no obligation on the part of a Company to put up the price of electricity to such a figure as will ensure payment of a certain dividend on the shares of the Company if for one or two or several years, the development of the undertaking does not allow of a dividend being earned when reasonable prices are charged for the energy supplied. The shareholder knows this full well, and often makes his investment knowing that for some years he will get no dividend, but he hopes that he will get a dividend in the end which will recoup him for the lean years. This fact stimulates the rate of development by Company enterprise, and the capitalist is willing to risk money, although for the time being no dividend can be paid. It not unfrequently happens that from various causes all the capital subscribed for ordinary shares is spent before a stage of development is reached sufficient to pay any dividend. If this continues money can only be raised by the issue of preference shares or debentures. There is, therefore, considerable risk in proceeding by means of Company enterprise, which obviously must be compensated for by the prospect of reasonably good dividends. There are, however, no electricity undertakings run by Companies which are free to make whatever profit they may like.

It may be that there are advantages in some ways in the Government or Municipal method of procedure, but on the whole the advantage, even from the public point of view, lies with a properly guarded and properly managed Company undertaking. If such a limitation were imposed upon the rate of dividend or interest which a Company might pay as to reduce it to the level of a Government or Municipal loan, no money would be found for any Company enterprise, and it is difficult to see how it could be found for Government or Municipal enterprise either, for a very large number of individuals are not satisfied to lend their money at very low rates of interest, in spite of the absolute security of rates and taxes, and there would come a time when, in order to get money, the rate of interest would have to go up. It is surely wiser to allow reasonable and proper freedom for the earning of interest on capital employed in public utility undertakings and so encourage the finding of more and more capital, than it is to hamper it by limitations which may take away all the spirit of enterprise, and which must also tend to hamper energetic and rapid development. In some of our large cities, of course, development has been very rapid, because of the enormous demands for power supply, coupled with the public spirit of the Municipal authorities, and the wonderful keenness of their engineers, and money has so far been found to meet the requirements of those cases. It is remarkable, however, that the Electricity Bill does nothing to encourage the idea that Government will readily find large sums of money for the development of electricity supply, though it provides for that being done more or less as a last resort. Elaborate provisions are set out for the financing of District Boards, if such Boards are formed, but they all seem to do away with the element of enterprise and take the form of powers granted to the District Boards and to Electricity Commissioners, to borrow money by the issue of stock bearing interest at some fixed rate, and redeemable at such time as the Electricity Commissioners may decide. It would seem very doubtful if individuals will be willing to invest their money in this way unless the rate of interest is considerably higher than it has been on Municipal or Government loans hitherto; and this interest, as well as the repayment of the loan, must all come for the consumer of electricity, which means, of course, that the price charged for electricity supply must be sufficient to cover all these charges.

The prospect of getting a cheap supply of electricity under a District Board does not seem very promising, but the Bill as amended, and now passed by the House of Commons, does not make the formation of District Boards compulsory. Under Clause 5 (2) authorised undertakers, local authorities, railway companies using electricity for traction purposes, large consumers of electricity, and other associations or bodies within the district, which appear to the Commissioners to be interested are given an opportunity to submit schemes for improving the existing organisation, if it needs improvement in the views of the Commissioners. This would seem to mean that in many areas the existing authorised undertakers, whether Municipal or Company, should get together and endeavour to propound some scheme under which the existing powers of all or any of them can be brought together under the control, say, of one joint Committee consisting of representatives of the various interests concerned and the undertakings of all of them dealt with as one whole so as to avoid waste, overlapping, the continuance of uneconomical power stations, and so securing true economy, while at the same time preserving the element of enterprise which is so necessary to development so far as one can see. It may not be easy to suggest, in detail, the way in which this can be done, but the first thing to do is to create the desire for such a scheme, and, having done that it is wonderful how difficulties seem to dissolve away. The problem might possibly be dealt with by the giving and taking of bulk supplies between the parties, but that would probably entail keeping up certain walls of separation between them, and it would probably be far better to make an actual amalgamation between the different concerns so that they shall all really become one and work with interest throughout. No doubt this involves the difficult question of finding a way to unite the different orders of capital, Municipal and Company. There cannot, however, be any insuperable difficulty about this matter, unusual though it may seem, and it must be remembered that the alternative is the District Board with its purchase of all power stations and its practically unavoidable waste of money both in first cost and in maintenance. The scheme cannot be complete without bringing in private plants which are not touched by the Electricity Supply Bill, but the owners of those plants will surely be willing to come in and join the amalgamation and to help in finding capital for it rather than to go on spending money on their own plants. If taken advantage of in this way the Electricity Supply Bill opens up an avenue of progress such as has not been possible before, but if we allow the formation of District Boards, as alternatively provided for, we shall be taking a retrograde step and causing at once a strong feeling of want of confidence among those who have their own generating plants. They will be afraid to place themselves in the hands of District Boards on the score of economy.

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[*] Abstract of an Address delivered before the Western Centre of the Institution of Electrical Engineers.

All that has now been put before you assumes, of course, that human nature remains what we have known it to be up to now. There is a great talk of the old order of things passing and of new and brighter things to come. But there is no tangible suggestion as to what these new and brighter things may be. Can anyone think they are to be found by forcing all capital to a dead level rate of interest, and that irrespective of whether it has been earned or not ? This cannot surely be argued seriously. It could not have any reforming effect on human nature, and that, after all, is what we want to get us out of all our troubles. Human nature cannot be reformed by coercion. We know that quite well; and we must look to something quite different from District Boards to bring about that unity of aim and interest which alone can give us prosperity and peace.

DISCUSSION.

Mr. H. **Faraday Proctor** said that he was advocating a district board for Bristol. Mr. Chamen referred to the difficulty of finding a sufficient number of investors who would provide money at low interest, and he also remarked that the interest which the Government or local authority paid was less than that which companies paid. This was because they could get money at a low rate. If money was cheap, it was sufficient evidence that the supply was sufficient. He did not quite follow Mr. Chamen's argument about the financing of the district boards. Two sums of money were mentioned in the Bill—£20,000,000 and £25,000,000—neither of which was intended for the systematic financing of the district boards. The first was intended for carrying out interim work, before the district boards were established, and the second was to allow the Board of Trade to advance sums to district boards where the undertakers could not raise sufficient funds themselves to carry out the necessary works. In a district board which included municipalities and companies, he took it that each municipality and company would guarantee a certain proportion of the capital required, and security and interest at a low rate would thus be obtained. In, say, an agricultural area which it was necessary to develop for industrial purposes, sufficient guarantees for a large scheme might not at once be forthcoming, and the commissioners would then provide the capital from the sum placed at their disposal. There was not of necessity very much difference between the district board and a joint electricity authority. The latter had to be representative of authorised undertakers within the district, with or without the addition of representatives of other interests. A district board included representatives of local authorities, companies, authorised undertakings, railway companies, labour and local authorities and county councils who were not authorised undertakers, but who provided financial assistance. These boards, in his view, would not be extravagant, and the representation of large consumers, who were the persons most interested in the production of cheap electricity, was the very best form of representation it was possible to have.

Mr. J. H. **Edwards** (Edwards & Armstrong) said that there was no question that finance was the chief thing in connection with electricity supply, but finance meant more than actual money. Taking the question of coal, in saving coal we were saving money, and in their proposal the Goveroment were aiming at conserving the coal resources of the country. By giving a cheap supply of electricity a good distance would be traversed towards the solution of the housing problem, and to obtain peace between the capitalist class and the workers some attempt must be made to solve the problems of the slums. Was it a reasonable suggestion that the actual generation of electricity and the provision of trunk mains could be efficiently nationalised while the more indirect section of the work, such as distribution, could be best left to private enterprise ?

Mr. W. **Hardy** (Bath Tramways Company) said he was interested in the Electricity Bill as a consumer, but he did not know whether consumers were going to benefit in the price of electricity supply, though unification should assist in the obtaining of a cheaper rate, provided the cost of transmission did not counteract the cheaper cost of production. He thought that electrical engineers did not produce the best value from coal. Only 18 per cent. of the heat in the coal was converted to electrical energy, and an engineer should be made to use the heat in exhaust steam for warming or other industrial purposes. This would not be possible in an electricity scheme with a large distributing area.

Mr. H. H. **Thompson** (Metropolitan-Vickers Electrical Company) said that he was personally optimistic as to the financial success of electricity supply under the proposed conditions. Electricity supply had become a prime necessity of our industrial growth and economic life. He thought it was a good feature that the new loans for the proposed developments should be raised by private subscriptions, and direct public interest should tend towards closer scrutiny, and consequently reduced expenditure. One speaker was fearful of the effects of Government control, or of what he termed "nationalisation"; but we had never had sound nationalisation in any branch of national industry. What we had had was mock or toy management, chiefly by a union of lawyers or by such people as retired stockbrokers and other amateurs, who endeavoured to guide and manage State departments and enterprises about which they knew very little. State management by expert officials had still to be tried and tested.

Mr. H. L. **Stanton** (Cosmos Engineering Company) did not think it correct to say the object of the Bill was to conserve the national coal supplies. Coal exports would not definitely cease. Steam raising coal, such as was at present used in generating stations, represented but a small fraction of the coal annually produced, and by the time the national coal resources were reaching their limit scientific developments of the age would have invented far superior methods of operation than those now employed. He thought that the Electricity Supply Bill was a recognition of the part played by electricity supply during the war, and aimed to utilise this source of energy to a far greater extent as an element of the highest importance during peace. He thought there should be no difficulty in obtaining the necessary capital, and though it was quite true that national control had proved incompetent and wasteful, as professional men it would be their duty to endeavour to change this when dealing with national electricity supply. If Government control of utilities had proved inefficient, there was no reason why it should continue to be so. It was in their power to raise the standard, and they should use this power. The best and surest way of obtaining progressive efficiency from the labour element was to prove by individual actions that the place of this element in the universe was recognised, and that no monopoly of intelligence existed anywhere. He had found a willingness to meet extraordinary requirements from municipal engineers which was not always experienced from private enterprise, where personal elements seemed sometimes to obstruct progressive effort.

Mr. W. A. **Chamen**, in reply, said the scheme which he favoured was the joint electricity undertaking. Mr. Hardy had said he did not know where the consumer was going to benefit under the Government scheme. He (the speaker) took it that the Government scheme aimed at the conservation of the coal supplies. Utilisation of exhaust steam was also provided for in the Bill, whether there was a district board or not. It seemed to him more satisfactory to arrange a unified scheme in which the big consumers took their part. They must all pull the same way to make things better and cheaper.

Carbon Arcs for Searchlights.

We give below an account of the discussion which took place in London on Messrs. C. C. Paterson, J. W. T. Walsh, A. K. Taylor and W. Barnett's Paper on "Carbon Arcs for Searchlights." An abstract of the Paper appeared on p. 625 of our issue of December 5, 1919.

Capt. J. K. **Im Thurn**, R.N. (Admiralty), said actual beam investigations had been made out of doors by the staff of H.M.S. "Vernon," and the work of the N.P.L. had been of the greatest assistance to them. The N.P.L. results pointed to the fact that any two types of carbon gave the same total light when burning under the same conditions. Various outdoor tests confirmed this. From the N.P.L. results one would expect a considerable increase in the intensity of the beam for a given current by reducing the size of the crater, but this had not been very marked, so probably most of the extra light did not reach the mirror. The diameter of an unburnt carbon gave no definite clue to the size of its crater. The general conclusions arrived at from the "Vernon" experiments were that the high current density arc was the most suitable for long range work, particularly if the carbon manufacturers could produce carbons which would give rays of the wave-lengths least affected by absorption.

Mrs. **Hertha Ayrton** first gave some account of early researches carried out by her when great difficulties were experienced owing to the poor quality of the carbons and the manufacturing conditions laid down by the Admiralty. It was important that the carbons should be shaped by manufacturers to the approximate shape they would ultimately take, or the arc must be kept burning for some time before measurements were taken. That might account for the excessive variation in the results obtained by the authors. She was rather astonished that they imagined that the candle-power was going to change considerably with the P.D. across the arc, because Prof. Ayrton showed at Chicago in 1893 that with small currents there was a considerable region across the arc in which the light emitted was practically the same, and this had been confirmed by M. Blondel. The fact that the candle-power was greater as the arc shortened was due to the fact that with very short arcs the negative carbon obscured very little of the light. If the arc were kept burning until the negative carbon was shaped one got from a 2 mm. arc with certain currents a very pointed negative which allowed for much more light to be emitted than in the ordinary way. For that reason she thought the curves at the end of the Paper and the equation for arc length in terms of diameter and obscuration were quite fallacious for short arcs. In the author's curve connecting candle-power and arc length the observation points showed that the obscuration had been taken to be much too great. That bore out what she said. The authors did not say whether the negative carbon was soft or hard cored, what was the thickness of the copper coating, whether the carbons burnt away at the same rate, nor whether the copper dropped on to the mirror and broke it. Hollow negative carbons burnt more steadily and better than any other carbons she knew of. The authors had not really measured the intensity of the current against the crater's brightness.

Capt. J. Paley Yorke said the Paper was a comparison of carbons, without reference to the searchlight beams. The total flux was not a criterion, and though he agreed that the intrinsic brilliancy might be more of a measure, yet one would have to be sure that the craters were of equal shape and uniformly luminous per square millimetre of surface, and that there was no flame, fume or difference in quality. The authors said "the more important factor is the total flux emitted towards the mirror . . . or the average candle-power of the crater in directions embraced by the mirror." This did not go far enough. It should be the proportion of the average candle-power in the angle embraced by the mirror which would fall upon the mirror in such a direction that it would be reflected back again within the angle of the dispersion required by the beam. That was often a very different thing. He thought the only way of comparing arcs for searchlights was by burning the arc in the manner which the authors originally intended. The difficulties of this procedure had been faced by the London Electrical Engineers, who had made hundreds of tests, and taken thousands of readings on outdoor work, and had obtained a crop of results of real value. The difficulties of outdoor work could be overcome to some extent by having one arc as a standard of reference, employing skilled *personnel* and holding careful rehearsals. They had first examined the standard beam, then the beam they were testing, then the standard beam and again the beam under test very rapidly. On different nights they might find beam A was twice as good as beam B with the same carbon, though the actual reading from the beams might be different on different occasions. With another pair of carbons the relationship was not the same. Sometimes one carbon was half as good as the other, sometimes three-quarters as good, and so on. That was often of value, as it showed the danger or advantage of using some particular form of impregnation in the carbon. Carbons 8 and 9 in the authors' table differed very little, as indeed all the carbons did. But in the tests he was describing those particular carbons differed so tremendously that the experimenters would have had no hesitation in rejecting the worse. Every objection the authors raised could be overcome. One gathered that such important matters as the reduction in the diameter of the carbons, the coppering of the carbons and the avolition of the core were introduced by the N.P.L. He was sure such an impression was not meant to be conveyed. He thought he might be pardoned if he said that those improvements were introduced by the Anti-Aircraft Searchlight Experiment Establishment of the War Office attached to the London Electrical Engineers at a date prior to the tests recorded in the Paper.

Mr. H. B. Grylls said in regard to the curves of candles and arc lengths, the authors pointed out that practically no difference existed when arc lengths of from 10 mm. to 35 mm. in length were considered. But there was considerable difference in the crater areas, and as the P.D.s across the arc were also very different these might give a clue to the most economical carbons. There was no question that with a shorter arc there was a more intense crater. Also, a short arc with a rotating positive was easier to manipulate than a long one. He did not know whether that would hold with Capt. Yorke's device. A short arc also had a smaller drop across it and gave a more intense beam. He found that carbons impregnated by the process for which Mr. Heap and the speaker were responsible had a lower P.D. at any arc length than unimpregnated carbons, and if they were cored carbons the P.D. was still less.

Mr. Haydn T. Harrison congratulated the authors on the ingenious design they got out for carrying out measurements on carbons, but he could not add the words "for searchlights." The requirements of a searchlight were not the spherical candle-power, but only 20 per cent. of the total sphere. The authors' method of testing could not prove the value of carbons for searchlight purposes, because it did not give any indication of the one quantity that it was necessary to know, the luminous flux which would fall on the mirror. It was, in fact, impossible from a luminous flux to ascertain the relative value of those carbons for searchlight purposes. The alternative method put forward was the intrinsic brilliancy of the crater. If the figures given of the brilliancy were meant for the intrinsic brilliancy, he would like the authors to state how they defined the edge of that particular area over which the brilliancy was taken. It was misleading to measure luminous flux in candle-power unless it was stated the exact sort of candle-power employed.

Mr. M. Solomon agreed that the ultimate test was measurement of the beam under working conditions, but no finality would ever be reached by that method of testing. The problem was complex, and the various parts must be dealt with separately, and a large number of those parts had been dealt with in this instance very satisfactorily under laboratory conditions. The authors had shown that the composition of the carbon did not make any very material difference to the candle-power. The N.P.L. many years ago had investigated the qualities of carbons 8 and 10 at low current densities, and had found that the composition of No. 10 was 25 per cent. better than No. 8. He was surprised to find that at high current densities that result no longer held.

Prof. J. T. MacGregor Morris agreed that the authors had tackled the subject in the right way, by clearing up one or two points before dealing with the whole problem. He asked whether carbons which were tested in the photometer were dried out before use. Mr. Forrest found that to get an arc to burn quietly the carbons must be heated to a red heat in an electric furnace, and afterwards kept in a fairly air-tight chamber. The speaker also raised a number of questions about the photometric arrangements.

Dr. H. F. Haworth was horrified to hear Prof. MacGregor Morris's suggestion to bake carbons in an oven. He thought it was right that part of the work should be tackled at a time. The curves of total flux measurements had been given great prominence in the Paper, but the crater intensity current curves, which were more interesting from a searchlight point of view, were tucked away in a corner. The crater brilliancy was plotted against current for one particular size of carbon. Would it not be fairer to take several sizes and test them so that the crater spread across the whole end of the carbon. With No. 2 carbon the crater brilliancy varied from 138 at 40 amperes to 175 at 125 amperes. If the carbons had been so proportioned in each case that the crater had covered the whole carbon, he thought the crater brilliancy curve would be much reduced. The statement that a positive carbon taking 200 amperes at 70 volts would emit the same light as one taking 200 amperes at 100 volts seemed to be rather contradicted by the curve relating to variation of candle-power with P.D. and arc length. With the 75-volt arc one got 75 mm. length, with the 100-volt, 150 mm. If the candle and arc length curve were continued downwards it cut the zero candle point at 133 mm., so the positive crater would be giving a negative illumination. It should be stated whether all the curves were taken with the Yorke control, and whether there was any difference in intrinsic brilliancy produced by the Yorke control as against the old standard service control? If crater brilliancy was fairly constant over a wide range of current the size of the positive carbon was practically fixed for a given current. The question of the negative carbon was more difficult. For a 16 mm. carbon carrying 200 amperes the current density might have to be pushed to 1 ampere per square millimetre. In order that the heat should not be too great for the negative carbon the copper sheath had to carry 90 per cent. of the current, and if the coppering was uneven the copper oxidised the carbon got red hot and was soon destroyed; also if there were too much copper it was dangerous to the mirror.

Mr. A. P. Trotter said that tests in the open country must be the ultimate method. These laboratory tests were of great interest, but they seemed to relate to carbons generally rather than to searchlight carbons. He could not understand why the authors gave so much attention to the total flux; intrinsic brightness was the only thing to be considered. With a crater of only 1 sq. mm. a mirror seen from a distance would appear full of light if it were a good one. It could not be more than full. If the area of the crater were increased, this would only widen the angle of the beam. It was a paradox, but the candle-power of the beam had nothing to do with the candle-power of the crater. The cube used by the authors could not act exactly like a sphere, but, by using eight equilateral triangles of about 840 mm. side to cut off the corners, a good approximation to a sphere would be obtained. The diameter of the crater was considerably less than the diameter of the carbons. In 1894 he had done some work on the intrinsic brightness of the crater, but he used a diaphragm with a small hole, and no lens at all. He could easily calculate the candle-power per square millimetre, and found it to be about 160. But he found that the surface was by no means uniform.* Mr. Forrest, by using very small carbons and a high density had avoided that.

Mr. A. E. Angold suggested that it might be practicable to take beam measurements by using a mirror, focusing at a short distance on to a disc and taking the c.p. measurements from that, thus overcoming the atmospheric difficulties. With regard to the improvement of candle power on a short arc, was it not possible that the brilliancy increased because the radiation was restricted to a narrow angle? In that case the brilliancy of the crater would be no guide to its value. To get the best out of a big arc he thought the negative stream should be thrown away from the positive and not allowed to impinge straight into the crater. Soft carbons, impure carbons or carbons impregnated with the Heape and Grylls solution reduced the unsteadiness which occurred with pure carbons owing to the higher temperature of the arc.

Mr. C. C. Paterson, replying to the discussion, said the authors would be sorry if they left the impression that they thought that the methods adapted by them were the only methods that should be used in judging a searchlight carbon. Open air tests were the ultimate criterion, but the method they had adopted was more speedy. Tests in the open, unless they were far more thorough and extensive than was possible in most cases, were unreliable. One knew a lot of Capt. Yorke's work, which was of the right kind, and they were looking forward to seeing the results of it. Capt. Yorke and his colleagues had put in an immense amount of labour and work which, combined with work that could be done in the laboratory, would enable a true judgment of the quality of carbons to be formed. He thought both the flux of light on the mirror and the intrinsic brilliancy of the crater must be considered in judging carbons. If one wanted a beam of minimum divergence and the greatest light concentration the intrinsic brilliancy of the crater was the one important factor, but if the beam was to be separated out the total flux on the mirror was more important. The agreement which Prof. Morris pointed out between the authors' work and Forrest's was interesting, and he would be sorry if it were thought the authors claimed that their determinations of crater brilliancy had in any way priority to Mr. Forrest's excellent work.

Telephonic Transmission of Superimposed Circuits.

A communication from the Electrochemical Laboratory of the Department of Communications, Tokyo, summarises some researches by Mr. K. Ogawa on the above subject. The paper is mainly mathematical, a variety of special cases being considered, but has a useful practical bearing.

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* The Electrician, Vol. XXXIII., p. 297.

Heating and Cooking Notes.

Christmas Utilities.

How many supply authorities and contractors are making an attempt to use the Christmas season, with its pleasant habit of distributing gifts, as a means of furthering the employment of electrical heating and cooking apparatus? The electric iron, coffee percolator, egg-boiler, toaster and kettle are all comparatively inexpensive articles which appeal to womenfolk and are of a decided utilitarian character. The nickel-plated and polished finish of these articles are in keeping with the idea of a present, and as a labour-saving device they act as a constant reminder of the donor's thoughtful kindness. Incidently, as we have often said, they also provide a most valuable means of first introducing electric cooking into the home. Their consumption of electrical energy being comparatively small, they can be used off a lamp-holder and the difficulty of special wiring does not, therefore, enter into the question. Again, the Christmas season brings with it the usual run of entertaining, what better opportunity could be provided for opportunely pushing home the advantages of electric heating? The advertisements of the large stores provide evidence of the fact that they are alive to the opportunity that exists at this time of the year for the sale of electrical accessories. Is all the activity to be left to them? We hope not, and trust that the supply authorities and the contractors will be alive to the opportunity that exists, for really they can give the purchaser better service in this direction.

A Rapid Electric Boiler.

With a view to meeting the demand that exists for quickly obtaining small quantities of hot water the Filbar Electric Heater Company, Ltd., of 46, Berwick-street, W.1, have designed and placed on the market the Filbar Electric Boiler. This apparatus is illustrated in Fig. 1 and consists essentially of a nickel-plated metal cylindrical housing in which is mounted an inner cylinder comprising a water container and a heating element, together with an automatic switch for controlling the element. The boiler stands 16 in. high, is 6 in. in diameter, and mounted on the outside are a push-rod for operating the inlet water valve, a water gauge, and an outlet water pipe. The mode of operation is as follows: To obtain a given quantity of boiling water the water inlet valve rod is pressed home until the desired quantity of water has run into the boiler and is so indicated in the water-gauge; the valve-rod is then released and in about half a minute boiling water is ejected through the outlet pipe. The ejection operation is automatic and cannot take place until the water boils. The capacity of the boiler as at present made is 2 pints and any quantity of boiling water from ½ to 2 pints can be obtained by the method described above. The apparatus can be installed in any room where there is a water supply; or by the addition of an auxiliary tank to act as a water reservoir it can be used in rooms where a water supply is not available. The boiler is so arranged that it is impossible to switch on the current unless the boiler contains the minimum quantity of water. The element and all live parts are well insulated and protected from accidental contact.

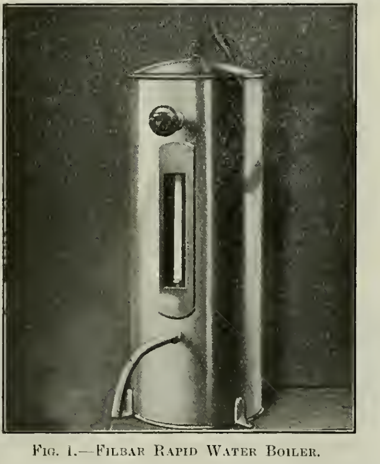
Fig. 1.—Filbar Rapid Water Boiler.

There should be a wide scope for the use of this apparatus for providing hot water for wash basins, toilet saloons, in restaurants for making tea, &c., and also in private houses.

This firm are also making an electric steriliser, the particular feature of which is that the elements are automatically switched off if the water-level sinks to within half an inch of a predetermined level. In addition the firm are also proceeding with the manufacture of a bath water heater and a domestic hot water heater for continuous service.

"Creda" Electric Fires.

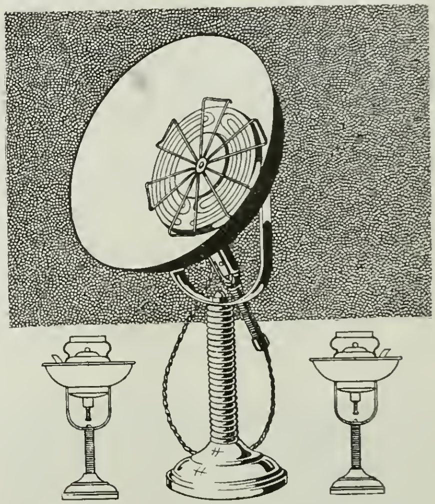
Fig. 2.—"Creda" Pedestal Fire.

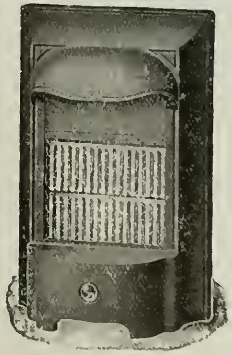
Fig. 3.—"Creda" Fire. Sheet Metal Frame. 2,250 watts.

We have just received from Messrs. Credenda Conduits Company, Ltd., a new list of their electric fires and Purser Electric Oven. The latter we described in our issue of August 1, 1919, and drew particular attention to the care which had been taken in designing the cooker in order to obtain high thermal efficiency. Good lagging and a tight-fitting door go a long way toward improving the overall efficiency of an electric cooker. We notice that this firm have produced a pedestal, bowl type radiant heater of 600 watts capacity. As a device for use in small bedrooms to obtain warmth to undress by, or to provide an auxiliary form of heating in a large room, this type of apparatus has a certain appeal. In most instances such apparatus can be used off a lamp-holder, and in this particular case the swivel arrangement provides a means of using the fire as a hot plate for boiling a kettle, heating milk, &c. The bowl type reflector is made of copper and swings on two forks, being adjustable to any desired position and controlled by two fly nuts. The metal stem and base form a means of support. We think the base might have been made somewhat larger with a view to making the apparatus more stable. The elements are of the standard "Creda" radiant type, mounted in a circular fire-clay support. We illustrate this fire in Fig. 2, showing it in use as a fire and also as a boiling plate.

This firm are continuing to manufacture their range of electric fires from 750 watts to 3,000 watts capacity in enamelled cast-iron frames finished plain black or vitreous enamelled in green or brown. These are a particularly serviceable type of heater, lasting in wear and pleasing to the consumer in that the element portion is run at a bright red heat, a feature which always attracts. The elements, though run at a high temperature, have proved themselves to be durable in use. To meet the demand which exists for a more fancy type of frame, these fires are now supplied with sheet metal frames, hand hammered and finished bright steel or antique copper. We illustrate a 2½-kw. fire, with sheet metal frame in Fig. 3. The prices of the fires with sheet metal frames are slightly less than those with enamelled cast-iron frames.

For industrial purposes there is a wall type radiator, which essentially consist of one or more "Creda" elements mounted on an iron base and protected by a perforated sheet metal cover. No switches are provided on the heater itself, it being intended that switch control should be effected by switches mounted locally on the wall or at a central control board. These heaters range in capacity from 600 watts up to 2 kw.

The Electric Drive in an Aeroplane Factory.

The aeroplane having recently shown its usefulness as a fighting unit, can now be said to have taken its place as a link in the great chain of material handling apparatus. Some notes on how the electric drive has been applied by the General Electric Company to the manufacture of aeroplanes cannot, therefore, fail to be of interest.

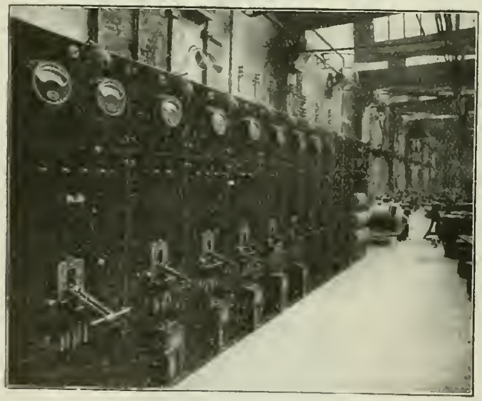

FIG. 1.—G.E.C. SWITCHBOARD AT AN AEROPLANE FACTORY.

The shops in question are at Manchester, which is a very busy centre of the aeroplane and motor-car industry, and where the General Electric Company have secured a considerable proportion of the contracts for driving the various factories. The particular firm whose factory we are describing has launched out on a considerable scale, has undertakings which include an important motor-car factory, considerably extended to accommodate the manufacture of aero engines; and, further, a new aeroplane factory, which ranks as one of the largest, if not the largest, in this country. The complete equipment can be taken as an example of the best practice in electric light and power installations. Incidentally, the factories have been laid out for working night and day.

The motor-car and aero-engine factories are supplied with three-phase power at 6,600 volts, and a frequency of 50. This power is brought into a sub-station, where three 500 kw. oil-insulated air-cooled transformers are installed. From the low-tension side of the transformers three sets of 420-volt cables pass to the main switchboard through isolating switches, which enable the board to be made dead when required. The main switchboard, which is illustrated in Fig. 1, comprises 12 enamelled slate panels, of which one controls the incoming power to the board; of the remainder, eight are power and two are lighting distributing panels, whilst there is one spare The transformer panel is equipped with a 2,000-ampere oil switch, with overload and no-volt trips, and includes an ammeter, voltmeter, current transformers, "Aron" energy meter and the usual accessories. The oil switch actuates a pilot lamp, which indicates automatically the position of the oil switch. The eight power panel have each an automatic oil switch of capacity varying from 100 to 600 amperes, and include an ammeter, wattmeter and graphic recording ammeters. In addition to the pilot lamp, the oil switches on these panels have a bell indicator signalling in the works when any of the switches automatically open. The two remaining panels are used to control the distribution of current for the lighting of the works.

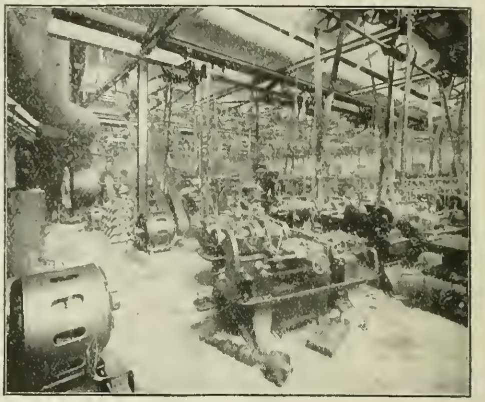

FIG. 2.—A "WITTON" MOTOR DRIVING LINE SHAFTING IN AN AERO-ENGINE WORKS.

Everyone conversant with the economics of electrification will realise the importance of the advantage claimed that valuable economies in power can be made by the careful use of recording instruments, and an intelligent application of the deductions to be made from their records. The graphic recorders mentioned, it has been found, have proved of great value in this respect, and provide useful information in the matter of variations in power consumption. From seven of the power panels mentioned lead-covered and armoured "Pirelli-General" paper-insulated cables run to various G.E.C. staggered type Home Office pattern ironclad distribution boards. V.I.R. cables pass from these boards in heavy gauge screwed and welded conduits to the various motors. From the eighth power panel cables run to a motor-generator, the function of which is to supply continuous current to a number of machines from which adjustable speed is required. These machines include several.

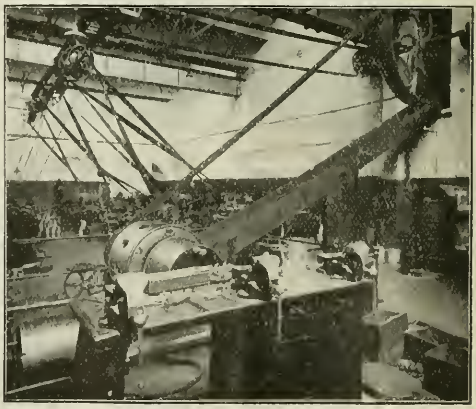

FIG. 3.—100 H.P. MOTOR DRIVING AUTOMATIC MACHINE SHOP.

4 H.P. adjustable speed Witton motors, driving gear quietening machines.

Cables are also taken from the main switchboard to four 45 k.v.a. and one 20 k.v.a. oil-immersed air-cooled transformers for lighting, as well as to motor-generators of 2 kw. and 3 kw. capacity, which are utilised for charging ignition and starting batteries for the motor cars, and for providing current for magnetic tables, clutches and similar devices. It will be observed that the motor-generators mentioned provide a solution of the problem feared by some engineers as to how adjustable speed machines should be run from an alternating-current supply. Parenthetically, it may be said that this problem for large machines can readily be solved by utilising alternating-current motors of special design; but for very small outputs it is easy to adopt the solution decided upon in these works and to put in continuous-current machines designed for adjustable speed work, and to supply them from a special motor-generator.

For starting the aero engines on their test benches a 40 H.P. G.E.C. "Witton" motor has been laid down, driving a line shafting to which the engines can be connected. Small $\frac{1}{2}$ H.P. motors are used for driving small portable machines situated in different parts of the works, whilst the "Witton-Kramer" electric drill has been extensively adopted, there being at present about 50 in use. The whole of the lighting throughout the works is carried out on the direct system, there being over 600 18-in. vitreous enamelled G.E.C. "Munition" reflectors for Osram lamps of various candle-powers, which are supported from the roofs by means of light link chains. In the offices the semi-indirect system of lighting has been selected, and 18 in. "Equiluxo" bowls are used for this purpose. Figs. 2 and 3 show views in the works.

Electricity Supply in British East Africa.

At a recent meeting of the London Chamber of Commerce (East African Section) Mr. James McBlain, Electrical Adviser to the Government of the East African Protectorate, attended to explain the objects of the Electric Power Ordinance, which has been passed by the Protectorate Legislature.

Our readers may remember that we commented upon this Ordinance in our issue of September 27th, 1918, and commended the measure as a piece of progressive and enlightened legislation. We gather that the approval of the measure expressed by the British Technical Press was highly appreciated by the Press and public of East Africa. Also that the latter are impatiently asking when the Ordinance, which has been badly wanted for a long time, is going to be enforced. The answer to this question appears to be that notwithstanding the publicity given to the matter and the specific invitation by public advertisement and by letter for representations on the subject to be made to the Committee of the Legislative Council, not a word was heard from concerns interested until after the Ordinance had been finally adopted by the Legislative Council, when objections against the measure were lodged with the Secretary of State for the Colonies. This obstructive attitude is, we understand, highly resented by the Nairobi Chamber of Commerce, who consider they are better able to judge what is required there than people in London.

Mr. McBlain, in briefly reviewing the objections for which the London Chamber of Commerce had made themselves responsible, stated that the question of the supply of electrical energy had long since ceased to be regarded as of a local or parochial nature, but was indeed one of national importance to any country which hoped to produce for the world's markets. By implication the representations made to the Colonial Office allege that the Ordinance has not been considered "by those who are informed as to the conditions and needs in B.E.A., and who are also informed as to the technical aspects of the subject."

Mr. McBlain, however, pointed out that the Ordinance has been designed from an intimate knowledge of electric power supply, particularly in colonial development. It will afford, he considered, the greatest assistance to industry and preclude the possibility of undue interference. On the other hand, Mr. McBlain remarked these representations exhibit a poor conception of the colony's industrial conditions and no knowledge whatever of those affecting its water powers. For instance, it is asked that groups of agriculturists be granted the use of water powers up to 1,000 H.P., free from all regulation, except with regard to safety of life, but if British East Africa is going to make progress it must be realised that all electrical power resources will require to be co-ordinated in the common service. As the country is on the threshold of its power organisation, the common-sense course has been taken of providing for standardisation on British standard lines. To this course strong objection has been made in the representations to the Colonial Office in which the statement is made that standard is more expensive than non-standard equipment.

With reference to the time limit within which existing installations must conform to standard system and pressures, Mr. McBlain stated he was quite satisfied that conversion within the time named in the Ordinance would be possible, but as some of those concerned appeared to be doubtful he had recommended that the periods of three and four years allowed for different cases should be extended to seven years or such further "period as approved by the Governor in Council."

Mr. McBlain pointed out these regulations, which were embodied in the Ordinance on the express recommendations of the Nairobi Chamber of Commerce, far from being drastic were simply a statement of the minimum requirements of ordinary good practice. As a statement of the law they are necessary so that if occasion arises offenders may be brought to order.

Mr. McBlain mentioned that the technical advisers of Government had received much valuable constructive criticism from commercial and technical men in the Protectorate, which they had gladly made use of. Even at this belated hour they still retained an open mind and would welcome any suggestion which would benefit the interests of industry and the public. So far, however, nothing had been advanced which would be as competent or as economical as the power supply which was possible under this Ordinance. At this point it was incumbent on him to emphasise, in contradiction of the statements made in the representations to the Colonial Office, that nothing suggestive of State control was contained in the Ordinance. It was also of considerable importance to note that in order to foster the development of good practice in power supply in the Protectorate, the law would enable competent operators to obtain more comprehensive powers of operation than was possible in any other country, with security of tenure. At the same time the public interest is fully safeguarded.

In conclusion, Mr. McBlain desired to emphasise that the pioneer hydro-electric power developer, in the person of the agricultural industrialist, would probably prove to be a valuable assistance in the scheme of power development, and elaborate provision had been made to preclude the possibility of his prejudice on expropriation by a bulk supply licensee. At the same time it must not be forgotten that while electricity is the ideal form of energy for industrial purposes, its generation and supply is essentially a business of an expert technical nature. Therefore, the sooner the business of this supply in any appropriate area is in the hands of a competent company formed for the purpose, the better. It is assumed in the representations made that agricultural industrialists are eager to secure water powers for development for their own use. The facts in possession of Government prove that only in isolated instances is this the case, and that almost universally these industrialists would prefer to take a supply of power from a power company rather than spend their capital in power development work which they do not understand.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Realities of Modern Science," by J. Mills. (London: Macmillan & Co.) Pp. xi.+327. 10s. 6d. net.

"Efficient Boiler Management," by C. F. Wade. (London: Longmans, Green & Co.) Pp. xiv.+266. 12s. 6d. net.

"Scientific Method." Its Philosophy and its Practice. By F. W. Westaway. (London: Blackie & Son.) Pp. xxi.+426. 10s. 6d. net.

"The Principles of Electrical Engineering and their Application. By G. Kapp, M.Inst.C.E. (London: Edward Arnold). Pp. viii.+388. 18s. net

"Telephony without Wires," by P. R. Coursey, B.Sc. (London: The Wireless Press.) Pp. xiv.+414. 15s. net.

"Alternating Current Work," An Outline for Students of Wireless Telegraphy. By A. Shore, A.M.I.E.E. (London: The Wireless Press. Ltd.) Pp. ix.+163. 3s. 6d. net.

"Coal Consumption of Power Plants and Bonuses for Coal Saving," by R. H. Parsons. (London: The Electrical Review.) Pp. 23. 1s., net.

"Calculations of Electric Conductors," by W. T. Taylor, M.I.C.S. (London: Constable & Co.) Pp. 34. 10s. 6d. net.

"Introduction a l'Etude des Radio Communications," by Leon Boutillon. (Paris: Libriarie Delagrave.) Pp. xiv.+193. 20 fr. net.

"Flow and Measurement of Air and Gases," by A. B. Eason, M.A. (London: Charles Griffin & Co.) Pp. xii.+252. 25s. net.

"Aviation Pocket Book for 1919-20," by R. Borlase Matthews. (London: Crosby, Lockwood & Son). Pp. xxiv.+535. 12s 6d. net.

"Present Position of the Theory of Ionisation." (London: Faraday Society.) Pp. 178. 12s. 6d.

The Electrician.
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The Reorganisation of Production.

Carlyle, in one of his philosophical denunciations of mankind at large, pointed out that happiness could only come through work. But we may well ask, after a consideration of the labour conditions in those days, exactly to whom the happiness derived from the work was to accrue. It would hardly seem to have been to the worker who was thought then, even by the most enlightened, to be different clay from the merchant, the capitalist and the landowner—a useful link in the industrial machine no doubt, but one whose duty it was to labour for long hours at an inadequate wage for the benefit of others. This question, however, is now looked upon from a different standpoint and all who are not definitely reactionary realise that work is a necessity equally for the employer and the employee, and that if there is any difference between the two it is the former who works the harder.

But work which is to assist in the advancement of mankind must not only be strenuous and definite in its aim, it must also be organised, efficient and, above all, interesting, if the best results are to be obtained. A worker cannot do his best unless all these factors are given their proper value, and unless the question of the fatigue of the human machine is taken into consideration. How little this was realised is shown by the procedure insisted upon by the Government, who, in their desire to increase output, forced up the working hours in munitions factories to such an impossible level that breakdown was the inevitable result. Indeed, to consider man as a machine at all is fundamentally wrong, and in the present reorganisation of our methods of manufacture which is now necessary in order that more may be produced with less effort, the problem must be tackled from the human point of view. For while everyone must work his, or her, hardest, they must also work in the best possible way, and what is more take an interest in their work. The actual operations which go to make up this finished product must be carried out scientifically, so that there is no waste of time or effort. The worker must be given some incentive to do his best and must be assured that his labour, which is as much his property as capital is the financier's, is not exploited without adequate return. Increased production must, indeed, operate for the general welfare and not simply to bring power and comforts to the few. It is only in this way that so-called scientific management can be a success. If this system is employed simply to put a few more shillings into some particular person's pocket it will suffer a well-deserved failure as it has done in the United States. But it can be made a success if both parties to the agreement come together and work together for the common good.

Now, in the past both capitalist and worker have taken up the wrong line. The former because he too often considered that all power was, and should be, his by a species of divine right, and the latter because they considered capital an unnecessary obstacle in the way of progress and that anything which helped to perpetuate it was an obstacle too. Both these points of view are wrong, though they can both be supported by many plausible arguments. To improve matters iconoclasm is not necessary. The foundations of the present system are sound if some of the superstructure is rotten. It is, indeed, simply that many of our manufacturing methods are inefficient, with the result that modern needs will make us change them, whether we like it or not.

Those who already realise this, and they are many, are looking round for a solution, but, as is too often the case, are rather inclined to consider effects as causes. Many suggestions have been made during recent years, with a view to giving the workman a more direct interest in the article he is producing, and to stimulate his production so as to increase the well-being of the community. These suggestions are well known. They include profit-sharing schemes, piece-work systems, arrangements for giving the worker a premium on his production, and methods of organising the work so as to ensure that the workman carries out the various processes in the best possible manner.

One of the best known of these systems is the one which may be conveniently called "Taylorism." This system aims at so organising production that nothing is left to chance and at ensuring that every worker, whether he be mental or manual, performs a stated part in the series of operations which result in the finished article in a perfectly definite way. This system has been adversely criticised by many, and we are therefore interested to see that Captain Scott-Maxwell, in a Paper read before the Institution of Electrical Engineers last week, has given a detailed description of Taylor's own aims, whence he seeks to show that the criticism which has generally been made that the system is inhuman in its tendency does not hold water. Captain Scott-Maxwell makes out a good case; but this particular argument against "Taylorism" is not altogether laid, in spite of what he says. As we have said above, a man's work must be interesting and unless a system of this sort is carried out with due regard to human idiosyncrasies and differences the result is no doubt a materialisation of the worker and a consequent bad effect on the production. Captain Scott-Maxwell states that the real cause of the strong opposition to scientific management, as he calls the Taylor system, is its inability to realise that the human factor must come first. This is a two-edged argument and might be equally well employed by some of the antagonists of scientific management.

In our view just the chief defect of the system is that in *bad* hands it may perpetuate all the old evils and create many new ones. It has the further disadvantage that it is at present disliked equally by employers and employees. A perusal of the discussion on Capt. Scott-Maxwell's Paper will show how true this is. Nevertheless, some system of this kind has got to come if we are to maintain our place in the world markets, and worked under proper safeguards it should bring real benefits.

Reviews.

Electrical Phenomena in Parallel Conductors. Vol. I.: Elements of Transmission. By F. E. Pernot, Ph.D. (London: Chapman & Hall.) 18s. 6d. net.

The continuous increase in the length of power transmission lines, together with the almost inevitable corollary, the rise in transmission voltages, has caused much attention to be paid to resonance and other phenomena connected with such lines. Many investigators have worked at this problem, but their solutions had generally a somewhat pure mathematical flavour and were not easily applicable to problems of the type found in practice. The first worker who recognised the need for throwing the equations into workable forms was Kennelly, and the book now under review carries his work several stages on, whilst still keeping to solutions which are rigorously complete; most attempts at making the equations workable have resorted to approximations and equivalent networks, but Prof. Pernot wisely avoids these in general, though he points out directions in which short cuts of this type can be made.

But the chief value of the book lies in the fact that the author realises that the main difficulty and in some cases danger—in long lines in practice lies in the phenomena due to the presence of higher harmonics in the wave forms of E.M.F. and current. The problem of telephony is essentially wrapped up with these phenomena, and, now that transmission line voltages are often near to that at which a corona begins to be formed, any resonance rise of voltage due to a high harmonic may be sufficient to cause a large static discharge with loss of energy. One of the examples worked out is the case of a 100-mile line working at 100,000 volts, with all harmonics up to the 11th in the generator E.M.F. wave; the amplitudes of these harmonics are small, so that their combined effect is to add only 4 per cent. to the value of the fundamental wave. But in this particular case there is a great rise of voltage due to the 7th harmonic, which at the far end has a value of 36 per cent. of the fundamental, whilst the combined effect causes a rise of approximately 50 per cent., quite enough to start a brush discharge in most countries. Any methods of calculating such lines so as to give really accurate solutions are, therefore, of much value, as approximate methods might easily fail in this particular case, where an increase in the length of the line of only 9 per cent. would cause exact resonance of the 7th harmonic.

In view of the importance of harmonics the author is to be congratulated on the inclusion of a chapter dealing with the limitations of the commercial oscillograph. The curves given by this instrument are generally accepted as representing the conditions in the circuit under examination when the oscillograph is not connected, whereas the current taken by the best-known instruments is of the order 0·05–0·1 ampere, which may cause serious distortion in a circuit under no-load conditions. He also considers the methods of introducing deliberate distortion to aid in the investigation of harmonics, and adds some interesting sections dealing with the calculation of the natural frequency of oscillation of the vibrator strips, and of the back E.M.F. induced by the motion of the strips themselves in the magnetic field; it is satisfactory to note that the latter is very small indeed, even at a frequency of 5,000 cycles a second. Altogether, from the practical point of view, this section is most valuable by virtue of its novelty, whilst another chapter which will be welcomed by the engineer whose mathematical attainments are limited is an appendix dealing with hyperbolic functions, and containing a short description of these functions, beside tables of those necessary for practical circuits.

Altogether this book should receive attention as a serious attempt to render mathematics more readily applicable to commercial practice, and the suggestion on the title-page that other volumes are to follow will be noted with pleasure by those who have read this one.

F. J. Dykes.

Physical Laboratory Experiments for Engineering Students, Part I.—Mechanics, Sound, Heat and Light. By S. Sheldon, Ph.D., D.Sc. and E. Hausmann, E.E., Sc.D. (London: Constable & Co.) Pp. v.+134. Price 6s. net.

This book, containing practical exercises in mechanics, sound, heat and light, has been prepared primarily for the engineering students in the Polytechnic Institute of Brooklyn, N.Y., who have already had some experience in practical physics. The volume contains 30 exercises, which are designed to be completed in one session. Each exercise contains sufficient theory to enable students who have access to the ordinary text books to obtain a thorough insight into the reason for the practical work to be performed. This is followed by a description of the apparatus employed and the method of procedure. Much of the detail supplied here is only of primary use to the student who employs the actual apparatus suggested in the volume, and modifications would be necessary in other institutions employing different apparatus or manipulating it in a different manner. Each exercise concludes with valuable hints as to the best method of recording observations and drawing correct deductions from them.

The scope of the work will be evident from a brief extract of the contents, which include exercises on the spherometer, planimeter, acceleration due to gravity, coefficient of restitution, moment of inertia, elasticity, viscosity, Boyle's law, effusiometer, Venturi meter, ratio of specific heats, air thermometer, specific heat, J, latent heat, heat of combustion, hygrometry, refractive index, focal lengths, ophthalmometer, interference, diffraction grating and photometry.

Each experiment has been chosen because of its close connection with engineering work, and in many cases the theoretical result may be calculated from the constants of the apparatus. In other cases a reference may be made to the appendix (pp. 123-130), which contains tables of the physical constants dealt with in the course. A comparison of these values with the practical results obtained in the laboratory will enable the student to see the accuracy of his work.

Forty excellent diagrams and illustrations are provided, and the volume concludes with a comprehensive index.

B. W. C

Fuel Economy. By W. H. Booth, M.Am.Soc.C.E. Second Edition. (London: S. Rentell & Company.) Pp. x. + 92. Price 2s. 6d. net.

If fuel economy was an important subject in 1911 when this book first appeared, it is many times as important now, and we, therefore, are glad to see so undoubted an expert as Mr. Booth given an opportunity of bringing his writings on the question up to date. Except for these necessary revisions and some notes on water softening, the book remains substantially the same as before, but it will be not the less useful for that reason. If we have one criticism to make it is that in revising the book the author has not taken the opportunity to address a few words on fuel economy to the domestic cook and the users of the open grate, who are, after all, no mean sinners when it comes to employing the commodities at their disposal in the worst possible way.

Elementary Lessons in Electricity for Bioscope Operators. By L. Calisch, A.M.I.C.E., A.M.I.E.E. (London: "The Bioscope" Publishing Company.) Pp. x. + 133.

This work contains in book form the results of a series of articles which recently appeared in the columns of "The Bioscope." It is intended to provide for the bioscope operator an easy and simple method of acquiring such knowledge of electrical phenomena as will help him in his duties. Units, circuits and the measurement of energy and power are dealt with in simple language, and some elementary facts are given about magnetism and electromagnetic induction. The dynamo, alternator, the electric arc and other electrical apparatus are subsequently similarly dealt with. The book is well written and the information is accurate. But we cannot help feeling that the multiplication of such books is a mistake, and it would be better if the earnest student, bioscope operator, or whatever he may be, were referred to some elementary standard work of which more than a few are in existence.

Catalogue of Lewis's Medical and Scientific Circulating Library. (London: H. K. Lewis & Company.) Pp. 492. 12s. 6d. net. Subscribers 6s.

Scientific workers who know Lewis's Library, and these are certainly numerous, will welcome the new catalogue which has recently been issued. It gives an excellent selection of works, and a feature which will be particularly appreciated is the index of authors under subjects. In order to save space, under each subject the mere surname of the author is given, but the desired book can be found at once by reference to the general index, in which the names of all authors are given alphabetically, followed by their works. The only modification we should like to see introduced in this part is the addition of the author's initials in every case, as their omission leads to the necessity of turning up more references than would otherwise be necessary.

Women's Engineering Society.

The first general meeting of this Society was recently held at the Central Hall, Westminster.

The President, Miss R. Parsons, who occupied the chair, said a million women were employed on war work—on munitions, aeroplanes, &c., in 1918. Of these, 45,000 were trained in the schools set up by the Ministry of Munitions. There was no reason why thousands of those women should not be employed in securing the increased production of commodities which they were told was vital for the country. It was not the employers but the Trade Unions who had decreed that women should not be employed in engineering, and the Pre-War Practices Bill gave the Trade Unions the right of veto, except that the Speaker had given a ruling that the Bill need not apply to new industries. The Women's Engineering Society had been formed to safeguard women's interests.

Mr. S. B. Caulfield, F.R.I.B.A. (chief lecturer in the School of Arts and Crafts), in the course of a short lecture on "Machinery and Art," sought to remove the erroneous, and, as he thought, general impression that art and engineering were opposed to each other, and said beauty in engineering could be secured as it had been in the case of the transporter across the river at Rouen, by each part of the structure being admirably designed to suit its purpose, every detail being considered and calculated, not only in itself, but also in relation to every other part. The conditions that should be fulfilled were that the work satisfied the needs, that it was designed to suit the materials used, and that it was carried out in strict accordance with the proper use of the tools. Instead of a machine being an inhuman beast which was going to control us he wished it to be considered as a complicated tool which was entirely at our service. The craftsman must learn the machine, and if the man who worked the machine was going to do any better he must be got to appreciate all the craftesman wanted in fine workmanship. He (Mr. Caulfield) started at the beginning of the war to train junior "draughtsmen." He trained about 500, and just over 400 were women. Some of them had been extraordinarily successful, and had risen to high positions in the Government service.

Sir Charles Parsons said he had known ladies excel as painters. Why should they not excel in engineering? In his own works they had a girl who could drill holes in shells quicker than any man they had, and many ladies had done extraordinarily well in such works during the war. The masters were in sympathy with the ladies. He hoped the Society would prosper, and that the ladies would learn to co-ordinate so as to put some pressure upon Parliament. He thought the attitude of Trade Unions was unfair. We should be better able to compete internationally if the skill the ladies possessed were properly utilised.

Sir Ernest Moir said women should deal with the injustice done them by the Pre-War Practices Bill by using the vote they could now exercise. All the Government should have restored to the men was the right to cease work till they got what they wanted. Members who voted for the Pre-War Practices Bill should be heckled at the next election until they gave justification for their action.

Several ladies took part in the discussion. One suggested that if the men would not admit women to their unions they would be justified in accepting a smaller wage than the men for similar work, another asked whether it was not a fact that the employers were in sympathy with the women chiefly because they would do the same work for less money than the men, and a third stated that the men's unions asked whether women were willing to undergo years of apprenticeship as the men had done. She thought that women should have equal pay for equal duties.

The President said it was of no use to send deputations to the men's unions to ask them to admit women. It was a question of repealing the Pre-War Practices Bill. She knew a large factory in the north where the employers were willing to pay the women the same wages as the men, but that did not weigh with the unions.

Sir Ernest Moir said women did certain jobs during the war, but it was a different thing to become a skilled mechanic. He sympathised with that feature of the trade union movement. If women wanted to take their part as skilled mechanics they must go through the mill. The average woman was married by 30, and she might only have five years on production after five years' apprenticeship, whereas a man might have 40 years. So there was not a parity between men and women in earning capacity. He would not like to have the women underselling the man. A man's wages was based on the fact that he was assumed to support at least one woman and a family. Those things had to be taken into account.

The Secretary, Miss C. Hazlett, replying to a question, said at one factory at least, women had commenced a three years' apprenticeship.

The London District Committee of the Electrical Trades Union, having discussed the employers' latest offer of 2s. per hour, which was not considered satisfactory, have issued a statement of their case. Objection is also taken to what were described as "black-legging clauses" in the proposed agreement. The committee repudiate the suggestion that they are likely to cut off the electricity supply of London at a moment's notice. Instructions have been issued to members of the union that the rates must be as follows: Electricians, 2s. per hour, *plus* 12½ per cent., and mates, 1s. 7d. per hour, *plus* 12½ per cent. of total earnings, pending the putting into effect of the result of the ballot, which by a large majority gave the committee the power to call a strike.

Correspondence.

A DIRECT METHOD OF CALCULATING SHUNT FIELD COILS HAVING TWO GAUGES OF WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of November 21st Mr. Jakeman gives a simple method of calculating shunt field coils having two gauges of wire. It appears from his opening paragraph that he is not acquainted with the method which I contributed to your pages on December 15, 1911 (Vol. LXVIII., p. 389). The latter takes into account the actual thickness of insulation on the wires, and gives reliable results when the guage numbers of the wires used differ by 2; the amount of labour involved is about the same as when Mr. Jakeman's method is employed.

According to the example which Mr. Jakeman gives, the suffix "1" is intended to apply to the larger wire in *both* final equations, though this is not stated in the text, where the derivation of equation (1) leads us to suppose that the suffixes 1 and 2 are interchangeable, or that they refer to the order in which the two gauges are used.—I am, &c.,

London, Dec. 6. F. T. Chapman.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am very much obliged to Dr. Chapman for drawing my attention to his article, which I regret had escaped my notice. I have now taken the opportunity of reading it, and I see that three curves are used in the treatment, a judicious guess having to be made of the final result in order to determine which curve is to be used. It seems probable, however, that sufficient accuracy would be obtained for practical purposes if these curves were replaced by a straight line representing the equation $l_2/l_1=1+kD/l_f$, where k is an empirical constant. This would obviate the necessity of referring to the curves. Even with this simplification, however, it is necessary to work out an expression involving nine terms (including the above constant) in order to obtain the ratio of the numbers of turns of the two gauges. Another expression involving four terms then gives the number of layers of each gauge. Further, in the latter expression an addition occurs, which makes it rather inconvenient for rapid work on the slide-rule. On the other hand, in my method it is only necessary to write down five numbers and then a simple manipulation of the slide-rule, and the addition of unity gives at once the ratio of the total winding depth to the depth of the larger gauge. In my own opinion, therefore, my method involves considerably less labour than Dr. Chapman's, and is very convenient for practical use in that the final expression can be so readily remembered. When the gauge numbers differ by 2, my method gives the value of the ampere-turns some 2 or 3 per cent. low, so that slightly more of the larger gauge should be used than the value calculated.

I am sorry I did not make it clear that the suffix "l" applies to the larger gauge, although it is stated about half-way down the second column. As far as equation (1), the suffixes 1 and 2 are interchangeable, since it is immaterial which gauge is wound first if the *number of turns* of the composite coil is to be the same as the single-gauge coil. It is only when it is desired to make the *ampere-turns* of the two coils equal that the order of winding makes a difference. I am, &c.,

Birmingham, Dec. 12. Robt. G. Jakeman.

CARBON ARCS FOR SEARCHLIGHTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your first editorial note of Dec. 5 you are good enough to refer to the above Paper. In doing so you lend support to two criticisms made respectively by Mrs. Ayrton and Mr. Harrison. You state that Mrs. Ayrton showed that the authors had forgotten the pointing of the negative carbon with short arcs when considering obscuration. The matter, however, is actually discussed in the portion of our Paper which you reprint on page 627 of the same issue. It is shown there that the pointing of the negative does not appreciably affect the figures given for the obscuration. It must be remembered that an arc length which is less than about 0·75 of the diameter of the positive carbon is not obtainable under practical conditions.

You also support Mr. Harrison in suggesting that the total flux of light to the mirror is the most important factor. For the highest intensity beams this is not the case, otherwise there would be little advantage in Mr. Harrison's lamp with its small carbon and high crater brilliancy. When the beam is made divergent, we agree that the total flux to the mirror and not the crater brilliancy, becomes important. This matter also is discussed in the Paper.

In the ordinary way one would have left these replies to the discussion till the Journal of the Institution was published. Your editorial note, however, implies that the authors have failed to recognise the points referred to. A perusal of the Paper will show that this is not the case, although with such elementary considerations as these we hope we may be excused for not having laboured them unduly. The Paper states quite definitely how much of the problem was tackled and indicates clearly the avenues of experimental work which had to be left for future investigation.—We are, &c.,

The Authors.

[It is true the authors stated that the reduction in the size of the positive tends to offset the reduction in the size of the negative; but is the diameter of the positive reduced by burning a very short arc? With regard to the second paragraph, it would seem that we are at cross purposes owing to loose phraseology and the overlooking of practical considerations. Every beam is necessarily divergent, since no arc is a point source. If a certain beam divergence is taken, then the total flux in that beam will be proportional to the total flux emitted towards the mirror in such a direction that it will be reflected back within the angle of divergence of the beam. If the beam divergence is reduced by decreasing the size of the carbon, then, of course, the intrinsic brilliancy of the carbon must be increased if the average intensity of the beam is to be raised.—Ed. *E.*]

MERCURY RECTIFIERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to your account of the mercury rectifier as supplied by Brown, Boveri & Company, I think it only fair to the General Electric Company and the Westinghouse Company of the United States to point out that six years ago they had a rectifier of this modern pattern actually at work. My colleague, Mr. Dalziel, and myself saw in the General Electric Company's works at the time a rectifier of 1,000 kw. capacity which was about to be placed on a New York, New Haven & Hartford Railway locomotive, the transformer taking 11,000 volts single-phase current from the overhead line, and the rectifier delivering, I think, about 600 volts to the direct-current motors. This locomotive ran some very successful trials on the New York, New Haven & Hartford Railway; but I understand the trials had to be discontinued during the war.

The General Electric Company informed us at the time that their intention was to develop them for the substitution of rotary converters in sub-stations. I am, &c.,

Derby, Dec. 15. J. Sayers.

Electricity (Supply) Bill.

In the House of Lords on Tuesday, on the motion for going into Committee on this Bill, the Lord Chancellor made a statement in explanation of amendments which stood in his name. He said that when he discovered that a number of peers who felt anxious about the measure was considerable he had to consider what were the prospects of the measure in view of the possible criticism and opposition, and he had no difficulty in deciding that it was not reasonable that the House should be asked, at this stage of the session, to address itself to a task of this kind. It was proposed that only one distinguishable portion of the Bill would be proceeded with by their lordships in the present session. The amendments would cut out of the Bill, first, all the compulsory powers for the establishment of district electricity boards; secondly, all the compulsory powers for the acquisition of main generating stations or main transmission lines; thirdly, they cut out the financial clauses of the Bill, excepting clause 19, which provided for emergency power stations. The Bill would not provide for the establishment of electricity commissioners, who would exercise the present powers and duties of the Board of Trade under the Electrical Lighting Acts and the orders and regulations made thereunder, and the power to conduct experiments provided in clause 3, and also the power to set up an advisory committee under clause 4. All the compulsory powers of the Bill were to disappear for the moment. The commissioners would be set up; they would have no compulsory powers, but would have an opportunity, when the subject was reintroduced, of examining and exploring the whole situation. It was at present the view of the Government that the proposals in the part of the Bill which had now been jettisoned were proposals which were greatly needed by the condition of the country. The present intention of the Government was to reintroduce early in the next session, in the form of a new Bill, those part of the measure which would now be jettisoned. The Treasury still consented to accept full responsibility for financing the proposal.

The House agreed to the amendments, and when the Bill comes up on the Report stage the amendments of other noble lords will be considered.

Manchester Extensions.

The new 25,000kw. turbo-alternator at Stuart-street station, Manchester, was started up on Monday. What is claimed to be the largest boiler in Great Britain, a Babcock & Wilcox water-tube boiler, which evaporates rather more than 100,000 pounds of water an hour, has also been recently installed in the station. In order to celebrate the installation a dinner was given in the evening when the chairman of the Electricity Committee, Ald. Dagnall, stated that the department had had a strenuous time in the last five years, but had never "let down" the munition manufacturers in the area. The declaration of the Armistice took away 25 per cent. of the demand for electricity, and the loss of income, with little corresponding saving of expense, accounted for the deficiency of many thousand pounds on the year's work. He believed their area had gone further ahead than any other in the development of electrical intercommunication, and it had already six stations connected up. He hoped that the principle would be extended to much wider areas. During the past ten years the plant had been increased by 120 per cent., and the maximum demand had increased in the same ratio. The average cost of production per unit gradually fell until 1914, since when it had risen on account of the war, and was still rising. Today the cost of production was the same as in 1909. The consumption of electricity had increased alarmingly in the last two months, and on the 9th inst. the output for the first time exceeded a million units. The maximum demand on that day at Stuart-street was 66,400 kw., and he thought that a justification of the Committee's policy of pushing forward the construction of the new station at Barton. There were now 2,000 people awaiting connection, and the Committee could not get the meters and the labour to connect them as quickly as they wished. By the end of the present financial year he believed they would be able to meet the whole of their expenditure and a part of last year's deficiency.

An Electrically-driven Bath Chair.

Among the latest things to undergo electrification is the invalid chair, or rather it would be more correct to say that the human element in the bath chair combination has been got rid of by the substitution of an electric battery and motor for the often inefficient and weary bath chair man. This process of transformation has been effected by Messrs. Carters, Ltd., the well-known firm of invalid chair manufacturers, who have just placed on the market an electrically-driven bath chair. As far as the chair part of the combination is concerned we need say little, as it is turned out in the way for which Messrs. Carters are already famous. The electrical portion consists of a 24-cell battery, which is placed under the seat and a small electric motor which is fixed underneath a bonnet-shaped housing over the front wheels, which it drives through means of bevel gearing. In addition there is the usual control gear. The ordinary hand steering apparatus usual to the bath chair is employed. A charging plug is fitted. Control is effected by means of a controller giving four forward speeds, and one reverse controller which is placed on the right-hand side of the chair within easy reach of the invalid's hand. The maximum speed obtainable in a forward direction is five miles an hour. It is obviously necessary that the braking arrangements should be adequate, and the return of the controller handle to the neutral position causes a solenoid brake to come into action, while in addition the chair can be checked down slopes or in emergency by means of a hand brake, which is operated from the left-hand side of the vehicle. The only thing which seems to be omitted to give absolute safety to the combination is a dead man's notch in case the invalid should suddenly faint owing to progress through the air being too rapid.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1915 Specifications.

[illegible] D[illegible] Glazebrook & Smith. Apparatus for determining the direction of wireless telegraphy and like signals. (25/5/15.) (Complete accepted 23/5/16. Patent sealed, 1/6/16.)

Consists of a vertical rotatable coil or equivalent closed circuit device constituting the receiving aerial, a transformer with a divided primary, the parts of which are connected to the receiving aerial and are connected together through a condenser, and a suitable detector connected to the secondary of the transformer, the secondary being connected or not to a condenser.

1918 Specifications.

133,725 Western Electric Co. Automatic or semi-automatic telephone exchange systems. (5/7/18.)
133,727 Ferranti. Electric transformers. (27/8/18.)
133,748 Thompson & Wood. Means for utilising the waste heat in electrical machinery and apparatus. (12/10/18. Addition to 18,763/17.)
133,751 West & Co., Breeze & Bossom. Alternating-current motor starters. (14/10/18.)
133,766 Heath. Sparking plugs for ignition purposes. (15/10/18.)
133,768 Damey. Electric switch. (15/10/18.)
133,783 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Electrical discharge devices. (17/10/18.)
133,792 Tudor Accumulator Co. (Soc. de l'Accumulateur Tudor.) Stoppers for closing the containers of electric accumulators. (18/10/18.)
133,799 Railing & Taylor. Means for gripping the flexible conductors or cords of electric lamp holders. (26/10/18.)
133,803 Tyler & Naylor. Non-spillable electric battery cells. (31/10/18.)
133,806 Stamp. Electrical controller for the operating of electrical motors of the series type. (4/11/18.)
133,817 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Electromagnetic lock-out switches. (14/11/18.)
133,845 Midgley & Vandervell & Co. Electric starters for internal combustion engines. (21/12/18.)
133,995 Crichton. Apparatus for electric welding. (11/10/18.)
133,997 John & Berry. Portable electric accumulators. (12/10/18.)
134,016 Price. Electric accumulator boxes. (22/10/18.)
134,018 Butcher, Deane & Kent Limited. Means for electrically signalling the movements of recording instruments. (22/10/18.)
134,019 Oldham & Oldham. Galvanic batteries. (22/10/18.)
134,045 B.T.-H. Co. (G.E. Co.) Systems of frequency transformation. (29/10/18.)

Relates to means for producing high-frequency alternating currents comprising a source of alternating current of a fundamental frequency having an electric circuit connected to it, comprising an air core inductance and an iron core inductance, series capacity in said circuit for neutralising the inductance of the source and of the air core inductance and shunt capacity in said circuit for neutralising the iron core inductance.

134,064 Miller, Brooke & British Westinghouse Electric & Mfg. Co. Electric motor control systems. (13/11/18.)

A system in which the various contactor swithes for rendering inoperative corresponding portions of a resistance in series with the motor are governed by relays which have their actuating windings connected in series with the motor, and so arranged as to open the circuits of the various contactors actuating or controlling coils as soon as the current is switched on to the motor, the closing of a contactor switch reducing the number of turns in the winding of the relay governing the circuit of the coil of the contactor which is next to operate, so that during the subsequent gradual reduction of the current in the motor circuit said relay will operate to close its contacts before the current has fallen sufficiently to permit the contacts of the remaining relays to close.

134,076 Prentice. Mounting of electrical apparatus in frames or cases. (21/11/18.)
134,098 Imbery. Hardening and tempering of metal wire by electricity. (7/12/18.)

1919 Specifications.

133,222 B.T.-H. Co. & Haigh. Dynamo-electric machines. (12/12/18.)
133,24[illegible] Fuller Accumulator Co. & Welch. Electric lamps for vehicles. (28/1/19.)
133,281 Jensen & Tilney. Electric terminals or end-pieces. (27/6/19.)
133,580 Bray & Bray, Markham & Reiss. Starters and controllers for electric motors. (31/1/19.)
133,59[illegible] Fuller Accumulator Co. & Welch. Detachable fixings for electric lamps or other articles. (19/2/19.)
133,592 Bra[illegible]n. Rotary electric switch. (24/2/19.)
133,60[illegible] Tweedie. Portable electric lamps. (10/3/19.)
133,625 Cable Accessories Co. & Reeves. Electric lamp lanterns. (2/5/19.)
12[illegible],546 British Westinghouse Electric & Mfg. Co. Protective arrangements for dynamo-electric machines. (17/6/18.) (Addition to 120,911.)
133,639 Siemens Bros. Dynamo Works, Howard & Morphew. Electrical transformers. (27/5/19.)
133,643 T[illegible]. Electrical system for generating intermittent high-tension current impulses for ignition purposes with or without low-tension current for battery charging, lighting and the like. (10/9/18.) (Divided Application on 14,715/18).
133,648 Owen. Brush-holders for dynamo-electric machines. (16/6/19.)
133,88[illegible] Smith & T[illegible]. Electric mercury switches. (13/2/19.)

Comprises a closed cylinder of insulating material, terminals inside the cylinder, and a plunger of insulating material having a cut-away portion or passage extending from end to end, the remaining space in the cylinder being filled with mercury, and the plunger serving to make and break contact by displacing the mercury from one end of the cylinder to the other.

133,882 Sc[illegible]. Anodes for use in electroplating. (19/2/19.)
133,883 Gerber. Devices for carrying out chemical processes by electrolysis. (20/2/19.)

Relates to the application of a travelling intermediate electrode moving between adjacent cells as a means of avoiding a porous diaphragm, said intermediate electrode being made of metal other than mercury, which metal transports the anions from one cell to the other cell, forming intermediately with these anions a compound which is substantially insoluble in water.

133,885 Sterling Telephone & Electric Co. & Be[illegible]. Telephone indicators or annunciators. (22/2/19.)
133,888 Siemens Bros. & Co. & T[illegible]. Electric [illegible] indicators. (26/2/19.)
133,9[illegible]1 Jack[illegible] & Mellersh (Taylor). Radio-telegraphic transmission systems. (4/4/19.)
133,924 C[illegible]les. Electric regulating switches. (24/6/19.)
13[illegible],9[illegible]3 Ferranti. Electric transformers. (27/8/18. Divided application on 13922/18.)
134,139 C[illegible] & P[illegible]. Construction of dynamos and magnetos. (6/2/19.)
134,178 Lin[illegible] & Allmanna Svenska Elektriska Aktiebolaget. Safety relays associated with starting and regulating apparatus for electric motors. (28/5/19.)
135,057 Phillips. Apparatus for grinding commutators for electric motors and the like. (31/1/19.)
135,06[illegible] Ba[illegible]. Electrically-operated bells or similar signalling apparatus. (3/2/19.)
12[illegible] M[illegible]. Iron cores for electric transformers, inductances and the like.
135,[illegible]66 Gr[illegible]lls & Heafe. Electric arc lamps. (10/2/19.)
135,073 Grab[illegible]. Dynamo-electric generators. (14/2/19.)
1[illegible]8,538 We[illegible]. S[illegible] for electric lamps. (18/6/18.)
135,1[illegible]9 Sve[illegible]. Automatic feeding mechanism with electrical interruption in connection with a balance for meat slicers or the like. (2/4/19.)

Legal Intelligence.

Adapter Pins for Electrical Work.

Last week Mr. Justice Roche heard an action brought by Messrs. Longbottom & Farrar, Ltd., against the B. E. Company (of London and Birmingham), Ltd., for the recovery of the balance of the price of certain brass adapter pins sold and delivered. For the defence it was pleaded that defendants were entitled to 2½ per cent. discount; that defendants were entitled to reject the goods because they were out of time, and also because the goods were not up to sample. Plaintiffs urged that defendants were not entitled to any discount. With regard to being out of time, it was said that the time had been extended by the conduct of the parties. Defendants accepted the goods, and only tried to reject at a very late stage. With regard to the goods being incomplete, plaintiffs had difficulty in obtaining some little screws.

After hearing counsel, his Lordship gave judgment for plaintiffs for £353 9s., with costs.

Postmaster-General v. Blackpool and Fleetwood Tramroad Co.

A Divisional Court (Lords Justices Warrington and Scrutton) heard an appeal of plaintiff from a judgment of his honour Judge Sturges in favour of respondents at Blackpool County Court.

Counsel for appellant (Mr. Ross Brown) said the appeal was from a decision in which the learned judge had held that the Postmaster-General was not entitled to recover expenses to which he had been put in repairing damaged telephone cable at Blackpool, caused by the working of the company's tramway undertaking. The tramway ran from Blackpool to Fleetwood, and running almost parallel with that line was the telephone cable of the Postmaster-General. At Bispham Point the two were within 7 ft. of each other, and the electric current escaped from the tramway line under the cable of the Postmaster-General, with the result that electrolysis was set up, which eventually caused a corroding of the lead sheathing of the telephone cable. It was a gradual process, and in the course of time there was a breakdown of the telephone cable, which appellant said was "an injurious affection of the Postmaster-General's telephone" within the meaning of the Blackpool and Fleetwood Tramroad Act, 1896, and for the expenses to which appellant was put in repairing it he claimed £16 18s. He contended there was an absolute obligation on the part of respondents under the Act to pay for such repairs.

Mr. Rigby Swift, K.C., for respondents, said the parties agreed that the County Court judge should act as arbitrator in the matter. The learned judge said that he had no jurisdiction to deal with the matter; but the parties agreed to waive any question of jurisdiction. In those circumstances, when the learned judge had given a decision the other side could not go back on that. It was not suggested the respondents had been guilty of any negligence, and if there had been a suggestion that they had in some way or other constructed or worked their undertaking in a manner they should not have done, the County Court judge had found that had not been proved.

Lord Justice Warrington, in giving judgment, said the tramway was constructed in 1898, and in 1914 the Postmaster-General caused to be laid along the same road a telephone cable. In 1916 there was a large leakage of electricity from the tramline, and, as the result of the electrical action, the Postmaster-General's cable was injuriously affected. It was necessary to effect certain alterations with the view of making good what had previously happened, and with the view of preventing it for the future. The case turned upon the proper construction of sec. 65 of the private Act, and in particular of sub-sec. 2. It was admitted that the telephone cable came within the expression "telegraphic line." The sub-section appeared to him to give to the Postmaster-General a statutory right to recover the expenses. Therefore he thought the judgment of the learned judge was wrong, and that the Postmaster-General was entitled to judgment for £16 18s. and costs.

Lord Justice Scrutton agreed, and the judgment of the County Court judge was, therefore, reversed.

Duty on Deferred Interest Warrants.

The Court of Appeal (the Master of the Rolls, and Atkin and Younger, L.JJ.) has dismissed the appeal by the Attorney-General, on behalf of the Crown, from a judgment of Mr. Justice Rowlatt, refusing a declaration that the issue by the South Wales Electrical Power Distribution Company of half-yearly deferred warrants to holders of its 5 per cent. debenture stock was liable to duty under sec. 8 of the Finance Act, 1899. The company, instead of paying the interest on the debenture stock in cash, has for about 10 years issued deferred warrants for the amount (less tax), the warrants themselves carrying 5 per cent. interest. The question was whether these deferred warrants were issues of loan capital within the meaning of the section, which said that "loan capital mean debenture stock, &c., or funded debt by whatever name known, or any capital raised by any company in the United Kingdom which is borrowable or has the character of borrowed money." Each warrant bore a penny stamp, and no stamp duty except that had been paid upon them. The amount in dispute was about £95,000, as being the sum on which the ad valorem duty would have to be calculated.

Mr. Justice Rowlatt found for the company, and held that the company had merely given an acknowledgment of unpaid interest.

Commercial Topics.

Committee on Merchandise Marks.

The Merchandise Marks Committee, who are considering the questions of indications of origin on goods and of national trade marks, met at the Board of Trade offices on Thursday and Friday under the chairmanship of Mr. Harry Greer, M.P. Evidence was given regarding the present position of the matters into which the Committee are inquiring, in so far as those matters affect the Board of Trade and the Customs, by Mr. H. Fountain, C.B., C.M.G., an assistant secretary of the Board of Trade, Mr. Temple Franks, C.B., Comptroller-General of Patents, Designs and Trade Marks and Comptroller of the Industrial Property Department of the Board of Trade, and by Mr. Mr. J. L. Mackie, an assistant secretary of the Board of Customs and Excise.

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Foreign Trade Commissioners

In pursuance of the policy of placing trade commissioners in foreign countries, several appointments have been made by the Overseas Committee of the Federation of British Industries and among the recent appointments are the following :—Mr. Ed. H. Capp, secretary of the British Chamber of Commerce for Italy, who will open an office for the Federation of British Industries at Milan at an early date ; Mr. G. L. Barley, c/o Messrs. Rugeroni & Rugeroni, Ltd., Rua 1° de Dezembro 82/84, Lisbon ; Mr. F. Dorrien Thoroton, Federation of British Industries, 6, Rue de la Liberte (Cox & Company), Algiers ; Captain Lafontaine, who will also open an office for the Federation in Constantinople at an early date. The Algiers and Portuguese offices will act under the supervision of the Federation's Trade Commissioner in Madrid (Colonel Thoroton) and the Constantinople office will act under the supervision of the Federation's Trade Commissioner in Athens (Major Kennard).

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The Indian Trade Outlook.

In an interesting report by H.M. Senior Trade Commissioner (Mr. T. M. Ainscough, O.B.E.) points out that before the war India was, and still is, the most important market in the world for British manufactured goods. From the abstract of the report in the "Board of Trade Journal" we learn that during the war many changes occurred and certain formidable competitors have established themselves in the market. In 1913 the imports of British metals and machinery were valued at £25,000,000, and of railway and mill stores, &c., at £10,000,000. The most important factor has been the elimination of the goods of the Central Powers, and their replacement by imports from Japan and the United States. In addition, both Japan and America have enormously increased their shipments to India and are successfully competing in articles which formerly were obtained almost exclusively from the United Kingdom. During the war the place of the Central Powers has been taken by the United States so far as iron ond steel, machinery, hardware and instruments are concerned, and by Japan in such articles as electrical accessories, copper, glassware, textiles, &c. The bazaar trade in cheap showy goods has been entirely captured by Japan, and it is difficult to see how any European nation will ever be able to compete with Japanese low-priced labour in those articles where quality is not considered and where price is the sole desideratum.

Mr. Ainscough refers to the gradual change of attitude in recent years on the part of the old-established conservative and yet powerful British merchant houses in Calcutta and Bombay, through whose hands in the past both the export and the import trade of the country was transacted. The large engineering agency firms are now so interested in managing local engineering works that they cannot be expected to pay the same attention to the interests of those United Kingdom engineers whom they represent, and in certain cases their manufacturing and their distributing interests clash. The time has come when the export merchant in London, who, in the past, has specialised on the Indian market, and who holds the selling agency for several United Kingdom makers, should extend his activities one step further in order to fill the gap. He should open his own offices at the principal ports, and set up an active selling organisation throughout the country. The old-fashioned methods still in vogue of treating import agencies in many of the largest merchants' offices in Calcutta and Bombay will not survive the competition of these strenuous times. The more recently established firms are taking a much more active interest in the import trade, and are realising that business must be sought. It is strongly recommended that when a United Kingdom manufacturer appoints a merchant firm as his agents in India, he should at the same time send out a trained representative, well acquainted with every particular of the goods he makes, in order to represent his interests. The changes brought about by the war have confirmed the fact that the only really satisfactory method of representation for manufacturers of engineering plant, machinery and articles which find a constant and large sale in this market is to establish their own branch and selling organisation in India.

The industrial development of India is proceeding on the most modern and scientific lines. Firms of managing agents to-day are not satisfied with anything less than the latest and most approved plant which is being used in any part of the world for any given process. They also require that assistance and technical advice which only trained engineers and specialists can give. In conclusion, Mr. Ainscough is of opinion that the day when large engineering makers could rely upon securing Indian orders without moving out of London is past.

Electricity Supply.

BEXHILL Council has applied for sanction to a loan of £4,000 for a new feeder cable.

BATH Corporation has authorised an expenditure of £15,000 on extensions of mains.

SUNDERLAND Corporation has sanctioned the introduction of the pre-war standard of lighting the streets.

MANSFIELD Corporation has been authorised to borrow £21,000 for extensions of the electric generating plant.

The ISLE OF WIGHT Electric Lighting & Power Company has applied for authority to erect overhead cables and poles in the Carisbrook and Northwood districts.

The Board of Trade has extended by three months from Jan. 31, 1920, the times specified in the YORK ELECTRIC LIGHTING (EXTENSION) ORDER, 1914, for laying mains, &c.

As the DARWEN electricity station is incapable of meeting the increased demands for current the Lancashire Electric Power Company has been asked to supply electricity in bulk.

The South Metropolitan Electric Tramways & Lighting Company has informed the BEDDINGTON and WALLINGTON Urban Council of its intention to lay mains through the district to a factory.

An important extension of the Limehouse generating station has been decided upon by the STEPNEY (London) Borough Council. The estimated cost is £116,500, but the whole scheme will cost £534,000.

AUDLEY Urban Council is considering the question of obtaining power to light the Talke district by electricity or gas, and inquiries are being made of other similar authorities as to the cost of a scheme.

WHITBY Urban Council has applied for authority to borrow £21,000 for extensions of the electricity works. There has been an increasing demand for power since the re-opening of the Whitehall shipyard.

WITNEY Urban Council has decided to call in a consulting engineer to report upon a proposal to install a 750-ampere hour battery at an estimated cost of £2,000. Extensions of mains are to be carried out at a cost of £350.

A syndicate formed by Mr. F. M. Gascoigne has acquired the HEXHAM and District Electric supply Company's undertaking ; additional generating plant is to be erected, and Messrs. Christy Bros. & Co. are acting as consulting engineers.

BLACKPOOL Electricity Committee recommend an expenditure of £30,000 on new feeder mains, distributors and services, and application for borrowing powers is to be made. A tender of the British Insulated & Helsby Cables, Ltd., for the supply of 4,000 yds. of cable has been accepted.

HACKNEY (London) electricity department is laying a main from its Dalston sub-station to connect up with the electric supply system of Shoreditch Council. There were already links between the Willesden system and Hackney, and thence with Shoreditch by way of Poplar and Stepney.

The Board of Trade has extended for three months from Jan. 8, 1920, the periods limited by the YEOVIL ELECTRIC LIGHTING ORDER, 1914, for laying mains, &c. The Board has also extended for three months the period limited by the DEAL & WALMER GAS & ELECTRICITY ACT, 1914, for laying mains.

The accounts of the WEST HARTLEPOOL electricity department for the year ended March 31, 1919, show revenue £31,798 (compared with £26,997 in the previous year) and working expenses were £19,684 (£16,146) leaving gross profit £12,114 (£10,851). Capital charges amounted to £12,128 (£11,450) and the net surplus was £356 (£110).

ULVERSTON Urban Council is desirous of introducing electricity supply, and the ratepayers are to be canvassed in order to ascertain the number of probable consumers. Mr. R. Dilworth has also been instructed to meet the directors of North Lonsdale Iron Company with a view of ascertaining the possibilities of utilising the waste gases at the ironworks for generating electricity.

Owing to the difficulty of coping with the demands for electrical energy Belfast Electricity Committee has been obliged to request all users of electricity to reduce their demand as much as possible between 4 and 5.30 p.m. until the 31st inst. Wherever possible electric motors should not be used during these hours, and one lamp in every five ordinarliy lighted switched off or removed.

Owing to protests against the present poor lighting, ARBROATH Town Council has asked the local electric light company to state its terms for the supply of electricity. It has been agreed to resume the electric lighting of the streets and the 20 existing standards will be purchased by the Council. Arrangements will at once be made for re-installing the electric light in the main streets.

At the meeting of the LONDON COUNTY COUNCIL on Tuesday, the Finance Committee recommended that a loan of £56,223 be granted to Hackney Borough Council, and of £49,925 to Hammersmith Borough Council, for extensions of their electricity undertakings. In view, however, of the radical alterations made in the Electricity (Supply) Bill in the House of Lords, it was decided, on the suggestion of Mr. Gordon, to postpone consideration of the loans until the next meeting of the Council, so that in the meanwhile the Finance Committee and the Special Committee on Electricity should reconsider their position.

The SHEFFIELD Electric Supply Committee estimated that the income of the department for the year ending March 25, 1920, would be £681,416, but the present estimate puts the figure at £641,000; and the estimated income for the year ending March 25, 1921, at £737,250. The original estimate of expenditure for the current year was £240,386, but the present estimate is £211,500.

Owing to the shortage of coal and the fear of a breakdown at the Corporation electricity works, the Hull Fuel Overseers have prohibited all outside and inside "display" electric lighting at shops between three and five in the afternoon, Saturdays excepted. The order applies to all places of public entertainment. All other consumers, including industrial users, are warned to reduce their consumption by one-third.

The Gloucester Electricity and Light Railways Committee has reported that extensions of plant are necessary, and the city electrical engineer (Mr. F. H. Corson) has prepared alternative schemes—one as to extensions necessary to meet the expected demands of the next year or two, and the other to enable the undertaking to participate in the Government electric scheme to the extent provisionally approved by the chief Electrical Commissioner designate.

The first meeting of the District Industrial Council for electricity supply industry for the counties of Shropshire, Stafford, Warwick and Worcester was held at the Council House, Birmingham, on Thursday last. Mr. R. A. Chattock, city electrical engineer, Birmingham, was elected chairman and Mr. E. J. Jennings, secretary of the Birmingham Electric Supply Department, secretary and treasurer to the Council. A draft constitution was approved and other business dealt with.

At a meeting of representatives at Cardiff on Friday last it was decided to form a Joint Industrial Council for the electricity supply industry in South Wales and Monmouthshire. It was also decided to form a Drafting Committee, and the following were appointed: Employers' side (local authorities): Col. Sinclair, Swansea; Sir John Courtis, Cardiff; Ald. John Moxon, Newport; Mr. W. A. Chamen, Cardiff; Mr. Lewis Dickson, Merthyr; and Mr. J. Stewart, Llanelly. Employees' side: Mr. James, A.S.E.; Mr. Quick, N.U.G.W.; Mr. Stevens, Workers' Union; Mr. Davis, E.T.U.; Mr. Thomas, S.E.M.; and Mr. Williams, C.&J.

Another appeal has been made to the electric supply consumers at Bradford to restrict the use of energy at certain times, especially between 9.30 a.m. and noon and 3.30 and 5.30 p.m. Immediately after the recent breakdown of a portion of the generating plant consumers were asked to discontinue the use of heating and cooking appliances between 3.30 and 5.30 p.m., and reduce appliances to half-heat from 8 a.m. to noon, and from 2 p.m. to 3.30 p.m. Unless more attention is paid to these requests the chairman of the Electrical Committee (Councillor Turner) states that the department will be unable to cope with the load between 3.30 and 5.30 p.m. The load at 4.30 p.m. on the 8th inst. was 19,172 kw., or 1,000 kw. greater than it had been on any previous evening this winter, and the whole of that 1,000 kw. was attributed to consumers failing to switch off their radiators at the time asked. The normal rated capacity of the plant available is 12,900 kw., and if consumers will not reduce their demands voluntarily during the restricted hours the Committee will have no alternative but to take the necessary steps to safeguard the plant and maintain only a restricted supply all round. The textile industry, both employers and employed, have agreed to work rather awkward hours in order to help the department, and it is hoped that all other users of electricity will curtail their consumption during restricted hours as far as ever possible.

An inquiry was held at Doncaster last week into the application of the Corporation for power to borrow £40,000 for the extension of the electricity station. It was stated that as the borough now included the districts of Wheatley and Balby-with-Hexthorpe, the demand for current had increased, and £40,000 was the lowest estimate of the cost of the extension. Mr. E. S. Rayner, formerly electrical engineer and tramways manager for the Corporation, said the Corporation had placed provisional contracts for a new turbine and a new boiler, and, in view of the increasing demand, they wished to complete the extension as early as possible. Present applications were practically all for power, and there was no doubt there would be a very large increase in the supply required by the Great Northern works. The Corporation would get the whole of the Great Northern load if their supply was satisfactory.

Mr. S. Balmforth, chairman of the Electricity and Tramways Committee, emphasised the fact that the works had no reserve plant, except the rotary converters. Unfortunately, the large turbo plates gave way two or three days ago, and the Great Northern Works had to be shut off. Referring to the national scheme, Mr. Balmforth said that he and other members of the Corporation waited upon Sir John Snell, and were told that Keighley would be the central station for the district, and that Doncaster would be transferred into a sub-district.

The Inspector said he was afraid they would be "in the cart" if they did not have a larger supply than they asked for. The Inspector explained that if the Ministry of Health were satisfied that the extensions were necessary, and that the plant proposed to be put down was a proper one, the Ministry would express a general approval of the whole scheme, and would give sanction for such amounts as the Corporation had tenders for. They gave a general approval, say, to the scheme; but one £40,000 might not be sufficient. Referring to the former proposal of the Corporation to extend the present building, the Inspector said, if the present obsolete machinery were swept out, there would be plenty of room for the new machinery. He would have an interview with Sir John Snell, and, if it was thought advisable to increase the present proposal, would the Corporation be prepared to fall in with the suggestion?

Mr. Balmforth said he was sure they would. They reduced their scheme to the lowest possible point because they did not want to go beyond what Sir John Snell thought desirable. He should have no hesitation in putting forward an application for a further £3,000 kw. set. There would then be no doubt about the supply being wanted.

Electric Traction.

The Minister of Transport has extended for one year from Aug. 15, 1920, the period limited in an Order by the Board of Trade dated Jan. 3, 1919, for the exercise of the powers for the construction of the railways authorised by the Central London Railway Act, 1913, &c.

A further increase in tramway fares is foreshadowed by the Highways Committee of the London County Council, which reports that the existing basis was approved in April, and the results show that there is likely to be a considerable deficiency. It had been intended to submit before the Christmas recess definite recommendations, but the Advisory Committee of the Ministry of Transport had asked that a decision might be delayed to permit that Committee to review the questions involved.

Mr. W. J. Squires, chairman of the Committee, states that the moulders' strike is seriously interfering with the work of repairing tramcars. The present congestion would be considerably relieved when these repairs were carried out. The question of ordering more new cars is under consideration.

The Light Railway Commissioners have held an inquiry into the application of South Shields Corporation for powers to construct a light electric railway between Westoe and Cleadon, where a big housing scheme is projected. The North-Eastern Railway Company opposed on the ground that the proposed light railway would draw traffic away from the railway and that, should the venture not be a financial success, the company, in addition to the loss of traffic, would, as large ratepayers to the borough, have to bear a portion of the loss. Mr. J. B. Hamilton, of Leeds, gave evidence as to the value of the new line, which would serve on an average for five years about 12,000 persons. Other witnesses were called and the Commissioners reserved their decision.

An inquiry was held at Newport (Mon.) last week into the application of the Corporation for a loan to purchase electric vehicles and motor lorries for scavenging purposes. It was stated that the scavenging work had been carried out in two contracts on the eastern and western sides of the river, and the present loan was in respect of the western side.

The borough electrical engineer (Mr. A. Nichols Moore) said that the contract for the western side had been thrown up by the contractors. The contract for the western side had been £8,400 a year, and the cost over 10 years by direct labour would be at the rate of £8,600 a year.

Sheffield Corporation has authorised a further increase in tramway fares. In justifying the increase, the chairman of the Tramways Committee (Sir Wm. Clegg) stated that all trading departments of the Corporation should be self-supporting. At the end of June last the net balance on the first three months' working for the present year was £12,927, but at the end of August, despite the fact that the traffic period was the best of the year, that had been reduced to £11,839; and on Sept. 29, the end of the half-year, the balance had been reduced to £4,723, while on Nov. 9 there was a deficit of £2,764 16s. 11d., or a loss from Sept. 29 to Nov. 9 of £7,398. During the four weeks to Nov. 23, 1918, the wages were £20,609, and in the corresponding four weeks of this year they were £35,053, an increase of £14,443. Since March, 1914, the cost per car-mile had gone up from 9½d. to 1s. 6½d. Electrical energy was now costing 1·033d. per unit, compared with 0·8d., a difference of £25,241 per annum. Tramway rails had risen from £9 10s. per ton to £24, representing £20,000 a year, and other materials had risen correspondingly. In round figures, the wages bill had increased between March 1915, and the present time by nearly £230,000 per annum.

The report of the inspector who inquired into the tramcar accident which occurred on Sept. 27 at Borough-road, Tynemouth, on the Tynemouth and District Light Railway, has been issued. The tramcar descended the hill in Borough-road at an excessive speed, and was overturned at the sharp right-handed curve at the foot of the hill. After a description of the car and its equipment, &c., the report states that the car was driven by an experienced motorman, who was well used to the route. On examination after the accident the inspector found the gear and brakes in perfectly serviceable condition; the car could easily be controlled on Borough Bank by either the hand or the track brake. It appears probable that the overturning point was reached when the leading wheels had travelled over some 45 ft. or 50 ft. of the curve to a position where the radius is about 85 ft., and the super-elevation falls to ⅞ in. Had the wheels not been locked it is quite probable that the car would have safely negotiated the curve. The report states that the responsibility for the accident rests upon the motorman (John Fothergill) for approaching the hill at too high a speed and for unskilful manipulation of his brakes and sanders. The case exemplifies the danger arising from the approach to a decline at a speed higher than that authorised, and a too-powerful application of the hand brake: and emphasises the great importance of ensuring that, before descending a steep gradient, an adequate application of the track brake has been made. To this end, motormen should be definitely instructed to make sure that the slipper brake is applied with full force before starting down a gradient, and then released sufficiently to enable the car to roll down the hill at the desired speed. The practice of starting down a steep hill by the release of the hand brake only is to be deprecated. The accident also emphasises the great care which has to be exercised in operating double-deck cars on this gauge down steep gradients. When the light railway was first opened (in 1901) single-deck cars only were allowed to be operated in Borough-road. This restriction was withdrawn six months later, when double-deck cars were allowed on condition that an additional employee was carried on the front platform for manipulating the brakes. In 1906 this further restriction was withdrawn, in view of the greater degree of training which motormen had acquired, and on the understanding that the super-elevation on the curve at the foot of the hill was 1½ in. throughout.

Imperial and Foreign Notes.

The installation of a wireless telegraphy service for Northern Manitoba has been recommended.

A diamond factory is to be erected at Kimberley which will contain 100 mills equipped with electric power.

The electric supply works of the Belize Ice and Electric Light Company, of Belize, British Honduras, has been taken over by the Government owing to the alleged failure of the company to fulfil the terms of its contract. New plant and electric supplies will be required for the undertaking.

The reservation to the State of the right to import electric incandescent lamps into Italy is now revoked, but the tax of 25 per cent. on the value of the lamps is still in force. The value of carbon filament lamps is assumed to be 1.60 lire each, and of metallic filament lamps :—up to 60 c.p., 3 lire ; from 65 to 250 c.p., 6 lire ; from 251 to 900 c.p., 16 lire ; and 1,000 c.p. or more, 24 lire.

The Minister of the Interior of the Canadian Government has made an arrangement between the Hydro-Electric Power Commission of Ontario and the Water Power Branch of his own Department for carrying out a thorough water resource and power investigation of the Province of Ontario. The investigation will be carried out under the supervision of the Director of Water Power of the Department of the Interior. A skilled hydrometric survey staff will be organised and put to work without delay.

In connection with the scheme of electrification of the Melbourne suburban railways the line to the suburb of St. Kilda ($3\frac{1}{2}$ miles from Melbourne) was recently brought under electric operation and comparison is now available between the results obtained under the new system and the old. The comparison is made between September of this year and the corresponding month last year, and it shows that the total number of ordinary daily tickets issued between St. Kilda and Melbourne increased from 210,254 to 286,493, an advance of 76,239, or 36·4 per cent. The passenger journeys increased from 333,335 to 459,726, an advance of 126,391, or 39·9 per cent. Not all of this increase is due to electrification, as the general increase in the number of passenger journeys for the 12 months ended June 30 of this year over the whole of the suburban system was 7·2 per cent. ; and for the St. Kilda line (outward booking only) 5·2 per cent. An official estimate is that an increase of at least 20 per cent. is due to electrification.

Miscellaneous.

At a meeting of the Staffordshire Iron and Steel Institute, at Dudley on Saturday, Mr. L. C. Harvey spoke on Pulverised Fuel, and said that if applied to electricity stations there would be a saving of at least 25 per cent. in fuel consumption and super-power stations if they did materalise would be known as the super white elephants of a profligate age, unless the economy following the use of this fuel was practised.

In order to inaugurate a Newcastle branch of the Electrical Trades Benevolent Institution, representatives of the North-East Coast electrical industries held a conversazione, supper and ball at Tilley's Rooms, Newcastle-on-Tyne, on Friday last. Mr. and Mrs. R. P. Sloan held a reception from 7.30 to 8 p.m., and there was a large company present. Mr. W. Fletcher, 65, Blackett-street, Newcastle, acted as hon. secretary.

The Industrial Court has decided a point in dispute between the Electrical Trades Union and Gravesend Corporation, which arose out of the award of the Committee on Production of Nov. 8, 1918. The union claimed that overtime should be paid on all hours worked beyond 47 and 48 per week between Feb. 1, 1919, and the date when the Corporation reduced the weekly working hours of the employees concerned ; but the Court decided that the claim had not been established.

The annual general meeting of the West of England Divisional Branch Council of the Electricity Supply Commercial Association was held at Bristol on Friday. Mr. T. H. Gait (Bristol), Divisional Branch chairman, presided, and the members present included representatives from Bath, Bristol, Gloucester and Cornwall. The hon. secretary, Mr. A. N. Allen (Gloucester), presented an excellent report giving a resumé of the work accomplished both by the Branch Divisional Council and by the National Council of the Association since the last general meeting, and hearty appreciation was expressed that so many operations of the Association had been successful. The hon. treasurer (Mr. E. E. MacVitie, Bristol) presented the annual statement of the accounts, and the meeting closed with a hearty vote of thanks to the officials of the Branch.

We have received from the British Insulated & Helsby Cables a copy of the Rules of the B. I. & H. C. Staff Guild, which has recently been formed to promote the prosperity of the staff and to be a means of communication between the staff and the directors on subjects connected with the welfare of the former. It will also promote social intercourse amongst members of the Guild and make arrangements with tradesmen and others for special discounts to be granted to the members. The business of the guild will be managed by a Committee of 15, drawn from the various departments. Although the Guild has only been recently formed it is already extremely popular, no less than 85 per cent. of the members of the staff having joined. It should be noted that while the Guild affords a regular channel by which the staff can make known to the directors of the Company through its management matters which need attention, the underlying keynote of the Guild is citizenship and service, thus implying hearty co-operation among all members of the Guild.

Telegraph and Telephone Notes.

The telegraph service between France and Germany was resumed on Tuesday. The charge is 18 centimes per word and no code messages will be allowed. Telegrams in French, German, English, Italian and Japanese will be received for transmission.

What is claimed to be the first provincial Wireless Receiving Station erected for the receipt of wireless time signals was put into operation on the 12th inst. in Messrs. Reid & Sons' premises, Blackett-street, Newcastle. The installation is licensed by the Postmaster-General, and was erected under the supervision of Capt. W. H. Leete, D.F.C., who will be in charge of the station.

One of the disadvantages of present-day telephones, especially in public call offices, is the insanitary character of the ordinary ebonite mouthpiece. To overcome this the Sterling Telephone Company are issuing a Glass Sanitary Mouthpiece at the very low price of 2s. As if this were not attractive enough in itself, they have produced a very well-designed cardboard stand for displaying it. The whole arrangement is well worthy of special notice, as our illustration indicates. We expect there to be a steady demand for these mouthpieces.

An inquiry was held at Hull last week into the application of the Corporation for sanction to borrow £61,786 for extensions of the municipal telephone system, including £3,000 for the erection of a building for a district automatic exchange. It was stated that in 1914 a net profit of £5,000 was made ; but during the war there was an adverse balance. Bonuses had to be paid, and the bargain that Post Office conditions should be granted to the Corporation staff was adhered to. The total loans obtained amounted to £256,498, of which £192,423 was paid for the undertaking. The Corporation had paid off £72,110, and the outstanding debt was £184,387. In addition, £11,734 had been spent out of revenue between January, 1912, and the end of the last financial year. Last year there was a deficit on net revenue of £1,105, the first deficit for 16 years, and entirely accounted for by increase of wages. The wage bill was £13,000 a year more than it was in 1913. The previous loans were granted for 25 years, and the inspector (Mr. T. Ekin) said the Corporation would not get that length of time for repayment of the £60,000, as the Ministry had settled the periods for repayment.

The Town Clerk pointed out that Hull was the only telephone authority in the country with the exception of the Post Office ; therefore, there could hardly have been a fixed period for repayment of telephone loans. Besides, if the Post Office had a fixed period, surely the position in Hull would be taken into consideration by the Ministry.

The engineer (Mr. Holme) : It is true the Post Office write off the loan in 20 years, but they use the depreciation fund for renewals, which is equivalent to allowing Hull to spend its sinking fund.

Educational.

The Glasgow University has received an anonymous gift of £5,000 to establish a lectureship in electrical diagnosis and therapeutics in connection with the Western Infirmary. Mr. John T. Cargill, who recently gave £20,000, has now decided to adopt the suggestion to found a Cargill chair of applied physics at the university.

Dr. C. H. Desch, of the Royal Technical College, Glasgow, has been appointed professor of metallurgy at Sheffield University in succession to Dr. Arnold, who recently resigned. Dr. Desch received his scientific training in Finsbury Technical College, the University of Wurzburg and University College, London.

The Council of the Senate of Cambridge University, while putting forward a grace for the appointment of a syndicate to consider the allocation and the administration of the benefaction of the British oil companies, are of opinion, after consultation with Prof. Sir W. J. Pope, that it is desirable to establish a professorship of physical chemistry, the stipend of which (£1,000) would be furnished out of the benefaction.

A donation of £10,000 has been given by Lord Cowdray towards the fund for the reconstruction and re-equipment of the engineering buildings at University College, London. An additional donation of the same amount will be given when the total sum collected reaches £70,000. In recognition of the gift of £34,500 by Sir Ralph Forster, to the fund for the chemistry building and equipment, the organic department of the chemical laboratories will be known by his name.

An influential deputation waited upon the Lord President of the Council (Mr. Balfour) and the President of the Board of Education (Mr. Fisher) in order to urge that powers should be conferred upon the Imperial College of Science and Technology to confer degrees in its own subjects. The deputation was introduced by the Marquis of Crewe, and in reply Mr. Balfour, who reviewed the proposal as presented by the deputation, and pointed out certain objections which would have to be considered, promised that the fullest and most serious consideration would be given to the matter.

Tenders Invited and Accepted.

The Victorian Railway Commissioners require tenders by 11 a.m., Jan. 7, for the supply of steel strand g.-i. wire (contract 32,718).

Johannesburg (Transvaal) Council require tenders for copper wire cable insulators and steel poles (contract 548). Tenders to the Town Clerk by noon Jan. 8.

Manchester Electricity Committee require tenders by 10 a.m., Dec. 29 for three-phase 6,600 volt sub-station switchgear. Specifications from Mr. F. E. Hughes, Electricity Department, Town Hall, Manchester.

Sydney (N.S.W.) Electric Lighting Department require tenders by 3 p.m. Jan. 19 for supply of sub-station equipment (except power transformers) (contract 558). Specifications from the City Electrical Engineer.

Tynemouth Corporation invite tenders for ten 250-k.v.a. transformers. Specifications from Mr. C. Turnbull, borough electrical engineer, Electricity Works, and tenders to the Town Clerk, Mr. Stanley Wilson, by Jan. 12, 1920.

Islington (London) Council require tenders by noon Jan. 28 for one year's supply of stores for their electricity department, including cables, meters, lamps, transformers, carbons, &c. Specifications can be obtained at the Town Hall.

Halifax Corporation want tenders by Jan. 5 for 13 months' supply or tramway stores, including lighting fittings, insulating materials, v.r cable, wires, trolley and overhead line materials, castings, &c. Forms of tender from the Tramways Engineer.

Tenders are invited by 3 p.m. of Feb. 10 for the supply and erection of 340 accumulators required by the Postmaster-General's Department, Western Australia. Tender forms from the office of the High Commissioner for Australia, 406, Australia House, Strand, London, W.C. 2.

Tenders are invited for the supply and erection of electrical machinery (power and lighting) and material for the port of Valparaiso, Chile. Specifications may be examined at the Chilean Legation in London, and tenders by 3 p.m. March 15, 1920, to the Secretary of the Ports Commission.

The Electric Supply Committee of the City of Sheffield invite tenders for the supply of materials and works required in connection with the supply and laying of 6-core e.h.t. split conductor cable. Specifications, &c., from the general manager and engineer, Mr. S. E. Fedden, Commercial-street, Sheffield, where tenders are to be delivered by Jan. 2.

Barnes Urban District Council invite tender for the supply of water-tube boilers, economisers, draught plant, turbo-alternators, condensers, air and circulating pumps, transformers and rotary converters. Specifications from Mr. C. S. Davidson, M.I.M.E., M.I.E.E., Electricity Works, High-street, Mortlake, S.W.14. Tenders by noon of Jan. 12.

Tenders are invited for the manufacture and laying of duct, electrical cable, &c., between the generating stations of Fulham and Hammersmith. Specifications from the engineer, Mr. Arthur J. Fuller, Electricity Works, Townmead-road, Fulham. Tenders to Mr. J. Percy, Shuter, Town Clerk, Town Hall, Fulham, London, S.W.

Palmerston North (New Zealand) Council require tenders by 4 p.m. March 2 for the supply of two 400 h.p. pressure producers and auxiliaries, 3,000-volt generating sets, converters, battery switchboards, &c. Specifications can be inspected at the Department of Overseas Trade (Room 40), 35, Old Queen-street, London, S.W.1.

Stepney (London) Electricity Supply Committee invite tenders for manufacture and erection of two water-tube boilers, economisers and other accessories, and one 5,000-kw. turbo-alternator condenser, accessories and switchgear. Specifications, &c., from Mr. Wm. C. P. Tapper, M.I.E.E., borough electrical engineer and manager, and tenders to the Chairman of the Committee, 27, Osborn-street, Whitechapel, E., by noon Jan. 22.

Heywood Council has placed orders with the Macintosh Cable Company for the supply of e.h.t. and l.t. cables and with Messrs. Bruce Peebles & Co. for a motor converter.

The tender of Messrs. J. Stanley & Company has been accepted for the provision of an electric light installation at the Redemptorist College and Church, Dundalk, for £950. There were six tenders, varying from £950 to £1,500.

Belfast Corporation has accepted the tender of Messrs. Orr, Watts & Company, for Iron work required at the new electricity station at £39,217. The price was increased by 10 per cent. owing to advance on cost of labour and materials since the tenders were sent in.

Manchester Corporation has accepted the following tenders:— Walter Scott & Company, tramway rails; Bruce Peebles & Company, supply of a 1,500 kw. motor converter at Dickinson-street Station; Brush Electrical Engineering Company, two 250 k.v.a. and two 500 k.v.a. 3-phase static transformers for sub-stations; Enfield Ediswan Cable Works, cable; Callender's Cable and Construction Company, 33,000 volt cable.

Hammersmith (London) Borough Council has accepted the following tenders:—Aiton & Company, steam piping, £1,080; Consolidated Pneumatic Tool Company, 7 in. electric drilling machine, £37; Foster Construction Company, steel girders, £63 10s.; Siemens Brothers & Company, Ltd., section pillars, £46 16s. 6d.; Park Royal Engineering Works, isolating switch board and swicthgear, £158; Western Electric Company, h.t. and l.t. cable, £1,520; British Electric Transformer Company, three 50 kw., six 100 kw. and eight 200 kw.; air-cooled transformers, £3,720.

Appointments Vacant.

A shift engineer and a junior shift engineer are wanted for a modern three-phase and d.c. three-wire system.

Two assistant lecturers in physics are required at the University of Birmingham. Stipend £300. Applications to the secretary, Mr. Geo. H. Morley, by Dec. 24.

The following appointments are vacant at Bradford Technical College: Assistant lecturers in physics, in electrical engineering and in textile mechanics. Salary £150–£350, with bonus of £78. Particulars from the Principal of the college.

Three charge engineers are required by the Shanghai Municipal Council Commencing salary 300 taels, rising to 450 taels per month. Applications to the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's gate, Westminster, S.W. 1, by Jan. 1.

A chief lecturer in electrical engineer (£350, rising to £400 per annum), an assistant lecturer in civil and mechanical engineering (£300) and an assistant lecturer in physics (£300) are required at West Ham Municipal Technical Institute. Applications to the Principal, Romford-road, Stratford, E.15, by Jan. 12, 1920.

Business Items.

Messrs. T. Fearing & Company, electrical engineers, will shortly open premises at 46, Market-street, Heywood.

In Bulletin No. 26 of the Railway & Industrial Engineering Company (Pittsburgh, Pa.) particulars are given of the Burke horn gap arresters and fuses.

John and Jules Jas. Symons, trading as the Zodiac Peerless Electric Lamp Company, 25, Denmark-street, Charing Cross-road, London, W.C., have dissolved partnership.

As a result of lengthy experiments in their laboratory the Automatic and Electric Furnaces, Ltd., have now, we understand, succeeded in obtaining a non-porous metal container for use in their electric salt bath furnaces. These new metal furnace pots are easily replaced, and with current at 1d. per unit it is claimed a ton of tools can be hardened for the small cost of £2 4s.

Mr. Edwin Jacob has resigned his post of managing director of the Tudor Accumulator Company, Ltd., of which he was one of the founders 25 years ago; he retains the business of the Rail Welding Company, which he acquired from the Tudor Accumulator Company last year, and his address will be 119, Victoria-street, S.W. 1.

We have received our first Christmas present. This has come from Pirelli General Cable Works, Ltd., and consists of a useful memorandum pad combined with a universal calendar. Both these articles are essential in an editorial menage, and during 1920 we expect to put them to a great deal of use.

Messrs. Watson & Sons (Electro-Medical), Ltd., notify that in consequence of the increasing demand for their instruments additions have had to be made to the staff, and Mr. Howard C. Head whose experience dates back to the discovery of X-rays in 1896, is joining the Board of directors. Mr. Head has been in charge of the X-ray and electro-medical department of Messrs. Siemens Brothers & Company of Woolwich.

Owing to the expansion of their business, and to the increasing demand for their specialities, the firm of Messrs. Mosses & Mitchell, which was established in 1865, has been converted into a private limited company, which takes over all the debts and liabilities of the firm. The general conduct of the business will remain under the direction of Mr. John Wood as governing director, with Mr. John C. Moore, who has been associated with the firm for many years, as general manager.

A new company, entitled the Consolidated Construction Company, is being formed by Messrs. J. G. White & Company, Ltd., for amalgamating the contracting business of Messrs. Dick, Kerr & Company and J. G. White & Company. The English Electric Company is interested in the new company, and has acquired a holding of ordinary shares in J. G. White & Company. The latter company will continue to carry on its business of engineering and operating management at its present address, 9, Cloak-lane, London, E.C.

One of the most certain things about modern trade is that it does not matter how good an article is if the public is not kept constantly aware of its goodness. If this is done and the article is worthy of merit its success is then assured. This dictum may be well applied to Osram lamps, and the latest attractive pamphlet dealing with them which has been designed by Mr. H. Clifford Palmer, the manager of the Publication Department of the General Electric Company, should lead to a still greater demand for this useful electrical apparatus. The pamphlet, the outer cover of which we illustrate gives full details including prices of various types of Osram lamps now on the market, both the vacuum and gas-filled types being dealt with. This artistic production, which has also been arranged as a show card, is well worthy the notice of electrical contractors and other large sellers of lamps.

Liquidations and Bankruptcies.

The discharge of Mr. Cecil Hellyar, electrical engineer, has been granted, subject to the debtor paying £60 to the Official Receiver.

The discharge of Samuel Lord, electrical engineer, formerly of James-street, Liverpool, has been granted, subject to debtor's consent to a judgment for £200 to be paid within a month.

The Rhymney Valley and General Electric Supply Company, Ltd., is being wound up voluntarily, and Mr. C. Carpenter has been appointed liquidator.

Companies' Reports, &c.

Eastern Telegraph Company, Limited.

The eighty-eighth ordinary general meeting of this Company was held on Wednesday, December 17, Sir John Denison Pender, K.C.M.G. (chairman of the Company), presiding.

The SECRETARY having read the notice convening the meeting and the auditors' report,

The CHAIRMAN said: I presume you will take the Report as read, as it has been duly circulated. It now becomes my duty to offer a few remarks on the Report and Accounts now presented to you.

When I last had the pleasure of meeting the Stockholders, I then expressed the hope that we would be able to hold this meeting at a date nearer to that on which we were accustomed to meet before the War, but the unavoidable delay in the receipt of Accounts from the various Administrations, together with the ever-increasing work in connection with our business, has again prevented the convening of this Meeting earlier in the year, and I am afraid it will be some time before we can revert to the pre-war date.

Our Gross Revenue has reached a figure considerably in excess of the previous year, which you will remember was the highest in the history of the Company. It will be of interest if I make a few comparisons to illustrate the growth of business during the War, and since the signing of the Armistice.

The War having broken out in August, the Revenue for the year 1914 was partly affected, so I will take the year 1913, when the Gross Revenue was £1,462,844. For the year 1917 it was £2,901,579, or an increase over that of the pre-war year 1913 of £1,438,735, or 100 per cent. For the year under review the Gross Revenue is £3,365,049, or £463,470 in excess even of 1917, and £1,902,205 above the pre-war figure. But, on the other hand, the total expenses have correspondingly increased, and large payments have accrued to the Government for Excess Profits Duty and Income Tax, the result being that notwithstanding the increase in the Gross Revenue over 1917, as I have said, of £463,470, the amount available for Reserve and Dividend on the Ordinary Stock is roughly £20,000 less than in 1917. To summarise, therefore, we find that although we carry to our General Reserve Fund the same amount as last year, £500,000, and pay the same dividend and bonus, the amount to carry forward to 1919 account is roughly £20,000 less.

You will notice that the amount charged in the Accounts under review for Income Tax and Excess Profits Duty payable in England alone is £861,300, and I find that the amounts paid and due to the Government from this and our Associated Companies for the last five years, total no less a sum than Six Million Pounds.

I do not propose to analyse the various items in the Revenue Account, as no useful purpose would be served under the abnormal conditions still existing, but I would like to draw your special attention to the Expenses Attending Maintenance of Cables, which amount to £364,807. As you are aware, this item has in the past been subject to very considerable fluctuations, and you can fully realise the great expense which this work now involves owing to additional cost of cable and materials, higher labour charges, and all the other items relating to the upkeep and running expenses of ships. The average annual cost of this item for the five years prior to the War was £107,021, showing a present increase over this average of £257,786, but included in the figures now before you is a heavy item for new cable laid in on repairs since the armistice which were delayed on account of the difficulties arising from the War. While dealing with this subject, I would like to take the opportunity of publicly acknowledging the valuable assistance which we received from the Admiralty and the various Naval Authorities, both at home and abroad, and our gratitude is due to them for the care and vigilance exercised in safeguarding our ships and crews during the dangerous work of repairing cables, more especially while the enemy's submarine and mine warfare was at its height. Although our men had necessarily to run risks like all the other brave members of the Mercantile Marine, I am glad to say that we did not lose a ship, although the whole fleet was at work practically night and day. This was largely due to the protection and advice we received from our Naval Authorities in various parts of the world. They realised the vital importance of maintaining telegraphic communication throughout the Empire, and it is a great satisfaction to us all to know that we were able to render important service to both the Naval and Military Authorities by laying, maintaining and working many strategic sections, as well as maintaining a satisfactory service for Government correspondence. In like manner, I desire to pay tribute to the Officials of His Majesty's Post Office, who rendered us every possible assistance, and who, by their valuable advice and action, contributed in no small degree towards minimising our difficulties and helping us to solve the problems which arose from day to day, not only in regard to questions relating to this country, but also to those more complex questions of international cable communications. This assistance is all the more appreciated when we remember the heavy burden borne by that department throughout the last five years.

The combined interests of this Country and of our Allies were our first consideration, and although our regular customers were subjected to many restrictions, and their commercial service hampered, it was, I believe, generally admitted that we did everything possible to provide the best service obtainable during the War. Unfortunately, the commercial service still falls very far short of the high state of efficiency which existed before the outbreak of war, and public telegrams are subject to serious delay. This is a matter of grave concern, not only to the Public, but also to the Companies, who, before the War, justly prided themselves upon the speed of transmission of telegrams, and the comparative freedom from errors in their telegraphic correspondence. Being fully alive to the confidence which our Stockholders have always placed in their Directors, it may be unnecessary to assure you that we are doing everything possible to improve matters, and I know that you will willingly approve of any reasonable expenditure that may be necessary to attain this object, and I ask the Public to believe that their interests are our first consideration. We realise full well that, as public servants, it is our duty to do so. That we shall succeed in again attaining at last our pre-war standard there is no doubt whatever, but it must necessarily take time, and I would ask the telegraphing public to exercise still further the patience which they have, on the whole, been good enough to show in the past. The unprecedented delay is due to a combination of circumstances for which we cannot be held responsible, because they could not have been foreseen.

1st. As I have stated on former occasions, prior to August, 1914, the routes owned by the Indo-European and by the Great Northern Telegraph Companies, which passed through Germany and Russia, dealt with approximately 40 per cent. and 30 per cent. of the Indian and Far East traffic respectively, and since that date we have had to deal with practically the whole of this work in addition to our own traffics.

2nd. Before the war, our system of duplicate, triplicate, and in some cases quadruplicate cables, and alternative routes, which provided security against the temporary breakdown from natural causes of one or more sections, always gave us a good margin of capacity over and above a likelihood of any abnormal volume of traffic which might arise from any special event of national or international interest. The consequence was that we were always able to maintain an evenly good and reliable service for Government, for commercial and for Press traffic; but when the unprecedented increase of traffic with which we had to cope was suddenly thrust upon us the whole of our previous margin of safety disappeared, and it was impossible to manufacture and lay additional cables to meet this emergency. Not only was this impossible, but it was with the greatest difficulty that we were able to maintain the cables already laid, although we employed not only our own ships, but, when available, the cable repairing ships of the Telegraph Construction and Maintenance Company and others, as well as craft temporarily placed at our disposal by the Admiralty. The additional expenditure on this account alone amounted to over £100,000.

3rd. There is yet another factor which should not be overlooked, namely, shortage of staff. To maintain a large staff such as ours it has always been necessary to provide a strong reserve of probationers in training to make up for the vacancies occasioned by deaths, breakdown of health, resignations, &c. The demand for youth to maintain the fighting forces had, naturally, the effect of cutting off the supply of suitable young men, and as it takes some years of training and experience to make an efficient telegraph operator, the burden during the war was thrown upon the shoulders of those who, from age or by the wise decision of the Naval and Military authorities, were prevented from taking an active part in the land and sea defences of their country. Nothing which I could say in praise of our Staff's successful efforts to maintain communication throughout the Empire would be more than is their due, and although we have endeavoured to relieve those who are most in need of rest and change, I regret to say that there is still a considerable number whose leave is long overdue. I am glad to say, however, that the supply of suitable young men is now more satisfactory, and the strengthening of our staff is now only a question of time, but it must be remembered that some years training have been lost.

4th. You will more readily realise our difficulty when I tell you that the Government telegrams exchanged with and through the United Kingdom contain on an average over 30,000 words a day, whereas in 1913 the daily average was only about 3,000 words. The total number of paid words dealt with by the Companies in 1918 was about 180 millions, in addition to which we have carried during the war 3 million words free of charge in connection with Wounded, Red Cross and other Benevolent Institutions. In 1913 the total number of words was only about 64 millions—that is, comparing the pre-war year with the past year, the number of words we carried increased from 64 to 180 millions.

We had hoped that with the removal of the censorship restrictions and the re-introduction of private codes, the volume of traffic would appreciably diminish. The reverse has taken place, the number of messages has increased, and their length is only slightly reduced.

As this total daily traffic which the Companies now receive is approximately equal to the total carrying capacity of our system, accumulations and delays are bound to occur whenever any of our main lines become interrupted from one cause or another, and, as you know, this is a factor which must always be reckoned with by all submarine cable Companies. As an example, I may mention that not long ago two of our main line cables were accidentally broken by ships' anchors, and although these were speedily restored, the accumulations due to these interruptions created very serious delay, because, as I have explained, there was no margin of capacity to deal with the congestion resulting from the interruptions.

Although it is hoped that the block will be cleared during the Christmas holidays, if all our cables are working normally, this will only give temporary relief, and no permanent improvement can be relied upon, if the traffic is maintained at its present level, until we can improve the capacity of our system by laying additional cables and introducing new apparatus, which will increase the speed of working. Neither of these means was possible during the war, as all the cable and electrical apparatus manufacturers practically devoted the whole of their energies to the output of war materials, and it will be some time yet before our requirements can be met. We have long since placed orders for both cable and apparatus, and the manufacturers are doing all they can to assist us, but the unavoidable delay in delivery hampers our initiative.

I am glad to say, however, that we made arrangements with the Ministry of Shipping to charter the "Stephan," one of the largest cable-laying vessels in the world, which was taken over from the Germans, and she has just completed the laying of another fast-speed cable between Porthcurnow, in Cornwall, and Gibraltar, about 1,200 miles in length, which will form the first section of a new main line between Great Britain and the Far East through the Mediterranean, and on via Bombay and Madras then taken on, by our Associated Company, the Eastern Extension Australasia and China Telegraph Company, to Singapore, involving an expenditure of about 7,000 miles of cable. Provisional orders were placed immediately there was a likelihood of the cable being manufactured, and as soon as each section is delivered it will be laid and worked. In the meantime partial renewals have been and are being carried out, and other means have been devised to improve the speed of some of our existing cables.

To illustrate the difficulties of increasing our capacity to enable us to cope with the great increase of traffic, I have only dealt with the question as it affects this and the Associated Companies, but our manufacturers are also being pressed by other Administrations to carry out extensive orders for cable to improve telegraphic communication in other parts of the world where there is also heavy delay.

I trust, therefore, that those interested who will read the remarks I have made to-day will be convinced that we, on our part, are doing everything that is humanly possible to achieve what they require, namely, a quick and reliable service. Although it is not our province to restrict our clients in the use of the cable service, I appeal to them, in their own interest, to do what they can on their side by reducing as much as possible—at any rate, for the time being—the number and length of their messages, and I would further ask those who are accustomed to send Christmas and New Year Greetings to their friends in different parts of the world, to forego the pleasure of making use of the cables for this purpose during the coming season. In the past these greetings have represented a large amount of traffic.

I would like to refer to the somewhat vexed question of urgent telegrams at triple rates. These messages are transmitted after Government messages, but before the ordinary full rate-traffic. Our policy has always been to make every endeavour to supply the Public with a rapid and accurate service, and we will always strive to attain this object. In normal times, when the delay from one end of the line to the other rarely exceeded three hours, there was no necessity for Urgent, that is, triple-rate telegrams, and these Companies are not in favour of their general introduction. Urgent rate telegrams are not generally accepted in this country, but as Continental Administrations had no such restrictions, British Merchants and others were placed at a disadvantage. Consequently, the British Government issued a notification through the International Telegraph Bureau in Berne precluding the acceptance of urgent telegrams from and via Europe *to* Egypt, and beyond passing over cables landing on British territory. The British and Continental Merchants were thus placed on an equal footing, except, however, in the case of urgent telegrams to Greece and Turkey, which continued to be accepted from the Continent as they could pass by another route over cables which did not land on British territory, namely, those connecting Italy direct with Greece. In order, therefore, to afford British Merchants the same facilities, the acceptance of urgent telegrams at triple rates from the United Kingdom to the Levant was authorised by the British Government.

In the case of *homeward* telegrams for the United Kingdom and the Continent, these can be accepted at urgent rates from countries which admit them. I have dealt with this question somewhat at length, but, as we have been unjustly criticised regarding the excessive charge for triple-rate telegrams exchanged with Greece and Turkey, I consider it necessary to give a full explanation as to the reasons for their introduction. As far as our own interests are concerned, we are certainly very much opposed to charging triple rates, and should be glad to see them discontinued everywhere ; but the matter is not under our control.

I may remark that we are one of the few public concerns which has not raised its charges during the war. On the contrary, we have, in fact, reduced our rates since 1914 with British West Africa, New Zealand, the Dutch East Indies, Japan, South Africa and East Africa, while reductions with China, Hong Kong and the Philippines will come into operation on 1st January next. Although we are always ready to reduce rates whenever circumstances warrant it, we must point out that the Governments of Great Britain and India have considered it necessary to increase their pre-war charges for local internal telegrams, and the rentals charged for pneumatic tubes and underground wires have also recently been raised, which has had the effect of considerably increasing our outpayments in Great Britain.

I think there is only one other point which I need refer to, but it is a most important one—namely, the General Reserve Fund. It is true that it has reached the figure of three million and seventy-six thousand pounds, but the reason it has grown to this figure is due to the conditions ruling during the last five years, which made it impossible to undertake necessary renewals and the laying of cables—even those which in the ordinary course would have been necessary to provide additional capacity to enable us to deal properly with the normal growth of our business. Therefore the moneys which would have been expended on this work had there been no war were invested for the time being in War Loans. When it became possible to get delivery of a part of our requirements, we laid the first link, the new Porthcurnow-Gibraltar section to which I have already referred. This Company alone must have at least another 4,000 miles of cable as soon as they can be manufactured and laid, the cost of which will be chargeable against our General Reserve Fund, and as the prices of cables to-day are so greatly in excess of pre-war prices, the Reserve Fund will be materially reduced. It is fortunate, therefore, that we are able to meet our prospective liabilities by having accumulated such a substantial Reserve as that shown in the Accounts to-day.

It may be as well to remind you that our Reserve Fund is not a "free Reserve" in the sense of the Reserves of other trading concerns, and cannot be looked upon as available for capital distribution. It is set aside for the specific purpose of providing renewals and additional cables, &c., as required ; and, as I have explained, the withdrawals in future will be very heavy if we are to revert to the excellent cable service the Associated Companies gave before the war, and nothing short of that will satisfy your Board, and I may say your Staff also.

We have considered it advisable to order a new cable repairing ship capable of consuming either coal or oil fuel, and fitted with all the latest cable repairing machinery and equipment. She will be a very useful addition to our fleet, and should materially assist in the maintenance of our ever-increasing cable system. Had it not been for the moulders' strike she would have been delivered in May next, but this date cannot now be adhered to.

Her cost will be more than double the pre-war price, and it is fortunate that the Maintenance Ships Fund has this year been augmented by the transfer of the Reserve made for special War risks of £157,000, on which, I am glad to say, no calls were made during the war.

I am afraid I have detained you a long time, but it was necessary this year to give a very full statement as to the position of the Company and of what we have done and of what we intend to do to endeavour to revert to pre-war conditions.

The report and accounts having been unanimously received and adopted, the retiring Directors re-elected and the Auditors re-appointed the proceedings terminated with a cordial vote of thanks to the Directors and the staff at home and abroad.

Eastern Extension Australasia & China Telegraph Co., Ltd.

The eighty-fifth ordinary general meeting of this Company was held at Electra House, on Wednesday, December 17th. Sir John Denison-Pender, K.C.M.G. (Chairman of the Company), who presided, said :

Gentlemen : Before dealing with the Report and Accounts, I must refer to the loss we have sustained by the death of our esteemed colleague, Mr. Francis Augustus Bevan, who had been a Director of the Company ever since its formation in 1873. His information and advice upon financial questions was always most valuable, and we have lost an able and valued colleague.

In presenting the Report and Accounts, which, I presume you will, as usual, take as read, your Directors have once more to express their regret that, for the same reasons that prevailed in 1917 and last year, they were unable to hold the Annual General Meeting as formerly in the month of May. I hope, however, that it will be found possible to hold our next meeting at a date nearer that which was customary in pre-war days.

The enforced delay in holding the meeting did not, however, prevent the distribution amongst the shareholders, at the usual time, of the final dividend and bonus for the year 1918, as the Board considered, from the estimated figures then before them, that they would be justified in paying 6 per cent. and the usual bonus of 2 per cent., both free of income tax, without waiting for the shareholders' approval, and the audited accounts now before you show that their views were correct.

The gross receipts for the year 1918 amounted, in round numbers, to £2,070,000, against £1,508,000 for 1917, showing an increase of £562,000, due to the enormous increase of traffic all over the Company's system during the past year.

The working and other expenses for the past year amounted, in round numbers, to £620,000, against £552,000 for 1917, showing an increase of £68,000, which is mainly accounted for by additions to the staff, salaries and war payments. After deducting from the increased earnings the additional expenses I have just referred to, there remains an increased nett revenue of roundly £493,000 for 1918.

The amount we have, therefore, to deal with at to-day's meeting is £1,449,000, out of which provision has been made for the payment of interest on the 4 per cent. mortgage debenture stock, amounting to over £30,000, for excess profits duty, and income tax, payable in England, together no less a sum than £860,000, and contribution to the General Reserve Fund £350,000, leaving a balance, after payment of the dividend and bonus which you have received, amounting to £240,000, of £41,000, which is carried forward to the current year's account, against £72,000 for 1917.

The Company's holdings in War Loan and National War Bonds on December 31st last amounted to £1,638,000. Since the close of the year we have invested a further sum of £857,000, making a total holding of nearly two and a half millions sterling, and I am sure you will be pleased to learn that a revaluation of our securities showed that the provision made in past years on account of investment fluctuations was found to be practically sufficient to meet the depreciation of the reserve fund securities on December 31st last, the date when the accounts now before you were made up.

You will have doubtless seen some of the many references appearing in the Press to the delays in the transmission of the traffic over the cables of the Eastern and Associated Companies, particularly during the current year, and to the public announcement recently made by the Eastern Telegraph Company asking the commercial community to curtail their cabling as much as possible until it is possible to effect an improvement in the existing adverse conditions. Only an hour ago the general meeting of our allied Company, the Eastern, was held in this hall, when I went very fully into the causes of delays on traffic, and showed clearly that no forethought in the past, or action at the present time, beyond that which we have already taken could have brought our work since the war started up to the efficiency of the service prior to August, 1914. To go over it again now, would be only to detain you unnecessarily. We shall, therefore, send you a full report of the meeting of the shareholders of the Eastern Company which will give you full information on this subject.

As an illustration of the enormous growth of traffic since the outbreak of war, I may mention that the trans-Indian and our local traffics between India and the Far East, &c., show an increase in 1918 of, roundly, 327 per cent. over the pre-war year 1913. Consequently, additional carrying capacity is urgently required to deal with this large volume of traffic, and we are making arrangements for the manufacture and laying of a new cable between Madras and Singapore at the earliest possible moment. The Eastern and other cable companies also urgently need more cables to meet their traffic requirements, and it will, therefore, take some little time before this can be effected. The money required for the Madras-Singapore cable will be taken from the General Reserve Fund, which, as the shareholders are aware, was created for meeting expenditure of this nature.

A letter received from a shareholder a few days ago suggests the capitalisation of the reserve fund, to bring the capital account into a truer relation to its actual assets, but our reserve fund is not a "free reserve," as prevails in some companies, and, instead of being capitalised as suggested it must be largely added to, as in the past, whenever possible, to meet the heavy calls that will have to be made upon it from time to time.

The vacancy in the directorate caused by the death of Sir John Wolfe Barry, K.C.B., has been filled by the appointment of John H. Wilson, Esq. C.B.E., which you will be asked to confirm when the resolution for re-election of Directors is submitted to you before the close of the meeting. For many years Mr. Wilson has been closely associated with the British India Steam Navigation Company, and other important shipping interests, and his knowledge in these matters and experience of many years in the East will be found of material assistance to the Board of this Company.

The report and accounts having been unanimously received and adopted, the retiring Directors re-elected, and the auditors re-appointed, the proceedings terminated with a cordial vote of thanks to the Directors, and the staff at home and abroad.

Western Telegraph Company, Ltd.

The eighty-sixth ordinary general meeting of the Western Telegraph Company, Ltd., was held on Wednesday, December 17, 1919, at Electra House, Finsbury Pavement, London, E.C., Sir John Denison-Pender, K.C.M.G., the Chairman, presiding.

The SECRETARY (Mr. E. Steer Hodson) read the notice convening the meeting, the minutes of the previous meeting, and the Auditors' report.

The CHAIRMAN: Gentlemen, it affords the Directors much pleasure in again submitting a satisfactory report and statement of accounts, although the preparation of them is still somewhat belated owing to the continuation of many of the difficulties with which we have had to contend during the past five years, and to which I referred in some detail at the last general meeting. This unavoidable delay was foreseen some months ago. When, however, we were in possession of sufficient data to warrant the declaration of the usual final dividend and bonus, the Board decided to issue the warrants to the shareholders at the end of last September instead of waiting until it was possible to present final accounts and to hold the meeting. I do not propose to detain you by going into any details of the figures now before you, which are very fully set out, but comparing the chief items with those of the corresponding period the revenue for this year shows an increase of nearly £498,000. The increase in working expenses, income tax, and excess profits duty accounts roughly for £286,000, leaving a net increase of £212,000. The Directors have transferred £450,000 to the general reserve fund, £30,000 in further reduction of the amount of capital expenditure in excess of the share capital and debenture stock issued, £50,000 to the maintenance ships' reserve fund, and £30,000 to the land and buildings depreciation fund. Three interim dividends of 1½ per cent. each, and a final dividend of 1½ per cent., also a bonus of 2 per cent., have been paid, amounting together to £166,344, making a total distribution of 8 per cent., free of income tax, for the year ended June 30th, 1919, thus leaving a balance of £37,803. 2s. 1d. to be carried forward to the next account.

You will observe that although in the report and accounts £450,000 has been transferred to the general reserve fund it has been debited with £600,000 odd, being part of the cost of the manufacture and installation of new cables. This fund thus stands at nearly £2,115,000. Now let me ask your attention to the calls we shall have to make on this reserve in the near future. The £600,000 to which I have referred is only a portion of the total with which we are faced in carrying out our programme, which I will now lay before you. It is with much satisfaction that I am able to inform you that since our last meeting an agreement has been made between your Company and the important American enterprise, the Western Union Cable Company, whereby that Company will join our new cable from Brazil at the Island of Barbados with a cable from Florida, thus forming the shortest and most direct communication between the River Plate, Brazil, and the United States. These cables will be of sufficient power, and be equipped with a system of working to enable these two Companies to deal with even a far larger volume of traffic than is contemplated to develop for some considerable time, thus providing the nations of South and North America with a service which has become a commercial necessity in these times. I feel sure this agreement will rebound to the advantage of both Companies. The new cable, to which I referred on the last occasion when I had the pleasure of addressing you—namely, that between the Island of Ascencion and Rio de Janeiro, were successfully laid in September last, and has somewhat relieved the difficulties experienced through the interruption of the original cable to Brazil, nearly 2½ years ago. It was impossible to arrange the manufacture of the necessary cable to lay the new and the cable to repair the old line, and the former was considered of much greater importance, and therefore was carried out first. We have put on order 1,000 nautical miles of cable to renew partially this old line, but shall not be able to obtain delivery and charter a suitable vessel to carry out the work until later, the demand for cables elsewhere being now so great. The threatened competition of which I told you last year will come into force within the next few months, when rival cables will be laid by the Central and South American Company between Rio de Janeiro and Santos and Uruguay.

Before the war we had just commenced to renew certain of the original cables along the Brazilian coast. This policy has necessarily been suspended for the last five years, as owing to the difficulty in acquiring cable, and the great risk of transport, which was also most difficult to secure, it was absolutely essential to conserve our stocks of cable at the foreign stations. These renewals are now of course more necessary than ever, and will be effected as soon as circumstances permit by our own cable ships stationed on the coast.

The shareholders will remember that our Company is the holder of all the preference shares, and 93 per cent. of the ordinary shares of the West Coast of America Company, which owns a single line of cables along the Chilian and Peruvian coasts as far as Lima, and which Company is connected to our system on the East Coast by land lines over the Andes from Valparaiso to Buenos Ayres. Although the total cable capacity of that Company and our competitors, the Central and South American Company, on that coast, is ample for all requirements—Government, commercial and Press—the competition is such that I must foreshadow the necessity in the interests of the West Coast Company and the Western Company of considerable expenditure, not only in strengthening the existing communications, but in extending the cables further north. A further sum of about £1,500,000 will be expended in the near future, apart from the cost of extensions on the Chilian and Peruvian coasts, to which I have just referred. Also we must not forget that the original cables have now been submerged for many years, and although they are carrying the traffic satisfactorily it is certain that heavy renewals will have to be effected sooner or later. We are now, therefore, reaping the benefit of the policy which, in the past, has so cordially been approved by the shareholders in building up substantial reserves which are requisite in order to maintain, renew and increase our plant, and thus enable us to assure a continuance of the prosperity of the Company, without having to resort to the issue of fresh capital, which in times such as these could only be done at a very high rate of interest.

I think I have now given you full information of what has taken place in your Company during the last 12 months, and will now move: "That the report of the Directors and the accounts for the year ended June 30th, 1919, now submitted, be approved and adopted."

The resolution having been carried unanimously, the retiring Directors re-elected, and the auditors re-appointed, the proceedings concluded with a cordial vote of thanks to the Chairman and the Board, and to the staff at home and abroad.

The Western Union Telegraph Company has declared a quarterly dividend of $.175.

A quarterly dividend of 1½ per cent. has been declared by the Brazilian Traction, Light and Power Company on the cumulative preference shares.

At an extraordinary meeting of the Adelaide Electric Supply Company, Ltd., on Tuesday it was resolved to split the £5 shares into five shares of £1 each.

In the report of the Northern Exploration Company, Ltd., it is stated that wireless stations have been erected by the company at King's Bay and Calypso Bay, Spitzbergen, and communication is now established.

The preference share and transfer books of the Automatic Telephone Mfg. Company are closed from the 18th to 25th inst., inclusive, for preparing the dividend warrants on the 6 per cent. preference shares for the half year ending 31st inst.

The directors of the Electric & General Investment Company, Ltd., have declared a dividend of 3s. per share on the preference shares, being at the fixed rate of 6 per cent. (less tax) per annum for the six months ending 31st inst.

The Auckland Electric Tramways Company, Ltd., has declared a dividend of 2½ per cent. (6d. per share), less tax, on the ordinary shares for the half-year, making 5 per cent. for the year. A sum of £22,500 has been placed to renewals and depreciation account, £42,643 to repairs and maintenance, and £9,777 forward. At the meeting last week Mr. C. Shirreff Hilton explained that the Corporation exercised the option to purchase and took possession of the undertaking on June 1. The whole of the purchase money was repayable in debentures of the Corporation, the exact amount being subject to various adjustments, and the chairman of the company (Mr. C. G. Tegetmeier) was on his way to Auckland to complete the arrangements.

At the annual meeting of S. Smith & Sons (Motor Accessories), Ltd., last week it was reported that owing to the accounts from the colonial branches not having been received, and in view of the outstanding queries under the Finance Act, the directors were unable to submit the usual accounts for the year ended July 31 last. During the year business had been entirely satisfactory, and the difficulties inseparable from the transition period had been overcome, so that during the present financial year the full benefit of the enlarged business should be felt. The expectations of large orders for peace-time products had been fulfilled, the orders in hand being sufficient to keep the works fully employed for a long time to come. The profits earned for last year justified the payment of a final dividend of 1s. 3d., which with the interim dividend, made 10 per cent., tax free, for the year. The business of the M.L. Magneto Company, Ltd., which was purchased in July last, continued to make satisfactory progress.

Mr. S. Smith, who presided, stated that it was no easy matter to convert a factory employing upwards of 2,000 workpeople from one business to another, but he claimed that they had been one of the first to overcome those difficulties, so that at present they were at present in full swing and producing at a higher rate than ever before in the history of the company. With the increased capital one expected to do more business but it had been a surprise to them that the company should have been invited to undertake contracts such as had been offered during the past few months. It proved that motor transport was still in its infancy. The actual sales of the company, and its subsidiaries, at the present time were at the rate of approximately £1,000,000 sterling per annum, a higher figure than it had reached at any time during the war, and ten times the pre-war sales of the company. The board anticipated that by the end of the present financial year the turnover would be at the rate of from one and a-half to two millions per annum. The greater the output the better they were in a position to treat their workpeople. The company's products had been well received throughout the trade. The company was increasing its selling organisation throughout Great Britain, the British Empire, and other parts of the world, and, with the increasing demand for their manufactures all over the world, he was confident that the business would expand. Their products included speedo-motors, the production of new models of which was in full swing and amounted to several hundreds daily. The demand was large and exceeded the supply. Their lighting and starting equipment had been recognised as one of the best on the market, and the demand was very large. Production was increasing week by week They anticipated an output of something like three-quarters of a million in that product alone. They were also doing well with their magneto and their K.L.G. plug.

New Companies.

CHARTER'S ELECTRIC SUPPLIES COMPANY, LTD (161,326).—Private company, reg. Dec. 5, capital £1,000 in £1 shares. Objects: To take over the business of an electrical engineer, and dealers in electric supplies carried on by C. H. Charters at Warrington as the "Electric Supplies Company." First directors are C. H. Charters (managing director) and P. Peacock (both permanent). Reg. office: 1, Mill-street, Warrington.

DAVIES & STACK, LTD. (161,270)—Private company. Reg. Dec. 4, capital £600 in £1 shares. Objects: To carry on the business of aeronautical, marine, motor, electrical, mechanical and general engineers, &c. First directors are Em. J. V. Howard Davies and A. R. Stack. Sec.: A. R. Stack. Reg. office: 30, Bedford-row, W.C.

ELECTRICAL & ENGINEERING DEVELOPMENT, LTD. (160,991)—Private company. Reg. Nov. 26, capital £10,000 in 9,500 8 per cent. cumulative preference shares of £1 each and 10,000 founders' shares of 1s. each, to carry on the business of manufacturers, repairers, importers and exporters of and dealers in electrical devices and materials, &c. First directors are E. Schattner, E. A. Godson and D. J. Longden. Sec.: D. J. Longden. Reg. office: 35, Copthall-avenue, E.C.

FITMENTS, LTD. (160,909) Private company. Reg. Nov. 24, capital £2,000 in £1 shares. Objects: To take over an agreement between A. S. Cubitt and J. W. Ellingham for the purchase of an invention relating to improvements in shade tilting devices, and to carry on the business of manufacturers of accessories, fittings, machinery, &c. First directors are W. S. Brown, G. W. Webb, C. Burwell and J. W. Ellingham. Sec.: W. S. Brown. Reg. office: 98, Spital-street, Dartford.

GEORGE AIREY & CO. ELECTRICIANS, LTD. (161,118)—Private company. Reg. Nov. 29, capital £1,000 in £1 shares. Objects: To take over the business of electricians, engineers and contractors carried on at Sheffield as George Airey & Company. Reg. office: 25, King-street, Sheffield.

HYMAN, WOOD & COMPANY, LTD. (161,191)—Private company. Reg. Dec. 2, capital £1,000 in £1 shares, to carry on the business of civil, mechanical, electrical and hydraulic engineers, manufacturers of and dealers in motor cars, &c., and to enter into an agreement with C. J. T. Hayman and J. H. Hayman. First directors are C. J. T. Hayman (managing), J. H. Hayman (deputy managing) and A. H. Wood. Reg. office: 41, Cheapside, E.C.

MOSSES & MITCHELL, LTD. (161,127)—Private company. Reg. Nov. 29, capital £35,000 in £1 shares, to take over the business of dealers in vulcanised fibre, carried on at Golden lane and Banner street, E.C., as Mosses & Mitchell, and to carry on the business of manufacturers of and dealers in "Vulnos" and other vulcanised fibre, Emanden steam jointing, asbestos, insulating materials, &c. First directors are J. Wood, J. G. Moore and W. P. Dunfoy. Reg. office: 122 4, Golden-lane, Barbican, E.C.

P. J. MASON & COMPANY, LTD. (160,489)—Private company. Reg. Nov. 11, capital £1,000 in £1 shares. Objects: To carry out at Darlington and elsewhere the business of motor and general engineers buyers and sellers of motor cars and machinery of all kinds, electrical, mechanical and general engineers, &c. First directors are P. J. Mason (permanent managing director) and E. M. Pullen. Sec.: P. J. Mason. Reg. office: 39, Priestgate, Darlington.

NORTHERN BALL BEARINGS, LTD. (160,618)—Reg. Nov. 14, capital £200,000 in £1 shares, to carry on the business of sellers and manufacturers of ball and other bearings, engineers, &c. First directors are N. O. J. L. Wallenius, L. E. Little, A. Senior, L. H. Coatalon, A. G. Scarnell, J. B. Tainton and J. Beswick. Mr. N. O. J. L. Wallenius is Swedish and M. L. H. Coatalon is French. Reg. office: 115, Great Portland-street, W.

PONSFORD & McHARDY, LTD. (10,775)—Private company. Reg. Nov. 26, capital £4,000 in £1 shares (2,000 preference and 2,000 ordinary), to carry on the business of electricians, electrical, mechanical and motor engineers, &c. First directors are S. Ponsford, J. G. McHardy and S. J. Ponsford. Sec.: S. J. Ponsford. Reg. office: 58, Gray-street, Broughty Ferry.

RAWLPLUG COMPANY, LTD. (180,817)—Private company. Reg. Nov. 20, capital £50,000 in £1 shares (20,000 ordinary, 15,000 cumulative 8 per cent. 1st preference and 15,000 8 per cent. cumulative 2nd preference), to carry on the business of manufacturers of and dealers in wall plugs, tools, &c. The first directors are J. J. Rawling and L. Tweedie-Smith, and others to be appointed by the subscribers. Sec.: (pro tem.) J. Kirkham. Reg. office: 95, Gloucester-road, South Kensington, S.W.

RAYNER & HEALD, LTD. (161,102)—Private company. Reg. Nov. 28, capital £10,000 in £1 shares. Objects: To take over the business of electrical engineers carried on as Rayner & Heald at Derby, and to enter into an agreement with W. H. Platts. First directors are W. H. Platts (permanent governing director), D. D. Rayner and J. R. Heald. Reg. office: 10, Park-row, Leeds.

ROGERS, WILSON & COMPANY, LTD. (160,570.)—Private company: reg. Nov. 13, capital £5,000 in £1 shares, to carry on the business of manufacturers of moulds, machinery and other articles and materials used in the manufacture of rubber and rubber goods, pattern makers, electric and general engineers, &c. First directors are C. W. Cooke, W. Rogers, J. E. Copeland, W. A. Rogers, C. H. Wilson and H. T. Hiam.

A. W. TOY & COMPANY, LTD. (160,925)—Private company. Reg. Nov. 25, capital £2,000 in £1 shares. Objects: To carry on the business of consulting, mechanical, electrical and aeronautical engineers, machinists, manufacturers of motor cars, &c. A. W. Toy is the first director. Sec.: H. Smith. Reg. office: 66, Victoria-street, S.W.1.

A. VEREY & COMPANY, LTD. (161,137)—Private company. Reg. Nov. 29, capital £1,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, &c. The permanent governing directors are: Lieut. G. H. Verey and A. K. Verey. Reg. office: 52a, Bow-lane, E.C.

WALLIS & WATSON, LTD. (161,048)—Private company. Reg. Nov. 27, capital £10,000 in £1 shares, to carry on the business of electrical engineers, &c., and to acquire the business carried on at Park-row, Leeds, as Wallis and Watsons. Governing director: E. C. Wallis. Solicitor: R. G. Emsley, Atlas Chambers, Leeds.

Prices of Metals, Chemicals, &c.

Tuesday, Dec. 16.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£115 0 0	£4 0 0	—
Electrolytic bars ...	,,	£117 0 0	£6 0 0	—
H.C. wire basis......	per lb.	1s. 3 $\frac{9}{16}$d.	$\frac{11}{16}$d.	—
Sheet	,,	1s. 4 $\frac{3}{16}$d.	$\frac{7}{16}$d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 7 $\frac{9}{16}$d.	$\frac{11}{16}$d.	—
Brass 60/40—				
Rod, basis	,,	0s. 11 $\frac{13}{16}$d.	$\frac{5}{16}$d.	—
Sheet, basis	,,	1s. 2$\frac{3}{8}$d.	—	—
Wire, basis	,,	1s. 2$\frac{1}{4}$d.	—	—
Iron—				
Cleveland Warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis 8 SWG	,,	£34 10 0	—	—
Lead Pig—				
English	,,	40 15 0	—	£0 15 0
Foreign or colonial	,,	39 12 6	—	£0 17 6
*Tin—*Ingot	,,	315 5 0	£10 15 0	—
Wire, basis	per lb.	0 3 10$\frac{1}{2}$	1$\frac{1}{2}$d.	—

Salammoniac.—Per cwt. 80s. and 75s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £22 10s.

Sulphuric Acid (Pyritea, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40.

Boric Acid (Crystals).—Per ton. £72.

Carbon Bisulphide.—Per ton £55.

Sodium Bichromate.—Per lb. 11d.

Sodium Chlorate.—Per lb. 6d.

Shellac.—T.N. Orange, 700s.; A.C. Garnet, 560s.

Rubber.—Para fine, 2s. 6¼d.; plantation 1st. latex 2s. 7d. lb

The metal prices are supplied by the British Insulated & Helsby Cable, Ltd., and the rubber figures by W. T. Henley's Telegraph Works Company.

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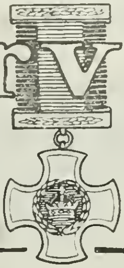

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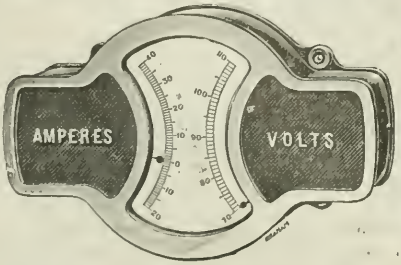

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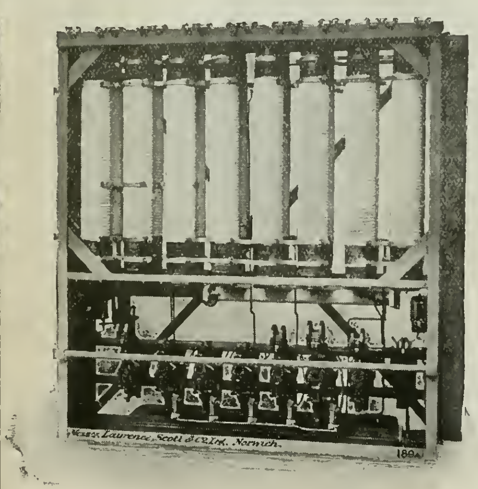

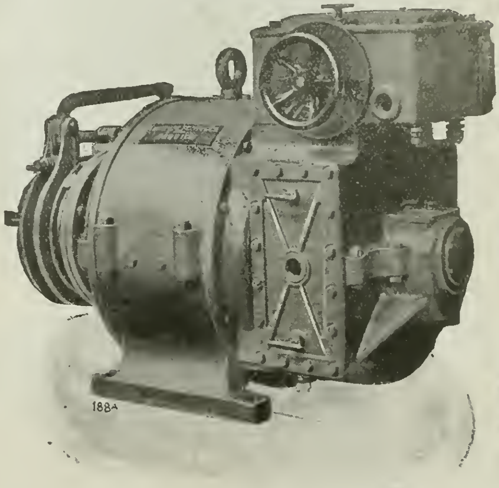

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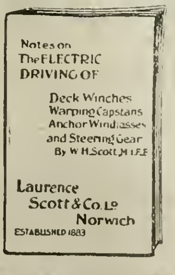

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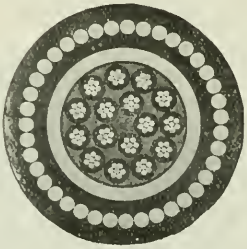

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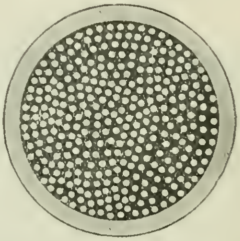

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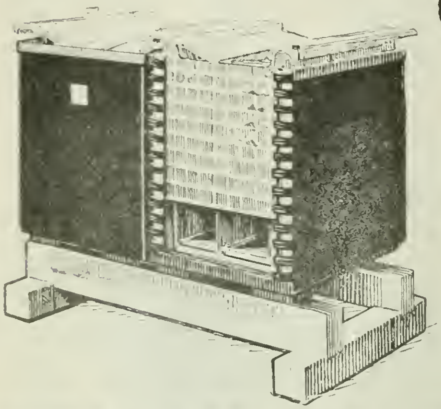

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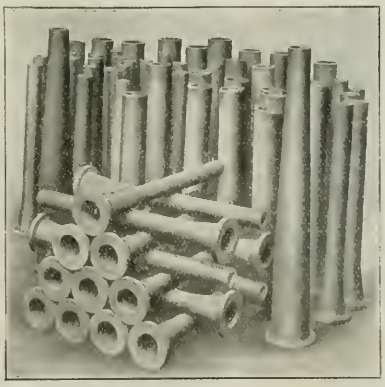

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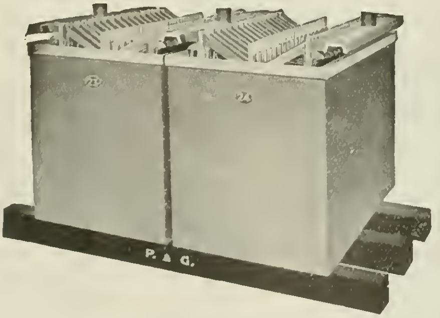

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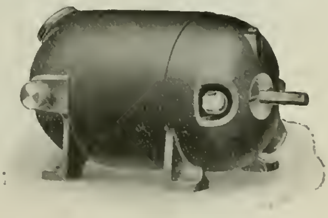

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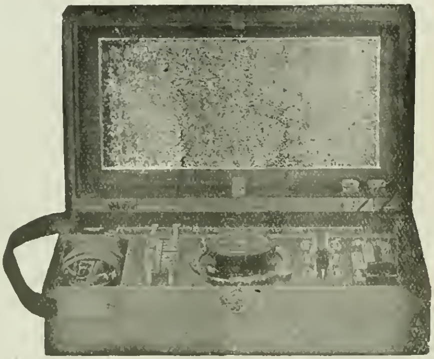

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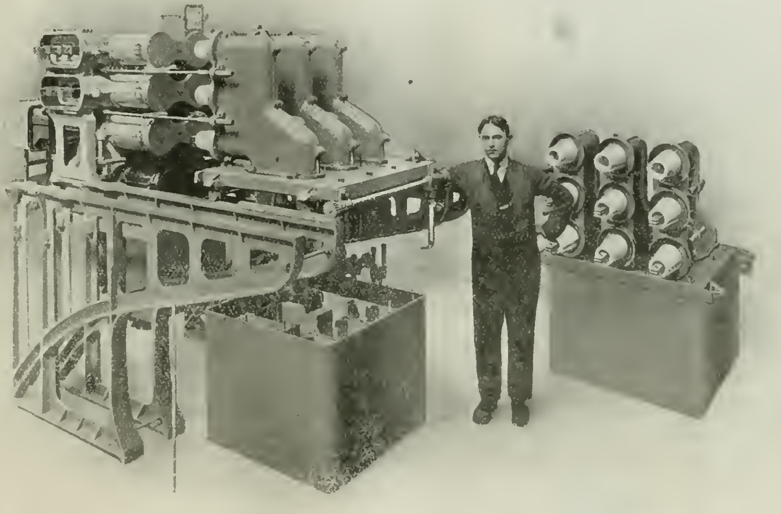

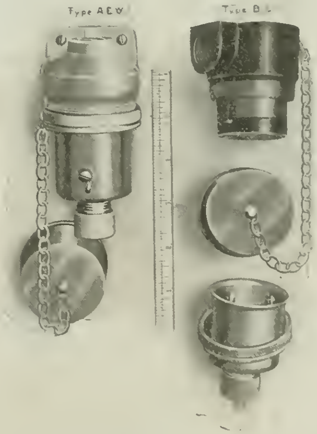

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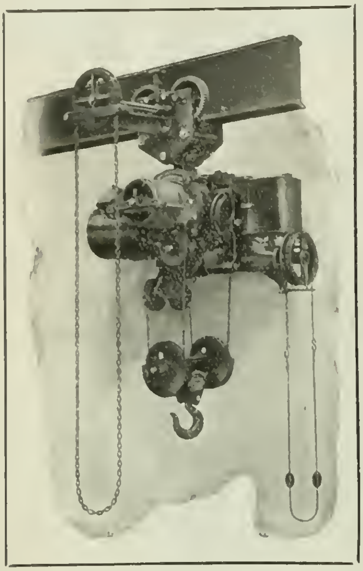

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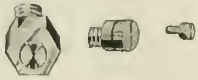
Contact Points  All sizes for all types.

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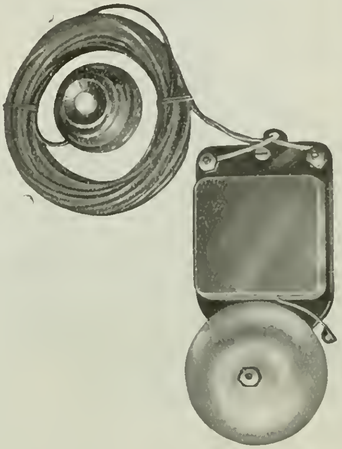

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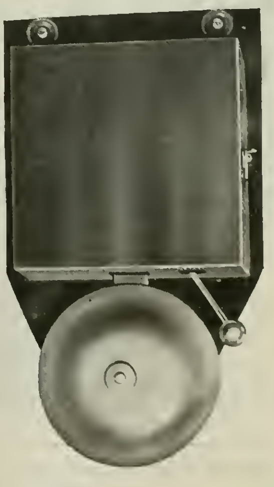

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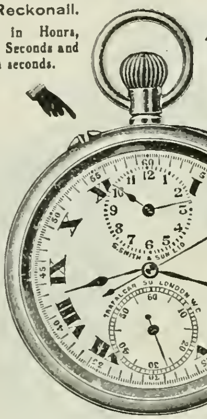

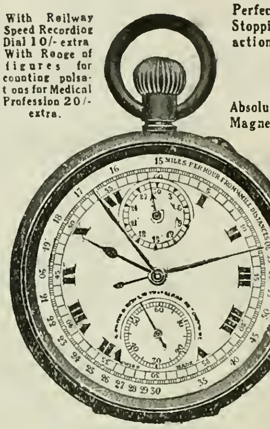

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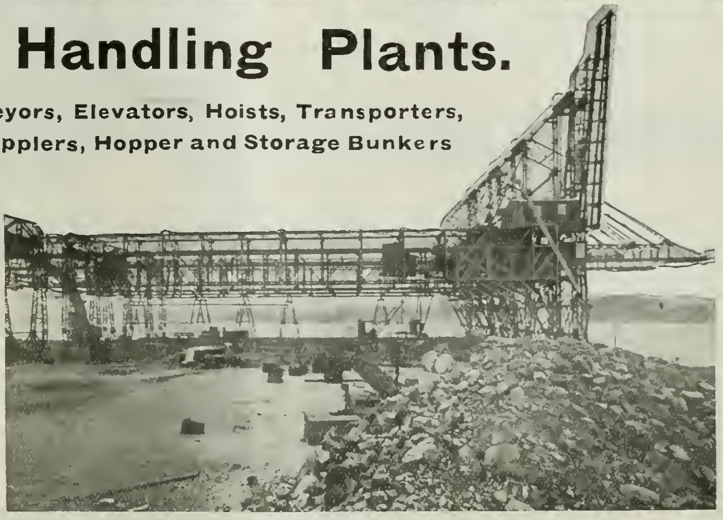

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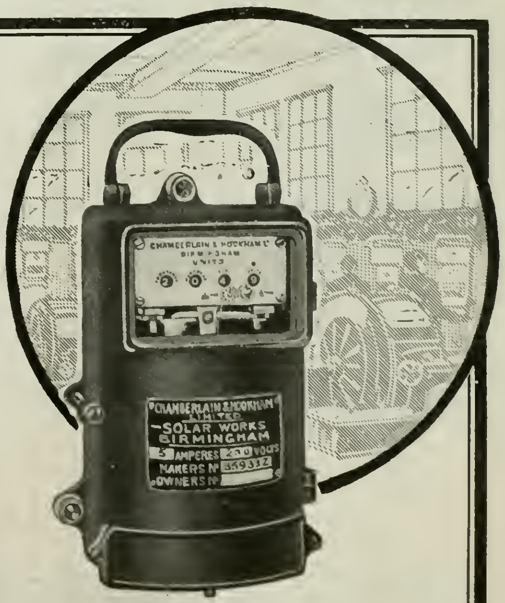

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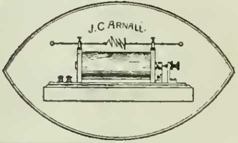

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NOTICE is Hereby Given that the TRANSFER BOOKS of the ORDINARY STOCK of this Company will be CLOSED from the 7th to the 14th January, 1920, both days inclusive.

By Order,
A. R. HARDIE, Secretary.

Electra House, Finsbury Pavement.
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Postmaster-General's Department,
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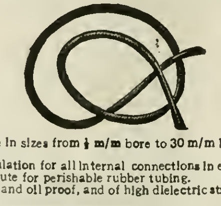

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[*Continued on p. xxvi.*

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MR. BELLINI'S Notice that appeared amongst the Advertisements, page 30, November 28th and December 5th and 12th is equivocal. He cites part of a passage of the judgment of the Court of Appeal of Turin, omitting the following words: Which search formed the object of the suit that took place in the years 1911-1912, and terminated with a transaction.

This passage is essential as it refers to the judgment given by the Court of Appeal that declared that Mr. Bellini, through a public deed dated April 5th, 1912, before Mr. Rolando, Notary Public, that ended a controversy on Patents 88,766 and 88,765 had to acknowledge without any reserve that the inventions covered by said patents, viz. the "Radiogonometer" and the "Dirigible Triangular Aerials" belong to Prof. Artom's intellectual patrimony, and bound himself in accordance with this acknowledgment, to withhold from any publication in Italy as well as abroad, through which Prof. Artom's right to said invention would be contested, while similar obligations were taken by other persons on Mr. Tosi's account.

This is the reason why the Court of Appeal concluded it was no more the case to decide to whom said inventions belonged; this question could not and will never have to be discussed again, and nobody will ever have the possibility of attributing to Bellini or Tosi the merit of inventions that the said Bellini and other persons for Tosi solemnly acknowledged to belong to Prof. Artom's intellectual patrimony binding themselves to withhold from any contest, even in print, in connection therewith.

Therefore Mr. Bellini is formally requested to observe scrupulously the obligations taken by him by the above-mentioned public deed dated April 5, 1912, subscribed in my presence and before Mr. Rolando, Notary Public, and solemnly confirmed by the Court of Appeal, and the Court of Cassation of Turin.

GERARD.

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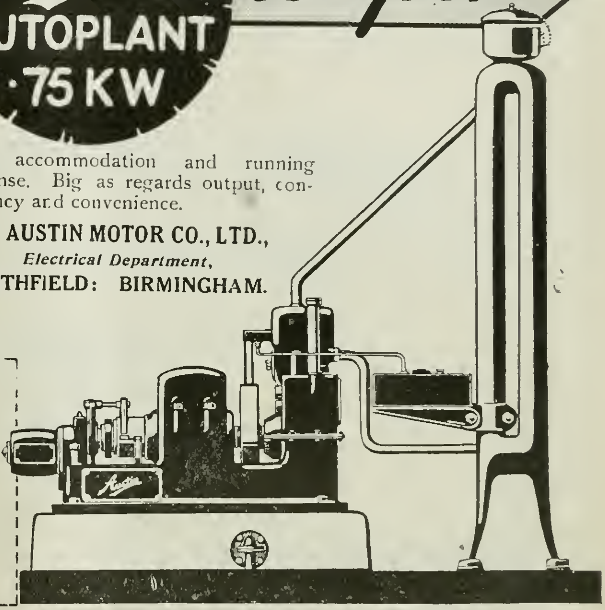

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Notes.

Restrictions on Electricity Supply.

At a time when great efforts are being made to place the trade of this country once again on a sound foundation and to increase our production to the highest possible figure it is unfortunate that the conditions in many electricity supply stations are preventing a supply of power adequate to manufacturing needs being given, and that restrictions upon the demand and upon the connection of the new consumers are in force in not a few places. The blame for this does not lie with the electricity supply engineer, who during the war worked under very great disabilities and was forced often against his better judgment to allow the connections to his mains to be increased above the safe limits imposed by the capacity of his plant, in order that the output of munitions might not be retarded. The slump in trade which followed the Armistice has, in its turn, been followed by even greater demands for power than during the war itself, and many supply engineers have found it so difficult to cope with these demands that they have had to refuse to connect any more consumers to their mains. This is an unfortunate plight to be in, but it is less unfortunate than that of those engineers where the load already on the mains exceeds the safe limit. To cope with this situation drastic steps have had to be taken. In one or two cases, notably at Hackney, an appeal has been made to the consumers to reduce their demands during the time of peak loads so that the general safety of the undertaking may not be endangered. In others, such as Birmingham, it has been necessary to take more coercive measures by actually reducing the permissible demand of each consumer during the periods of stress. At St. Pancras a request has been issued to cut off radiators and reduce the power load between 4.30 p.m. and 5.30 p.m. until about a fortnight after Christmas; while at Bradford a similar appeal has been made. These restrictions will not, of course, do much to assist production, but until fresh plant is installed it is difficult to see how they can be avoided. And at any rate some supply is better than none at all. The whole thing is but another example of the vicious circle. Extra plant for the stations now in difficulties has been on order for some time, but such equipment as a large turbo-generator is not the sort of thing which is kept in stock like matches or tobacco. But restrictions on power supply will not cause delivery to be made any sooner. While, therefore, agreeing that some restrictive policy is right and necessary we hope it will be employed with judgment, and that the first things to suffer will be display lighting and other more or less luxury uses of electricity. We realise that it is Christmas time: but all the same we feel that the real trade of the country is of more importance than the provisions of blazing shop windows or glaring and ephemeral displays of bad illumination. In many places, of course, the lighting load is exceedingly small compared with that for power purposes, but to restrict it might just make the difference. We hope manufacturers on their side will push on with delivery of the plant now on order, so that supply authorities will be placed in a position of less anxiety than that which they are enduring at the present time. The settlement of the moulders' strike, which is now foreshadowed, should help towards this desirable end.

220 K.V. Transmission Systems.

The Paper read by Mr. Silver on the above subject before the A.I.E.E., which is summarised in this issue, is of great interest. Although the pressure of electricity supply has been continually rising, and 150,000-volt systems have operated satisfactorily, the advance to 220,000 volts may seem a bold step. It appears, however, that although greater care in construction will be necessary, and various structural features will require to be modified, there are no insuperable difficulties. Indeed, as will appear, from another Paper, also dealt with in this issue, a 220 k.v. transmission system on a large scale in California is now actually under consideration. We, in this country, have naturally little experience of transmission at pressures of this order, but in view of future possible developments progress in the United States should be closely studied. The recent report of the Conjoint Board of Scientific Societies on Water Powers in the British Empire lamented the inadequate facilities for training for men entering upon these hydro-electric developments destined to play an important part in the Colonies and Dominions, if not also in this country. In this department of hydro-electric engineering the conditions under which these "super-voltage" transmission schemes are operated should be very carefully watched. Otherwise there is a danger that we may have to go mainly to other nations for knowledge and experience in this field.

Dull Discussions.

A week or two ago, in considering the methods in which the Institution of Electrical Engineers might be of greater use to its members, we suggested making the Papers read at the ordinary meetings more controversial in tone, in order to invite discussion and that Papers with which this could not be done should not be brought up at a meeting but should find their proper place in the pages of the "Journal." There were some who disagreed with us, but our confidence in our own opinion remains unshaken, and we think that many of those who were present at the meeting last Thursday, when a Paper by Messrs. D. M. J. Hutchison and W. J. Wayte on "Electricity in Tin Mining" was the business of the evening, will admit that there is something to be said from our point of view. For this the authors are not to blame. Their Paper is a most valuable one, for it gives a description of the application of electric drive to the tin mines in the Federated Malay States, about which very little is known in this country. But it deals with facts purely and simply, and for that very reason offers little opportunity for discussion. As a result the few who spoke found very little to say, although they were able to say it at great length. We feel that purely descriptive matter such as that contained in Messrs. Hutchison and Wayte's Paper is best published in the columns of a technical journal, where also any differences of opinion, can be aired by those interested in the correspondence columns rather than it should be brought up at a meeting, where, in order that interest may be sustained, the discussion should be the principal thing. In contradistinction to the dullness at this very formal meeting we may call attention to the brightness at the informal meeting on the Monday previous when Mr. R. Rankin opened a discussion with "Some Reflections on Labour." Mr. Rankin threw his remarks, as he admitted, into a definitely controversial form and the end in this case justified the means. The discussion was well sustained and full of point, and it lasted without any flagging of interest for over two hours. We feel that if, as we all desire, more interest is to be stimulated in the affairs of the Institution by the general body of electrical engineers, this is one of the ways in which it can be done.

Another View of Nationalisation.

The exact computation of the benefits or otherwise to be gained by nationalising one or more of our industries differs from time to time, not only with the political opinions of each person, but with the value in the scheme of things of the particular industry considered from that person's special point of view. What may be sauce for the goose is not always sauce for the gander. At the moment the tendency seems to be setting rather against nationalisation, even in quarters where it was most favoured. For instance, the miners, who were highest in its praise for their own industry, are now not so sure that it will bring with it the Utopia they once expected. This view is a tribute to their sense if it is based on the happenings of the past few months. For what all business men, including electrical engineers, fear from nationalisation, and trade unionists will do well if they fear the same, is that a dead hand will be laid on enterprise, and that the whole of their time will be occupied in the filling in forms and passing useless minutes from one department to another. Responsibility will cease to be shouldered if it can be passed on. There will be no necessity to make a profit. Moss will grow in the once busy offices. In considering nationalisation from this point of view, however, there is, perhaps, a little confusion of terms. For what business men really fear is not nationalisation so much as bureaucracy. It was recently remarked that we have never really had a chance to try efficient nationalisation. The administration of Government departments under ordinary peace-time conditions is in the hands of officials who have never had any experience of business methods, going, as they do, straight from the university or the secondary school into the office where they become fossilised by tradition in an extraordinarily short space of time, and generally become expert in nothing but twining red tape. The only leaven to this lump comes, in the normal course, from the introduction of outsiders with legal training which in itself tends to narrowness rather than to broadness of outlook. It will be argued that recently we have seen business men in Government departments, and that the experiment has not been a great success. We think, however, that this was due to the extraordinary amount of work which had to be performed, and to the stress under which it was carried on, with the result the leaven was not able to have its full effect, especially as the real control was still left in the hands of the tape-bound civil servant. It is unfortunate that most of the business men so introduced soon got tired of the ways of Government offices, and after the Armistice took the first opportunity to retire once again into private life. For we feel that the way to improve our bureaucracy is by the introduction of men with previous business training, whereby they have gained a broad outlook, and are able to view problems in a broader way than one who has been shackled from youth with departmental tradition. This is now the more necessary when the business of administration is becoming every day more technical. We hope that the Electricity Supply Bill will at least give this opportunity to electrical engineers, but it is an idea which must be further developed if we are to have really efficient Government departments.

The Institution of Electrical Engineers.—*Scottish Centre.*—Arrangements have been made to hold a conversazione of this centre on Wednesday, February 4th, 1920, at 7 p.m., in the St. Andrew's Hall, Granville-street, Glasgow. Tickets may be obtained from Mr. A. Lindsay, 173, Bath-street, Glasgow.

"N.P.L. Review."—We have received the first issue of the "N.P.L. Review," a magazine to which we wish every success. A large part of this issue is taken up by biographical notices of Sir Richard Glazebrook, the retiring Director, and of Prof. J. E. Petavel, who is taking his place. From the remainder we gather that the staff of the N.P.L. is not purely concerned with matters of high scientific importance, but that they seem to be able to take interest in such mundane things as mountaineering, music, football, hockey and chess.

The Distribution of Radiation on the Disc of the Sun.—In the "Proceedings" of the Koniklijke Akedemie van Wetenschappen te Amsterdam, Prof. W. H. Julius comments on an interesting characteristic of solar radiation—namely, that the intensity of light on the sun's disc diminishes appreciably from the centre to the limb. It was formerly suggested that this effect might be explained by the absorption due to the sun's atmosphere, the energy thus absorbed being radiated again by the gaseous envelope; but the fact that the sun's atmosphere supplies, apparently only 1/1000 of the total radiation shows that it cannot be responsible for the big radiation noted. The author prefers to explain the phenomenon by a theory based on irregular refraction by the gaseous layers.

Society of Technical Engineers.—At a recent meeting of this Society an address was given by Mr. E. C. de Segundo on "The Proper Position of the Electrical Engineer in Industrial and Political Circles." In introducing the speaker, Dr. J. F. Crowley, who was in the chair, said that in his opinion enquirers should take a keen interest in political problems and do all in their power to educate those subordinate to them in the duties of citizenship, and the necessity for increased productivity in the industry. This was one of the objects for which the Society of Technical Engineers was founded and was just as important as the improvement of the engineer's status, which should be accomplished by legitimate means. We hope to give an account of Mr. de Segundo's address in a subsequent issue.

Electrical Fume Mask.—Fine fumes are commonly more difficult to absorb than gases, and this difficulty was experienced in dealing with the poisonous materials used in the war. The charcoal gas mask is adapted to the absorption of gases, but in order to absorb the fumes an extra filter would be necessary, adding to the difficulty of breathing. In May last year an electrical fume mask was experimentally developed with the idea of condensing the fumes by electrical discharge, and a short account of these experiments is given in a Paper by Mr. W. W. Strong, summarised in the "Physical Review." A small induction coil was used, the electrical element being supplementary to the ordinary gas mask. The weight of the mask had been reduced to 2 lb., but at the date of the Armistice the life only amounted to several hours, a period which was much too short and would have required lengthening.

I.E.E. Wiring Rules.—The Council of the Institution of Electrical Engineers have approved the following recommendation of the Wiring Rules Committee: That wiring rule 39 be amended to read as follows: "Except for wiring fittings, the cross-sectional area (table, col. 2) of any copper conductor must not be less than 0·0015 sq. in. (1/·044"). The cross-sectional area of fittings wires must not be less than 0·0010 sq. in. (1/·036")." The matter is one of importance in view of the introduction of the new standard sizes, and the question has been raised in correspondence with the Institution and in the Press. A complete revision of the wiring rules is in hand, and the Committee will be glad to receive suggestions (in the form of specific amendments) for consideration during the revision. Suggestions should be addressed to the Secretary of the Institution, 1, Albemarle-street, London, W.1. Many valuable suggestions have already been received.

Physical Society and Optical Society's Annual Exhibition.—The above exhibition will be held on Wednesday and Thursday, January 7 and 8, 1920, at the Imperial College of Science, South Kensington, and will be open from 3 to 6 p.m. and from 7 to 10 p.m. on both days. A discourse on "Some Polarisation Experiments" will be given by Prof. F. J. Cheshire, C.B.E., at 8 p.m., on January 7th, and at 4 p.m. on January 8th, and a discourse on "The Use of Light in the Transmission and Reproduction of Speech," will be given by Prof. A. O. Rankine, D.Sc., at 4 p.m. on January 7th, and 8 p.m. on January 8th. The lecture will be illustrated by experiments.

Invitations have been given to the Institution of Electrical Engineers, the Institution of Mechanical Engineers, the Faraday Society, the Wireless Society of London, and the Röntgen Society. Admission in all cases will be by ticket only, and therefore members of the societies above mentioned (including also the Physical and Optical Societies) desiring to attend the exhibition should apply to the secretary of the Society to which they belong. Others interested should apply to the Secretary of the Physical Society, National Physical Laboratory, Teddington, S.W.

Society of Glass Technology.—At the meeting on the 17th inst., Dr. W. E. S. Turner, lecturer in charge of the department of glass technology of Sheffield University, was presented with a cheque and a silver tea and coffee service, and Mr. Frank Wood, of Barnsley, the first president of the society, with a silver rose bowl. The society also intend to found a Wood prize in the department of glass technology of Sheffield University. Subsequently there was a discussion on "The Position of the Glass Industry in America," and among the Papers was one contributed by Dr. Turner, who recently completed a tour of the leading manufacturing centres of the United States. The author said it was quite impossible to draw a hard and fast line, but it might be said that very fine artistic glass was made in the State of New York, which also produced most of the optical glass during the war; lamp-blown and graduated scientific apparatus making was largely concentrated in the southern portion of New Jersey. Illuminating and general domestic glassware was a widespread industry. Insulators for telephone and telegraph wires were almost everywhere of common green glass. Two other recent developments were the manufacture of glass oven dishes for baking and cooking. Much had been written in regard to the excellence of the glass sands in the United States, and in this respect the country enjoyed considerable advantages over our own. Those most widely used were the Ottawa sand from Illinois, and that from Berkeley Springs and West Virginia. Dr. Turner described the mechanical appliances used by American manufacturers, and drew contrasts between the American and British methods of production.

Railway Electrification in Switzerland.—Scarcity of coal has given a great impetus to railway electrification. In the United States, as is well known, extensive schemes are being considered, and in countries with poor supplies of coal and abundant water-power rapid progress in electrification is to be expected. Switzerland is a typical case. The shortage of coal led to great difficulties during the war, wood being used as fuel for locomotives on some lines. The "Electrical World" recently gave an interesting summary of the situation. The chief Swiss railways are Government owned. The water-power immediately available exceeds 2,000,000 H.P., of which half is already developed hydro-electrically; but it is estimated that the total water-power reserves could be raised to 8,000,000 H.P. The Swiss Confederation owns about 1,800 miles of railway, and of these only a small portion has so far been electrified. On the other hand, 622 miles out of 1,416 miles privately owned are electrical. The first important section of Federal railway to be converted to electricity was the St. Gothard Railway; it was decided to electrify 68 miles (from Erstfeld to Bellinzona) in 1913, and the section is expected to be completed this autumn. Other sections (Bellinzona to Chiasso and Erstfeld to Lucerne) are expected to follow in 1921. The cost of electrifying the entire Federal system is assessed at about £50,000,000. The electrification of various other sections of the Federal railways was decided upon in 1918, including an extension of the Simplon Tunnel line, opened in 1906. The electrified Berne–Thun line, which facilitates connection between the Swiss capital, the Bernese Oberland, and the Valais and Northern Italy, was opened in May last. The electrification of these lines, many of them in very mountainous districts, presents many interesting features.

Personal.

Dr. S. R. Wells has been elected Vice Chancellor of the University of London, and Sir Richard Glazebrook has been appointed to the Zaharoff Chair of Aviation in the University.

Commander J. P. Schofield, M.B.E., Principal of the Cardiff Wireless College, has been presented by the students with a silver cruet set. The College turned out 1,000 wireless operators during the war.

Mr. Charles G. Robertson, C.V.O., has been appointed Principal of the University of Birmingham, in succession to Sir Oliver Lodge. Mr. Robertson has been Tutor in Modern History at Magdalen College, Oxford, since 1905.

Col. Sir Andrew M. J. Ogilvie, K.B.E., C.B., R.E., Joint Second Secretary of the Post Office since 1914, will retire from his official duties at the end of the month. He has been concerned chiefly with the work of the telephone and telegraph services. He took a prominent part in the arbitration on the transfer of the National Telephone Company's system to the Post Office in 1911. Sir Andrew was made Director of Army Signals (Home Defence) in 1914, and during the war he was largely occupied in arranging for the provision of telephonic and telegraphic communications for the Forces in Great Britain, including anti-aircraft defence lines, &c.

Arrangements for the Week.

ROYAL INSTITUTION.

At Albemarle-street, Piccadilly, London, W. Six Christmas Lectures for Juveniles on "The World of Sound," by Prof. W. H. Bragg, C.B.E., D.Sc., F.R.S.

Tuesday, Dec. 30th.

3 p.m. Lecture I., "What is Sound?"

Thursday, Jan. 1st.

3 p.m. Lecture II., "Sound and Music."

Saturday, Jan. 3rd.

3 p.m. Lecture III., "Sounds of the Country."

FRIDAY, Jan. 2nd.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Automatic Electric Weighing Machines as Used with Machine Packers," by Mr. V. Sims.

Electricity in Tin Mining.*

By D. M. W. HUTCHISON, B.Sc. and W. J. WAYTE.

General.

The full title of this paper should be "Electricity in Tin Mining in the Federated Malay States," the authors' experience not having extended beyond the tin fields of that country; methods of mining are, however, generally similar in other parts of the world. The group of States—Perak, Selangor, Negri Sembilan and Pahang, known as the Federated Malay States, or the F.M.S. for short—form part of the Malay Peninsula, and furnish the product known in the metal market as "Straits tin"; the output is very large, the exports in 1913, the last normal year, being 50,127 tons, value approximately £9,800,000.

The labour force employed in tin mining in the same year numbered 225,000, 216,000 of this number being Chinese, but the adoption of machinery and other causes combined has resulted in recent years in a large decrease in the number employed. Machinery, which is already used to a large extent, is likely to come into use much more in the near future. The present position roughly is that European-owned mines employ a maximum of machinery and a minimum of labour, and the Chinese-owned mines a maximum of labour and a minimum of machinery. Mines under Chinese management in 1918 produced about 70 per cent. of the total output, and as there are less than half a dozen electrically-driven Chinese mining plants there should be great scope for the electrical engineer in the immediate future. In 1917. 7,600 kw. of generating plant and 8,300 H.P. of motors were installed on tin mines, but the majority of mines where power is employed still use steam, generally in a very wasteful fashion. The increase in the cost of firewood, owing to its scarcity, the discovery in recent years of a valuable deposit of coal in Selangor suitable for burning on mechanical grates, and the necessity that now exists for working low-grade propositions on a large scale, are three factors which are bound in the near future to result in the installation of up-to-date economical power plants for mine working.

The labour used for mining purposes is almost entirely Chinese; the ordinary Chinese coolie is a born miner, and appears to be naturally gifted with the instinct to locate tin-bearing ground. Up to the present time very little methodical prospecting work has been done by Chinese miners. The large mines are usually started by small parties of tributers who appear to decide upon the right spot to commence operation either by guesswork or by instinct; the Chinaman is a gambler and faces his losses philosophically. The pre-war rate of pay for Chinese labour was 60 cents (1s. 5d.) a day; it is now about 80 cents (1s. 10½d.). Mechanics are usually Chinese, but there is a fair sprinkling of Tamils, Bengalis, Japanese and other races, the pay varying from $1.40 to $2 per day (3s. 3d. to 4s. 8d.). Men in charge of electrical machinery have by law to possess certificates of competency issued by the Examining Board under the Electricity Enactment. This law extends to European engineers, who, however, if Associate Members of this Institution, are not called upon to appear before the Board. The rate of pay varies greatly with the individual, especially in the higher grades, but the following are approximate rates paid in Perak:—Second grade chargemen $24 per month (£2 6s. 11d.): first grade chargemen $40 to $75 (£4 13s. 9d. to £8 15s. 8d.); second grade engineer $120 to $200 (£13 11s. 2d. to £23 8s. 8d.); first grade engineer $350 to $450 (£39 to £50 14s. 7d.).

Problems in Tin Mining.

The ore-bearing ground, or karang, lies in beds, varying in thickness from a few feet up to 20 ft. or more, which may be close to the surface or may be as far below the surface as 150 ft., a depth of 70 ft. being more usual. In some cases the karang is found in one or more large beds; in others it may be found in several beds at varying depths, and in many cases there are no well-defined beds, the whole of the ground containing tin ore to some extent. The object of the miner is to get the ore out of this karang with the least possible expenditure, and he has, roughly speaking, a choice of three methods: open cast mining; hydraulic mining; and bucket dredging. As each of these methods presents a different problem in regard to the supply and utilisation of power, it has been considered most convenient to deal with each in turn. It does not follow, however, that every mine adopts one of these methods only. The problem of lode mining is treated separately, as no useful comparison can be made between this form of mining and alluvial mining. At present only a very small proportion of the total tin output is won in lode mines, but as alluvial deposits become worked out more attention will no doubt be devoted to this form of mining.

Open Cast Mining.

A typical large open cast mine in full working consists of one or more huge oblong pits in the ground, perhaps 80 ft. deep and many acres in extent. At one end of each pit will be an incline consisting of a double line of rails up which the karang is hauled to the puddler station; in another position a similar incline for the removal of overburden, which is dumped out of the way, into an old working for preference. The puddler station, which usually serves one pit only, consists of a level timber platform forming a terminus to the karang incline, and is furnished with rails and a double-drum winch which serves to haul up the full trucks and lower the empty ones. The full trucks are brought to rest on the puddler platform opposite an opening directly over the puddlers into which the karang is tipped.

The puddlers are of two main types, that used depending on the class of ground worked or on individual fancy. The most widely used type is merely a cylindrical open top brick or iron tank about 25 ft. in diameter with a wood block floor, in the centre of which is a vertical shaft driven at about 5 revs. per min. by bevel gearing. This shaft carries four cross-arms, to the ends of which are attached two cast-iron "harrows" fitted with blunt teeth. The karang being dumped into this machine and mixed with water is churned by the harrows. The process is continuous, the mixture after being churned being led to sluice boxes through a coarse screen. The other type of puddler consists of a horizontal shaft carrying knives and running in a plated timber container at a speed of about 120 revs. per min. This high-speed type is generally furnished with a flywheel to take up shocks when the karang is tipped in.

The puddled mixture, in either case, is led by launders to the sluice boxes after being thinned down slightly by the addition of clean water. The sluice box, which forms a common feature in all tin-mining systems, consists of two or three compartments 200 ft. or so long, furnished with removable slats across the bottom which catch the heavier tin particles and allow the lighter sand and slimes to escape to the tailings dump. Each compartment is capable of dealing with the whole output of the puddler serving it, and this allows the others to be washed down with clean water and the tin ore removed without any slackening in mining operations.

Open cast mines are of all sizes varying from the modest hole in the ground worked entirely by Chinese labour to propositions with capitals of £120,000 or more. In nearly all mines of this type, however, power is used in some form or other. The source of power in most general use is the portable non-condensing steam engine burning wood fuel, and it is quite common to see half a dozen or more of these fuel-wasters at work on the same mine. It is only fair to state, however, that for outputs of from 60 H.P. to 100 H.P. very efficient, portable, condensing, superheated steam engines can be obtained. Diesel and semi-Diesel engines are in use to a certain extent, and in some of the large mines, and in several smaller ones, electricity is the driving power. The chief uses for power are for hauling, pumping (both for unwatering the mine and for supplying water for the puddlers and sluice boxes), and for puddler driving and lighting the mine at night.

Table I. gives particulars of four typical open cast mines, and Tables II. and III. of hydraulic-electric, dredge and lode mines. In all cases (except Lahat, Pengkalen and Idris) the energy used has been calculated from switchboard readings, and a power factor of 0·75 to 0·8 has been assumed. Mine managers who indulge in the practice of buying plant direct from the manufacturers would do well to insist on a proper provision of instruments for measuring the output. If, as is usual, they ask for tenders for "one plant complete," they should not expect luxuries and certainly will not get them. It has been impossible in many cases to separate generating from distributing costs, but when possible this has been done. This must be borne in mind when comparisons are made with hypothetical bulk-supply systems. Capital costs have been omitted owing to the general practice of grouping together generating and mining plant; such figures as are obtainable are apt to be misleading. It will be seen that some mines are run partly by electricity and partly by steam and gas, the two latter being used as a rule for operating the fluctuating winch or puddler loads or as a stand-by for emergency pumping in case of flooding. Naturally such a practice produces a high electrical plant load-factor, but when electrical plant can be obtained again the whole of the mining load will doubtless be dealt with electrically, with a benefit to the all-round power costs.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

Table I.—*Open Cast Mines.*

Name of Mine.	Year.	Power House.				Distribution.												Cost per Unit Generated.					Various Data.					Remarks.
		Prime movers.	Total kw. and gen. volts.	System voltage.	Annual output in units.	Winches. No.	Winches. B.H.P.	Puddlers. No.	Puddlers. B.H.P.	Gravel pump. No.	Gravel pump. B.H.P.	Water pump. No.	Water pump. B.H.P.	Other uses. No.	Other uses. B.H.P.	Total. No.	Total. B.H.P.	Fuel.	Oil and stores.	Repairs and maintenance.	Salaries and wages.	Total works cost.	Fuel used and cost Dd.	Fuel per unit.	Units used per cubic yard.	Power cost per cub. yd. cents.	Cubic yards treated.	
Sungei Besi	1917	Steam compound condensing	525 kw. 550 v. 3 ph. 50 ∾	500 v. M. 220 v.d.c. for L.	1,644,000	Steam		1	80	1	50	2	500	6	107	10	737	2·00	0·45	0·45	0·45	2·45*	Rawang coal $4·98 per ton	9·1 lb.	7·9	19·5	205,631	Lb. of fuel per unit in 1919 reduced to 6. Installing mechanical stokers & economisers.
Lahat Mines	1918	Diesel	220 kw. 2,200 v. 3 ph. 50 ∾	2,200 v. and 400 v. M. 230 v. L.	1,695,194 purchased	4	120	Gas		2	120	2	355	4	82	12	677	..	Power purchased from Pengkalen			..	...	..	3·7	--	425,021	Diesel stand-by only.
Tekka Mine	1918-19	Diesel	136 kw. 650 v. 3 ph. 50 ∾	650 v. M. 230 v. L.	9 months 415,500	2	40	2	60	..	..	3	150	..	..	6	250	1·47	0·16	0·04	0·84	2·51*	Crude oil 22 C. per gall.	0·066 gall.	2·8	7·45	140,000	Distribution costs 0·29 cent per unit. Tekka and Tongwoh supervised by same engineer.
Tong-woh	1918-19	Diesel	272 kw. 650 v. 3-ph. 50 ∾	650 v. M. 230 v. L.	9 months 556,500	2	36	2	59	..	..	3	180	..	..	7	275	1·33	0·11	0·01	0·78	2·23*	Crude oil 20 C. per gall.	0·066 gall.	3·0	7·16	173,309	Distribution costs 0·36 cent per unit. Auxiliary steam.

* Includes cost of distribution of mine. M = Motors. L = Lighting. C = Cents. (To convert cents to pence multiply by 0·28.)

Table II.—*Miscellaneous Mines.*

Name of Mine.	Year.	Power House.				Distribution.		Cost per Unit Generated in Cents.					Various Data.				Remarks.
		Prime movers.	Total. Kw. and gen. volts.	System voltage.	Annual output in units.	Motors. No.	Motors. B.H.P.	Fuel.	Oil and stores.	Repairs and maintenance.	Salaries and wages.	Total.	Fuel used.	Units used per cubic yd. or ton treated.	Power cost per yard or ton. Cents.	Cubic yards or tons treated.	
Tin Bentong Dredge	1918	Pelton wheel	800 kw. 2,200 v. 3-ph. 60 ∾	Step up 11,000 v., step down 2,200 v. and 230 v. M. 110 v. L.	1,463,500	10	680	..	..	0·37	0·80	1·17	..	1·69 per cub. yd.	2·21	775,000 cub. yd.	Motors on dredge 595 B.H.P. Motors on shore 85 B.H.P.
Chendai Lode	1916-17	Power purchased	—	400 v. M. 230 v. L. 3-ph. 50 ∾	6 months 85,470	3	120	..	..	..	..	..	..	19·89 per ton	..	4,355 tons	Motors—Ore crusher 10 B.H.P. Stamps 75 B.H.P. Tables and mills 35 B.H.P.
Pahang Consolidated Lode	..	Steam turbines and Diesels	950 kw. 550 v. 3-ph. 50 ∾	500 v.	3,350,000 approx.	..	1,000	..	..	..	..	..	Wood and Crude Oil	..	..	..	Compressor motor 435 B.H.P. Pumps 565 B.H.P. underground. Boilers supply steam winders in addition Mill driven by Diesels.

M—Motors. L = Lighting. (To convert cents to pence multiply by 0·28).

Large Scale Generation Inadvisable.

The question of generating on a large scale in central stations and distributing to mines has been discussed many times, most recently by a Commission appointed to inquire into various questions connected with tin mining. The authors do not consider that the prospects of a power company would be very rosy, for the following reasons:—(1) Absence of diversity. Beyond a very small proportion of town lighting there is practically only mining load to consider. (2) Limited paying life of the power company due to tin-bearing areas being worked out. It must be remembered in this connection that the application of power to mines now mainly worked by coolie labour would result in the deposits being more rapidly exhausted. (3) Heavy capital charges due to the high rate of interest expected in this country and also due to heavy amortisation charges on account of short life. (4) Comparatively poor load-factor during useful life, due to the short-lived nature of many mines, the temporary shutting down or restriction of output in times of low tin prices, and the failure to get the most profitable consumers, the large mines, which can generate very cheaply with their own plants. The majority of a power company's consumers would be the small or medium-sized Chinese mines now using portable engines and working from 10 to 18 hours out of the 24. (5) Heavy wayleave and maintenance charges, as the lines running over mining land would have to be moved frequently.

A co-operative power station to supply a group of well-proved mines is, of course, a different proposition altogether and seems to be the solution of the problem. There is no reason why such a power station could not supply the more or less ephemeral demands of small mines near by in addition to its nucleus load. The authors do not consider, taking everything into account, that the average yearly load-factor of a power company taken on the maximum useful station capacity over the period of its paying life would exceed 40 per cent. A co-operative group power station under similar circumstances should be able to reckon on a load factor of 50 to 60 per cent. In this connection it is as well to bear in mind that the years now under review were years when the tin output was being forced up as much as possible to provide munitions, and plants were being run to their greatest capacity. At present steam users with a certain maximum horse-power installed have a way of over-estimating the horse-power-hours used per annum, with the result that the calculated cost per horse-power-hour comes out unduly low and unfavourable comparisons are made with electricity. A comparison of units generated and brake horse-power connected on electrically-worked mines will give a good idea of what may be expected in this way.

Hydraulic Mining.

Hydraulic mining may be defined as a process whereby the ground is removed and treated by the agency of water. It has many forms and combinations falling into three main classes:—(1)

Table III.—*Hydraulic Electric Mines.*

Name of mine.	Year.	Power House.				Distribution.												Cost per Unit Generated.					Various Data.										Remarks
		Prime movers.	Total kw. and generated volts.	System voltage.	Annual output in units.	Winches.		Water pumps.		Gravel pumps.		Nozzle pumps.		Other uses.		Total.		Fuel.	Oil and stores.	Repairs and maintenance	Salaries and wages.	Total works cost.	Fuel used and cost Dd.	Fuel per unit.	Units used per cubic yard	Power cost per yard treated.	Cubic yards treated.	Static head at power house, feet.	Static head at mine, feet.	Length pressure pipe above power house, miles	Length pressure pipe below power house miles	Length trans. line, miles	
						No.	B.H.P.	No	B.H.P.	No.	B.H.P.	No.	B.H.P.	No.	B.H.P.	No.	B.H.P.																
French Kampar	1917	2 Water turbines 1 Diesel	744 kw. 6,000 v. 3 ph 50 ~	Step down 400 v. M. 110 v. L.	2,327,234 *a*	..	..	..	..	3	370	2	150	..	202	..	722	..	..	..	..	1·76 (*b*)*	Crude oil 17·17 C. per gall.	..	5·75	11·02 C.	383,500	1,312	..	..	..	1	1917 output includes power sold to tributers or used for town lighting.
	1918				1,757,000	..	..	..	..	4	435	2	150	..	..	5	595	..	..	..	..	..		..	6·25	13·26 C.	238,500	..	..	..	..	..	
French Tekka	1918	Pelton wheels	1,020 kw. 450 v. 3 ph. 40 ~	Step up 9,000 v., step down 400 v. M. 230 v. L.	4,790,000	3	69	10	144	8	859	..	..	2	16	23	1,088	.	(*c*)	0·18	0·83	1·01 *	..	..	3·14	3·84 C.	1,270,000	328	328	2	4·35	7	(*a*) Diesel 1,059 140. (*b*) Overall cost for estimated total output. (*c*) Not included.
Idris Hydraulic	1918-19	Pelton wheels	900 kw. 400 v. 3 ph. 50 ~	Step up 3,000 v., step down 400 v. M. 230 v. L.	6 months 900,890	..	..	1	35	6	510	..	..	..	..	7	545	..	..	0·11	0·37 (*d*)	0·48	..	..	..	..	..	936	360	1	1½	1·5	(*d*) Exclusive of cost of Head Office supervision.
Pengkalen	1917-18	Steam turbine and triple expan. engine	1,100 kw. 2,200 v. 3 ph. 50 ~	Step down 400 v. M. 230 v. L.	4,208,800	4	120	6	400	4	371	1	110	6	182	21	1,173	1·68	0·03	0·06	0·42	2·17	Local coal $6·86 per ton	5·5 lb	..	..	..	..	..	..	..	5	Started as suction dredge Shut down Nov. 1918 Now sells power. Water-tube boilers-chain-grate stokers, overhead power lines.

* Includes cost of distribution on mines.

Abbreviations: M = motors. L = Lighting. C = Cents. (To convert cents to pence multiply by 0·28.)

hydraulic mining proper, including ground sluicing; (2) hydraulic-electric mining; (3) suction dredging.

Hydraulic Mining Proper.—Here the ground is cut by jets of water projected by monitors under a natural head of from 50 ft. to 400 ft., and the mixture if necessary elevated by hydraulic elevators (see Fig. 1) to the sluice boxes where the treatment follows the procedure outlined under open cast mining. In ground sluicing, which is usually only carried out on a small scale, the ground is broken down by hand labour into channels where it is mingled with water, the resulting mixture being passed over sluice boxes. Overburden and karang are generally treated in the same way, although in some cases the overburden is removed by coolie labour. The hydraulic method, using water under pressure, is used on some of the largest properties in the country, and provided that plenty of water at a suitable elevation is available and the value of the property is suffiient to justify the cost of an expensive dam and pipe line this method is usually adopted.

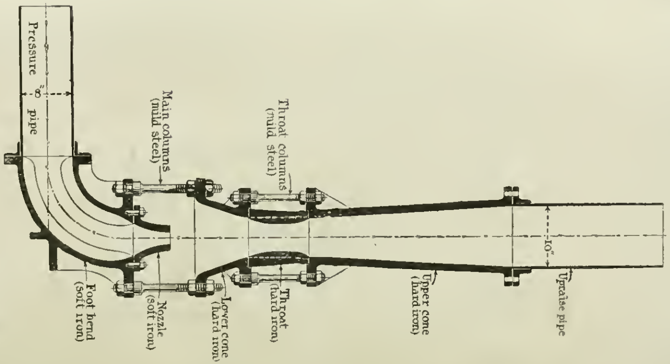

Fig. 1.—Section of Hydraulic Elevator, with Names of Parts.

(*To be concluded.*)

Protective Resistances for High Voltage.*

By H. GEWECKE.

Carborundum has the peculiarity that its resistance decreases with increasing voltage; it is, therefore, specially suitable for resistances under certain conditions. If a coil is protected by such a resistance in parallel with it, a surge will pass through the resistance, which then has a resistance much lower than its normal value. When the surge has passed off, the resistance becomes as before—*i.e.*, of a much higher value than that due to the abnormal conditions. If carborundum is the material out of which a series resistance is made, this variability of resistance is, in fact, undesirable. Long rods are therefore used in place of the disc-shaped bodies which are employed in parallel resistances. But even this does not entirely remove the peculiar characteristics of bodies like carborundum.

Now carborundum, and other bodies which have similar peculiarities, consist of a mixture of particles, some of which conduct while some do not. Thus, if there are enough non-conducting particles, the resistance will be high; but it is unnecessary at the moment to go further into the question of the hypothetical structure of the alloy. If a certain voltage is applied, and conduction takes place, it is necessary to suppose that a discharge takes place between the conducting particles over microscopic air-gaps, all of which are in series with one another. Thus, as the voltage is raised, the number of these air-gaps, over which the discharge takes place, is increased, and the total resistance of the path is correspondingly diminished the result being in no way due to internal heating. In order to circumvent this, and to produce resistances of constant value out of a material like carborundum, which has a very high specific resistance, it is necessary to provide some kind of metallic substructure, which acts as a definite connection between the terminals. This substructure has a high resistance, but it exercises a very great effect on the resulting resistance if the other material, such as carborundum, is afterwards incorporated with it The oxidation stages of certain metals possess peculiarities of this kind; of these, copper oxide is a notable example. Experiments and tests were, therefore, carried out with rods of copper oxide. Baedeker had found that copper oxide can be obtained in the form of thin laminæ, which have a resistance of 400 ohms per cubic centimetre. Rods of this material were finally obtained after certain initial experimental difficulties. The method of obtaining them will probably be published later These rods had a considerable mechanical strength, their ends being coated with copper so as to provide a good contact at the terminals. During the process of manufacture a large portion of the cupric oxide is converted into the cuprous form, which has a lower specific resistance of about 40 ohms per centimetre cube. It is, however, possible by making suitable additions to the material to obtain any ohmic value. Certain experiments were carried out with these resistances in a laboratory which was arranged for testing protective devices, and it was found that, as expected, the variation of resistance due to voltage was much less. Figures are given showing the results of these tests with horn arresters. When submitted to the effect of a surge, these resistances have values between 50 and 70 per cent. of their values when measured on the Wheatstone bridge, whereas with carborundum the value falls to 1 or 2 per cent. With resistances of cupric oxide, the value certainly falls, and this is due to the following causes: When the surge passes along the resistance, clearly visible discharges are seen, which provide an air path in parallel with the main resistance; but the resistances also have a certain capacity which at high frequencies gives rise to a current out of phase with the voltage. The fall in the resistance, in fact, partly depends on the frequency of the applied voltage. Tests also showed that these resistances of copper oxide were better as a protective device than carborundum resistances. A special advantage is also the strongly marked negative temperature coefficient of the new type of protective device, which enables it to carry a comparatively heavy load for a long time. The rising current heats the rod; thus the resistance is lowered, and the current is consequently kept below a certain value. As a result of their high heat capacity, the resistances are proof against short heavy overloads.

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* Abstract of an article in the "Elektrotechnische Zeitschrift," No. 31, 1919.

A Proposed 220-kilovolt Transmission Line in California.*

BY R. W. SORENSON, H. H. COX and G. E. ARMSTRONG.

California has available ample hydro-electric power to supply the industrial and agricultural demand for many years. Small developments aggregating 325,000 kw. have been completed. There are also four large projects as indicated in Table I., which can be readily developed to a capacity of 1,500,000 kw. in the near future.

Table I.—*Large Power Resources.*

—	Newly developed and under construction.	Proposed developments, 1926.	Reasonable future developments (not ultimate capacity).
	Kilowatts.	Kilowatts.	Kilowatts.
Pit River	None.	200,000	500,000
Feather River	100,000	200,000	300,000
Big Creek	100,000	300,000	500,000
Colorado River	None.	None.	200,000
Total	200,000	700,000	1,500,000

Total 1926 hydro-electric power development, including small projects, 1,025,000 kw.

Load Demand.

The best available information indicates a demand in 1926 exceeding 1,000,000 kw. In order to carry this load approximately 500,000 kw. additional in hydro-electric capacity will be required, and a plan has been developed for a 1,100 miles 220 k.v. transmission system. The proposed scheme involves the construction of a two-circuit transmission system extending from Pit River to Los Angeles, a distance of 570 miles. Branch lines of like voltage connect the three other power projects and the San Francisco load centre to this main line on which the other load centres are located. The main line thus becomes a high-tension bus extending nearly the entire length of the state. This arrangement makes possible unlimited interconnection and exchange between all the power companies of the state.

Sub-stations have been located at Marysville, Stockton, San Francisco, Fresno, Bakersfield and Los Angeles. These points are natural load centres and suitable points for connecting with the present power systems.

The standard frequency, 60 cycles, has been assumed on the basis that the Southern California power systems operating at 50 cycles will ultimately find it advantageous to conform to the A.I.E.E. standard. In the natural growth of the load 70 per cent. of the 1926 load will be supplied by the 60-cycle systems. Inter-connection of such large load centres or power sources through frequency changers, limits the exchange of power is uneconomical, and increases tremendously the required operating vigilance. The practicability of the high-voltage line has been well demonstrated by over five years of remarkably successful operation of the 150,000-volt lines of the Southern California Edison Company, which, during this period have delivered from the Big Creek power houses over the 240-mile lines to the Los Angeles distribution systems, 1,200,000,000 kw.-hours at an average efficiency of 87·5 per cent., with a 45 per cent. load-factor. During this period there have been no interruptions for which the high voltage is responsible, and on the contrary, the system has been free from disturbance and interruption to a greater degree than the lower voltage lines in the same locality.

The present Big Creek lines can be operated at 220,000 volts 60 cycles, without material change, and this is proposed as a link of the transmission bus, and its operation under these conditions will be analysed and applied to conditions of the proposed system. As now operated at 150,000 volts and 50 cycles the voltage is only 80 per cent. of the lowest critical voltage of any part of the line, and there is no corona loss. At 220,000 volts 60 cycles, corona loss occurs to some extent on the entire line, but amounts to but 0·4 per cent. of the line capacity during fair weather. With storm conditions over the entire line, and with an assumed reduction of 20 per cent. in the critical voltage, the corona loss would be 8 per cent. of the line capacity. This loss is not sufficient to make the line inoperative, and would occur too rarely to be an economic factor.

The Big Creek 150,000-volt lines have nine units in each suspension string, and two 11-unit strings in parallel on dead ends. During the $5\frac{1}{2}$ years of operation only two insulator string failures have occurred. The Big Creek line operated at 220,000 volts is at the critical corona voltage and any disturbances resulting in a higher voltage will quickly expand their energy in producing corona loss, which will permit a smaller safety factor to be used.

Long high-voltage lines can not be operated without synchronous condensers at the receiving station to regulate the voltage, and as a consequence the charging current, even at the standard 60-cycle frequency becomes a factor of no great importance as long as these synchronous condensers are connected to the line. Without these condensers the line charging current must be furnished entirely by the generators, in which case the generators may become greatly overloaded and at the same time produce a very high voltage over which the operator has no control. To avoid this emergency a transmission line with its generators, transformers and synchronous condenser must be considered as a unit and as such should be securely coupled together electrically at all times. This has been proved practical in the case of the Big Creek system, in which it is possible to start the 15,000 k.v.a. condensers and bring them up to speed with the generators.

The Big Creek lines as operated at 150,000 volts with 30,000 k.v.a. condenser capacity per line at the receiver end are each good for 57,500 kw. at 85 per cent. power factor, and will have under these conditions a line drop of 11 per cent. Operated at 220,000 volts, these lines should each have a capacity of 125,000 kw. with an equal line drop when provided with the proper condenser capacity, which is approximately 75 per cent. of the line capacity in kilowatts.

This is a fair indication of the conditions which will exist in the proposed system, the load centres of which are so distributed as to limit the actual average distance of transmission to about 200 miles. The economic gain in doubling the capacity of lines which cost approximately $6,000,000, the present cost of which would be at least 30 per cent. more, would more than offset the cost of all necessary changes, including the adoption of the standard frequency.

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* Abstract of a Paper read before the American Institute of Electrical Engineers.

A Remarkable Property of a Well-known Alternating-current Circuit.

By E. B. BROWN, M.Sc., A.C.G.I.
(Lecturer in Electrical Engineering, University of Melbourne, Australia.)

The author has recently come across a property of a very simple circuit which does not appear to be generally known. If, as in Fig. 1, a choke coil of constant inductance and a constant non-inductive resistance, R_1, be connected in series across constant potential alternating current mains, a certain alternating current will flow from the mains indicated on an ammeter, A_1. Shunting the choke coil with a non-inductive resistance, R_2, as in Fig. 2, would naturally be expected to increase the current taken from the mains. On the contrary, however, for a certain range of value of shunting resistance the shunting may be found actually to diminish the current taken from the mains, and there will be a minimum current for a certain value of the shunting resistance R_2. An analytical solution of the problem shows that the maximum lowering in the main current in such a circuit could not exceed about 13·4 per cent. Similar results would be expected if a condenser replaced the choke coil in Figs. 1 and 2, as has also been confirmed by experiments.

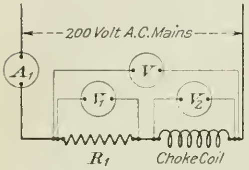


FIG. 1.

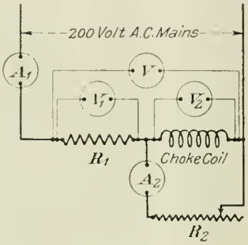


FIG. 2.

The accompanying diagrams and experimental results are taken from a demonstration given by the author before the Electrical Association of Australia on March 27, 1919. The choke coil was of the type frequently used in series with arc lamps, a single solenoid with straight laminated core; but any choke coil which gives a considerable phase angle between voltage and current would serve equally well.

Main volts.	Volts on R_1.	Volts on choke.	Main amps.	Amps. in R_2.	——
193	140	128	8·2	0·0	R_2 open circuit.
193	128	113	7·5	2·0	
193	126	102	7·3	3·5	
193	131	97	7·3	4·0	
193	127	91	7·3	1·5	
193	127	86	7·3	5·0	
193	131	77	7·6	6·0	
193	137	65	7·9	7·0	R_2 decreased.

The connections were made as in Figs. 1 and 2, and the current was taken from the 50-cycle alternating--current lighting mains. Ordinary switchboard ammeters and voltmeters were used in the demonstration, which were known to be reasonably accurate, and any errors there may have been do not affect the main conclusions. The accompanying graph, Fig. 3, in which the main current is plotted against the current in R_2, the shunting resistance, shows a marked minimum value of 7·3 amperes in the main current. Fig. 4 shows a vector diagram constructed from simultaneous voltmeter readings taken with the circuit of Fig. 1, and Fig. 5 shows a similar diagram for the circuit of Fig. 2 when R_2 was adjusted to give minimum main current. Figs. 4 and 5 show that the effect of the shunting diminishes the phase angle between the two components, which, vectorially added, make up the constant line voltage to such an extent that both components are simultaneously diminished. This provides an explanation of the drop in the main current, because, as R_1 is constant and non-inductive, the volts on R_1 represents the main current both in phase and magnitude to a suitable scale.

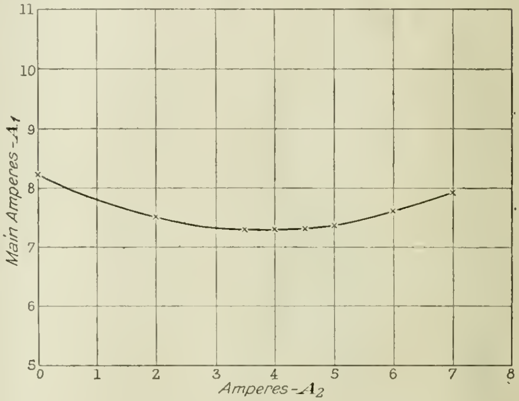


FIG. 3.

An analytical solution for a choke coil of negligible resistance and iron losses confirms the existence of the minimum value of the main current as follows: Let E be the line voltage, $2a$ mhos the conductance of R_1, g mhos the conductance of R_2, b mhos the susceptance of the choke coil, I amperes the main current.

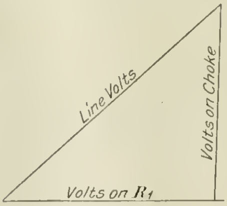


FIG. 4.

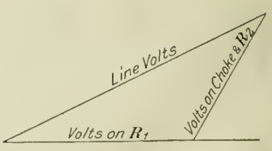


FIG. 5.

The solution for the main current is

$$I = 2aE\sqrt{\frac{b^2+g^2}{b^2+(g+2a)^2}},$$

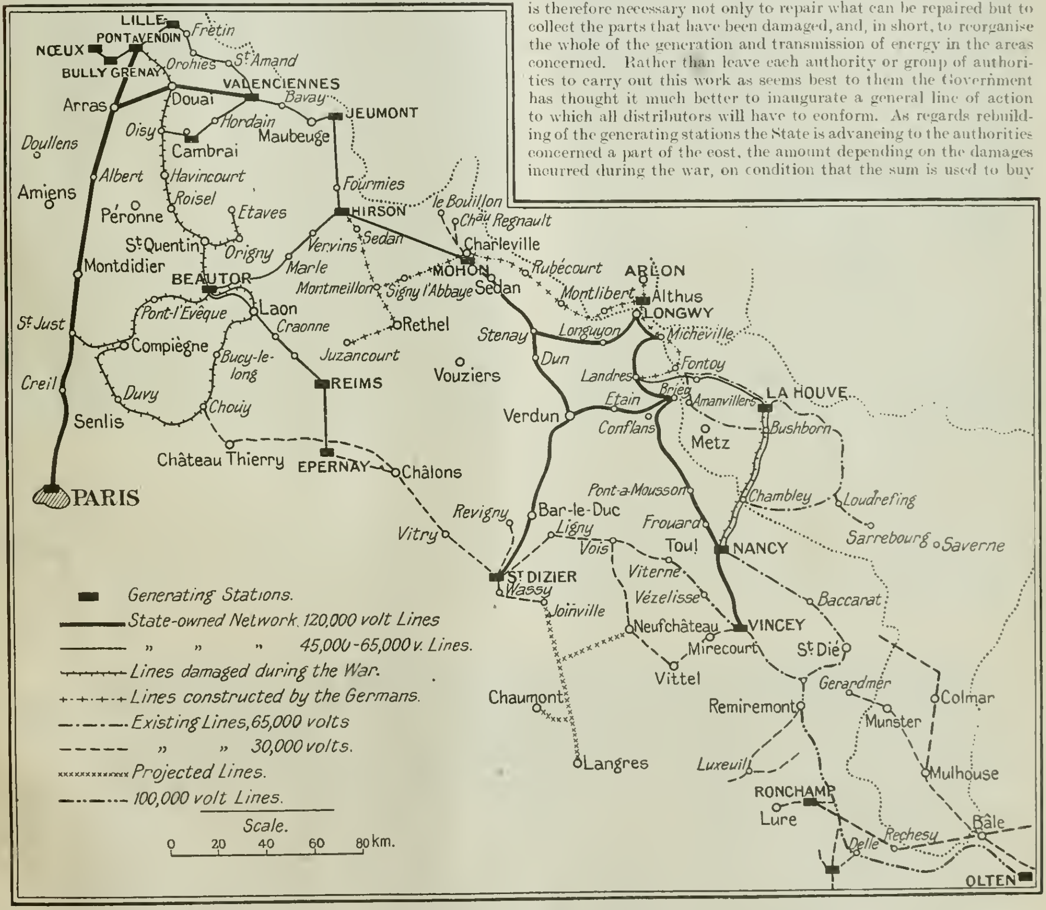
which will be found to have a minimum value when $g = -a+\sqrt{a^2+b^2}$, the minimum value being

$$I_{\min.} = 2aE\sqrt{\frac{\sqrt{a^2+b^2}-a}{\sqrt{a^2+b^2}+a}}.$$

The largest percentage lowering is obtainable in a circuit in which $b = 2·5a$ approx.—that is, in which the resistance $R_1 = 1·25$ times the impedance of the choke coil; this maximum lowering effect is obtained with a shunting resistance $R_2 = 1·18R_1$.

Electricity Supply in the Devastated Areas of France

The question of rehabilitating the areas of France which have suffered from enemy action during the recent hostilities is one which is both important and urgent; and it is therefore interesting to note that the French Chamber of Deputies has recently passed a law authorising the establishment by the State of a high tension system for supplying electrical energy in the liberated areas and laying down rules for the future development of this system. A recent law has as its object the development of the supply of electricity by the organisation and concentration of generating plant in large stations situated at the most favourable places for that purpose, *i.e.*, near waterfalls, coal mines or metallurgical works and by the interconnection of these stations both with each other and with the various centres of distribution by high tension networks erected either by the State or by interested persons under State control. This law, which like the Electricity Supply Bill now under consideration by our own Houses of Parliament, is applicable to the country as a whole, but having regard to the urgency of the work of reconstruction of devastated areas as well as the special conditions under which the generating and distributing companies in the north and east of France find themselves at the present time, the Government has thought it best to apply without delay to these areas the principles which it proposes to employ throughout the whole of France at a later date. The scheme includes a reduction in the number of generating stations and an increase in the size of the generating units employed in them.



Map Showing the Schemes of Supplying Electricity in the French Devastated Areas.

These generating units will be of a similar type everywhere, so that parallel working would be possible, while the erection of high tension lines joining the central stations and the various centres of distribution must be carried out. As is well known the methods followed by the Germans during the war caused the destruction, or at least grave damage to a number of generating stations and the same is applicable to the transmission lines. At the same time it may be noted that the Germans when retreating abandoned a number of stations which they had erected for their own use, especially the station at Hirson, which was left in an unfinished state. It is therefore necessary not only to repair what can be repaired but to collect the parts that have been damaged, and, in short, to reorganise the whole of the generation and transmission of energy in the areas concerned. Rather than leave each authority or group of authorities to carry out this work as seems best to them the Government has thought it much better to inaugurate a general line of action to which all distributors will have to conform. As regards rebuilding of the generating stations the State is advancing to the authorities concerned a part of the cost, the amount depending on the damages incurred during the war, on condition that the sum is used to buy under the control of the administration generating plant and other electrical equipment. The State has also decided to carry out at their own cost the completion of the German generating station at Hirson, of which it has become the owner. The transmission lines which are to be erected are shown in the accompanying map and will cover the area from Lille to Paris, and from near Saint-Dizier to Chambley in Lorraine. The total length of transmission line in this area would be about 1,500 kilometres. For financial reasons the proposed programme has been divided into two parts, the more urgent of which will be carried out first. In the first place lines operating at a pressure of 45,000 volts will be erected between Nœux, Bully-Grenay, Lille and Valenciennes; between Pont-a-Vendin, Douai and Cambrai; between Valenciennes, Jeumont, Hirson, Beautor, Laon, Rheims, Epernay and Saint-Dizier; between Stenay, Longwy, Piennes, Briey, Nancy and Vincey and between Piennes, Fontoy, La Houve, Buschborn, Chambley and Nancy.

Renewed Lamps.

The Process of the Aladdin Renew Electric Lamp Corporation, Ltd.

A good many years ago a process came on the market for the renewal of incandescent lamps and while it aroused a certain amount of interest, so far as we are aware it never attained to any considerable commercial success. In due course it passed out of existence, presumably because the margin between the cost of renovating a discarded lamp and that of a new lamp was insufficient to give an adequate return. This, we believe, was in the days when the carbon lamp was alone in the field. Now, however, that the metal filament lamp has almost superseded the carbon type, the subject is worth reconsideration, if for no other reason than that the price of the metal lamp is considerably higher.

It is, therefore, not surprising that a renewal process should now be in operation. We refer to that of the Aladdin Renew Electric Lamp Corporation, some of whose results were stated at the statutory general meeting held last month, and which were reported briefly in our columns at the time. It might be inferred that the process is quite new. This, however, is not the case. The methods employed have been developed over a period of some years by the Renew Electric Lamp Company, whose business has now been taken over by the more recently formed company with a view to expansion. Thus it is that we found the works in Harrow Road, London, to be much more extensive than we anticipated, and to be in brisk operation. We were informed that the output is 30,000—35,000 lamps per month, and that the works are equipped for 1,000,000 per annum. The business is growing rapidly, and consequently a new factory is in course of erection at Birmingham.

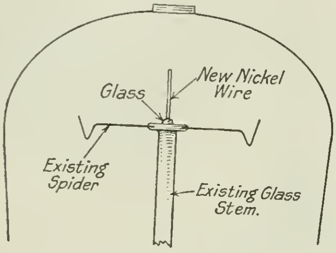


Fig. 1.—Arrangement for Holding Temporary Spider.

The Process.

Through the courtesy of the company we are now able to give a detailed account of the methods adopted. They are due to Mr. F. Harrison.

Upon arrival, the old lamps are sorted into makes, voltages and candle power, and at the same time any that are so badly damaged as to be past repair are thrown out. For example, those in which the stems are broken are not at present utilised. Full particulars of the lamps received from each source are noted.

The first renewal operation consists of removing the pip, and opening out a hole in the bulb of about $\frac{1}{4}$ in. in diameter. It is through this hole that the complete process of renovation is carried out. An addition is now made to the lamp, and this is the only one in the process. It takes the form of a short length of nickel wire ($\frac{3}{8}$-in. long). This is made up with a small bead of glass at one end. The lamp is held in a clamp and the end of the bulb is protected by a metal shield having a hole of the same size as that in the bulb. A blowpipe flame can then be directed on to the top end of the glass stem which carries the filament, and the bead of glass on the nickel wire being also fused, the wire can be attached as a prolongation to the stem (Fig. 1).

To explain the object of this nickel wire it must be remembered that the filament is commonly carried by two spiders, one at either end of the stem. The lower one (that nearest the cap) is of nickel wire and is rigid. The upper one is of molybdenum and is intentionally much weaker, having a certain springiness so that it will take up the expansion of the heated filament on the one hand and yield to the contraction of the cooling filament on the other. Consequently the molybdenum spider is not sufficiently strong to allow a filament to be wound upon it, and for this reason a temporary spider is provided for the purpose. The object of the nickel wire is to carry this temporary spider.

The construction of this spider is very simple. A small piece of fine steel tube is provided with a vulcanite washer at one end, and this is dipped into melted sealing wax so as to become surrounded with a good thickness of the wax. Short lengths of copper wire are then inserted into the wax so as to make a spider with the required number of wires, and with one to spare (Fig. 2). The bore of the nickel tube is such that it will take the nickel wire already mentioned as a fairly close fit. Having made this spider we may now return to the course of operations.

After the nickel wire has been fixed on to the stem the interior of the bulb is cleaned. Reticence is observed as to the precise solvent that is used for this purpose. Suffice it to say that the action is quite rapid. After the solvent is removed the bulb is filled with warm water and allowed to stand, after which it is filled with methylated spirit, finally drained and allowed to dry at ordinary room temperature.

Next we come to preparations for the new filament. Here the first operation is the cutting away of the ends of the leading-in wires. These cannot be conveniently used with their original attachment to the old filament. They are therefore cut by means of a small surgical instrument and bent outwards. The temporary spider is then introduced, the copper wires being bunched together to permit of ready insertion through the opening in the bulb. It is slipped on to the nickel wire, and the copper wires are straightened so that each arm is over one arm of the permanent (and original) molybdenum spider.

In winding the new filament a neat method is adopted to secure the necessary end contacts. Obviously an ordinary jointing method cannot be employed. Small, closely wound, steel helical springs are therefore used for the purpose. The spring is opened up by inserting a fine blade, and the end of the filament wire is placed between the two convolutions; the blade is then withdrawn and the wire is thus firmly clipped in the spring. This gives one of the required contacts, namely the contact on the filament wire. The next thing is to obtain a similar contact on the leading-in wire with the same spring. For this purpose a special tool is provided, so made that a movement of the thumb at one end causes a blade at the other end to force its way between two convolutions of the spring, the latter having been placed in position on the tool. The spring thus held can now be passed down the bulb and manipulated until one of the leading-in wires is between these two convolutions, when a further movement of the thumb causes the blade to be withdrawn, and thus the spring is left firmly clipped on to the leading-in wire and contact is secured to the beginning of the filament.

It should be mentioned that the arms of the temporary spider have been adjusted by a previous operator according to the voltage and wire that is to be used, instructions being issued for this purpose with each batch of lamps. Consequently all that remains to be done is for the wire, cut to the specified length, to be wound on; a second little helical spring is attached to the other end of the wire and contact with the second leading-in wire is secured as already described. The only point to observe is that the filament forms an inverted V at the end of each arm of the temporary spider, the arm being at the apex of the V. It is necessary for a later operation that the corresponding arm of the permanent spider should be within this V.

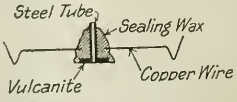


Fig. 2.—Section of Temporary Spider.

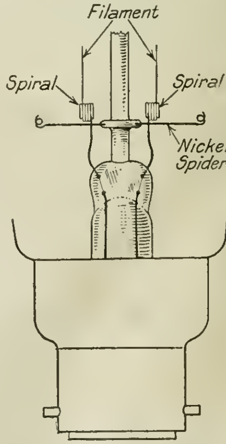


Fig. 3. Showing Details of Connection of Filament to Leading in Wires.

The filament being in position is now "set" by passing a current through it so that it becomes incandescent. The filament is then no longer springy, and does not exert the same pull on the spider. This operation can only be carried out in vacuo or in some inert gas, and for this purpose the bulb is bedded on a cork which is recessed and is made of very flexible rubber, the exhaust tube passing down the centre. If necessary a little glycerine is used to ensure a sufficiently good joint. The degree of vacuum is judged by the discharge through a vacuum tube, and as soon as this is indicated the filament is flashed up.

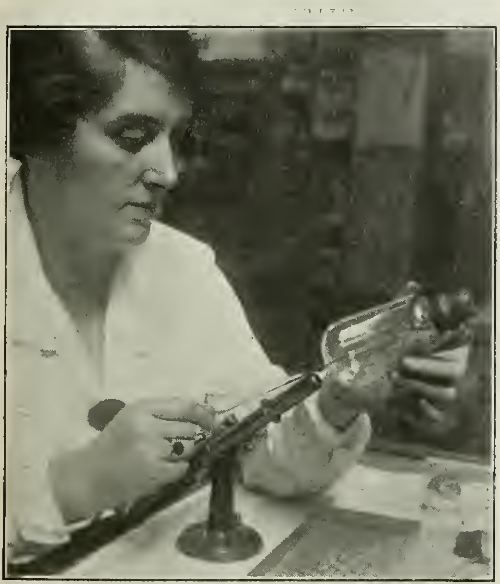


FIG. 4.—ATTACHING PIN TO CENTRE STEM.

The arms of the permanent spider can now be raised and those of the temporary spider depressed so that the filament is carried by the former. The temporary spider is then removed and can be used again.

FIG. 6. GENERAL VIEW OF THE TESTING ROOM.

The subsequent operations follow the standard practice adopted in the ordinary manufacture of electric lamps. A tube is fused on to the bulb for the purpose of evacuation, and a little red phosphorus is introduced into the part of this tube near the bulb. The lamp is then exhausted, the bulb being meanwhile heated to, say, 300°C., and current being allowed to flow through the filament. When the required degree of vacuum has been obtained, as judged by the discharge, the lamp is sealed off, leaving about 1½ in. of the tube still attached enclosing the phosphorus. The lamp is next overrun to the extent of 50 per cent. the tube being heated to vapor in the phosphorus. The latter combines with any residual gasses that may be driven off the filament.

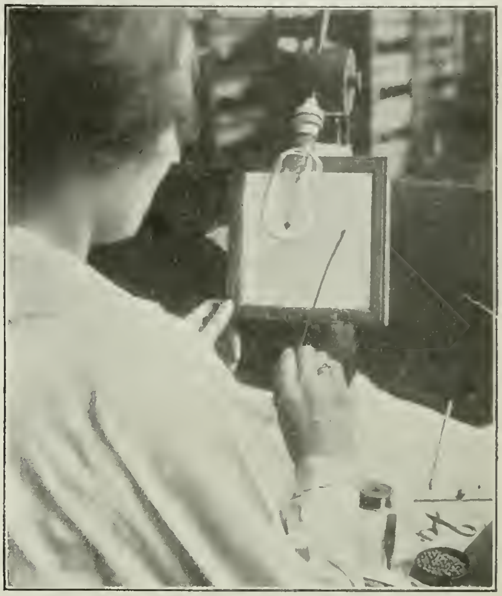


FIG. 5.—WINDING ON A NEW FILAMENT THROUGH THE HOLE IN THE BULB.

The lamps are then finally sealed off, are run for a time to detect any weaknesses, and are stamped as "renewed lamps," with the appropriate data. After being sorted to the various racks they are ready for dispatch.

COMMERCIAL CONSIDERATIONS.

We need scarcely say that the technical process, however excellent—and we confess that the process above described struck us as being both ingenious and thoroughly practical—is only one side of the question. The other side is the consideration whether the process adopted can be run at a reasonable profit.

The old electric lamp bulbs are sent by the customer. He actually supplies the Company with the lamp he desires renewed, and instructs the Company how he desires it refilled as to voltage and wattage. Naturally, there are reasonable limits—that is to say, if the lamp was originally a 110 volt 30 watt, then it can be renewed for a circuit of 100 volts and made to dissipate 20, 25, 30 or 35 watts if desired, or to work at its original rating. This makes a new market in old electric lamps, and some of the Company's agents buy up the old electric lamps and have them renewed, and so maintain a lamp exchange business. We learn that the Aladdin Renew Electric Lamp Corporation, Ltd., charge 2s. 3d. each for a 200 to 250 volt lamp for renewing—whereas a new lamp will cost 3s. 6d. each; showing a saving of 1s. 3d. per lamp to the ordinary consumer. So far, gas filled lamps have not been renewed on a serious scale.

From what has been said it will be seen that the new material used for lamps consists merely of the filament wire, two small springs and a little nickel wire. The remainder of the old lamp holds good. It is a question, therefore, whether the saving in material and labour over that in a new lamp more than compensates for the labour required in the various operations of renewal. As far as we are able to judge they should, for they are all very simple. Of course it is impossible to express any very definite opinion on this part of the subject, as it entails information which we can scarcely expect the Company to place at our disposal.

It must be remembered, however, that the margin of profit depends upon how far the Company are able to maintain their present prices, and this in turn depends upon whether the makers of new lamps will maintain the prices which at present hold. It would be a rash man who would prophesy that these prices will not fall during, say, the next ten years.

We notice that the chairman at the statutory meeting, to which we have already referred stated that the renewed lamps had a longer life and were more efficient than the new lamps against which they had been tested. There may be persons who think that these better qualities will enable a relatively higher price to be maintained. We are sorry to see a statement of this kind made in connection with a process which appears to us to be sound. There is obviously no reason why a renewed lamp should be better than a new lamp, beyond the rather remote possibility that the glass should be freer from gaseous films which must be removed as far as possible. The only sound statement that can be made in regard to this point is that a good renewed lamp may certainly be better, both in life and efficiency, than an inferior new lamp.

The results cited by the chairman are a testimonial to the excellence of the Aladdin Corporation's technical work, but it is not legitimate to construe them into an inherent virtue of a renewal process without much more serious investigation.

Our thanks are due to Mr. C. W. Fletcher (the General Manager) and Mr. J. J. Russell (the Works Manager) for their courtesy and for the ready manner in which they showed us every detail of the process.

Electrical Development in Johannesberg.—The extremely rapid growth of electricity supply in parts of South Africa is illustrated by a contribution by Prof. J. H. Dobson, read at a recent gathering of the South African Institute of Electrical Enigneers. In 1909 Johannesburg proper accounted for only 6,000,000 units. To-day the output approaches 36.000,000 units, and takes in a very wide adjacent area comprising many developing townlets; 97 suburbs of Johannesburg now receive an electrical supply. Both underground and overhead services are in operation. The choice of the former was dictated largely by aesthetic considerations, but it has proved a great difficulty in cases where large additions have been made to the load and additional cables are required. Since 1909 all suburbs have been equipped on the overhead system, which appears better suited to new and rapidly developing localities. As illustrating the faith that exists in progress it is worth noting that in some districts recently given a supply the present demand would scarcely overload a 5-kw. transformer! The usual practice appears to be to install a transformer to supply a street, but, with a view to the development of a heating and cooking load, the installation of local house transformers, the losses in which would be utilised towards the heating of water, was also suggested.

A 150-Ton Electrically-Driven Winding Engine.

A new winding plant has recently been installed at the Cowpen Coal Company's Isabella Colliery. This plant is of a modern type, which, though not claimed to be original, is unique in the county of Northumberland.

The winding engine is operated and controlled on the Ward-Leonard system, the electrical energy being supplied by the Northern Counties' Electricity Supply Company, as three-phase current at 40 cycles per second and a pressure of 2,750 volts between phases. The engine is designed to raise ultimately 150 tons per hour, and at present is doing 120 tons per hour from a vertical depth of 900 ft., the weight of the cages and ropes being balanced. There is one decking level, and decking is done without the assistance of mechanical appliances.

The winding plant is fitted with a cylindrical drum 10 ft. in diameter, of sufficient width to accommodate the necessary 4½ in. circumference winding ropes. The brakes are of the post type, disposed one on either side of the drum. Both brakes are applied by means of weights, and are held off the brake rims by a compressed air brake engine with 50 lb. per square inch air pressure, the air being supplied either from a self-contained electrically-driven compressor forming part of the plant, or from the main pit supply.

A vertical depth indicator is attached to the engine; this is fitted with two pointers and a warning gong, which is driven by means of machine cut gearing and arranged for automatically retarding and stopping the winding motor in case of over-wind. Other electrical and mechanical safety appliances achieve such results as: (1) Stop the winding motor and apply the brakes in case of failure of current supply to converter set; (2) stop the winding motor and apply the brakes in case of failure of exciting current, or should the air pressure fall below 50 lb. per square inch; (3) to make it practically impossible for the driver to raise the cage higher than a predetermined distance above the keps, which in this instance is 3 ft. As a further protection against over-winding, an end limit switch gear is fixed in the head gear, which coming in contact with the cage, releases emergency brake and stops the engine in the remote event of the cage travelling beyond the 3 ft. mark.

The Ward-Leonard set is of the three-bearing type, the present motor being constructed for an output of 445 kw. when running at a speed of 590 revs. per min., the bedplate being designed to accommodate the permanent driving motor, which will be wound for a speed of 800 revs. per min. and give an output of 550 kw. The winding motor is of the direct-current open-ventilated type, and is fed direct by the Ward-Leonard variable-voltage dynamo. The speed, with full pressure applied to its terminals under present conditions, is 53 revs. per min. for an output of 120 tons per hour, the ultimate speed being 70 revs. per min. for an output of 150 tons per hour.

A Kapp phase compensator of Messrs. Sandycroft's make works in conjunction with the motor and the Ward-Leonard set. The control gear includes a controller for the field of the Ward-Leonard dynamo with about 150 steps, combining an arrangement for automatically reducing the field of the winding motor to 25 per cent. of the full amount when the engine is standing, also an emergency switch for breaking the field of the Ward-Leonard dynamo; a direct-current brake magnet for working the strip gear on the emergency brake; a maximum relay actuating the brake magnet should the armature current exceed a maximum, together with a minimum cut-out in series with the field of the winding motor. The driver's control frame is suitably placed and fitted with all the necessary levers capable of easy manipulation. A recording tachograph, speed indicator, ammeter and voltmeter are fixed in full view of the driver.

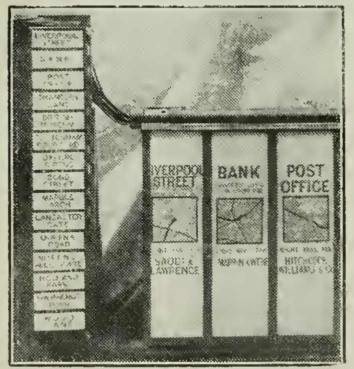
The whole of the electrical apparatus was supplied by Messrs. The A.E.G. Electric Company, and the mechanical parts by Messrs. Douglas & Grant, of Kirkcaldy. The erection was completed in August, 1914; but, owing to war conditions, it was deemed inexpedient to commission the plant until about the middle of November of the present year. The steel pulley framing and structural works was carried out by Messrs. Joseph Cook, Sons & Company, Ltd., Washington, county Durham, and the housing and foundations by Messrs. J. & W. Simpson, of Blyth, all to the plans and designs of the coal company's engineering staff. It may be interesting to mention that this modern electric winding engine is working in every way satisfactorily, and supplants a vertical condensing steam winder which was built by the late famous firm of Messrs. Thomas Murray, of Chester-le-Street. This has done good service for a period of 70 years.

Station Indicator for Railway and Tramway Systems.

Regular passengers on the London tube railways are sometimes apt to forget that though they are fully aware of the idiosyncracies of the traffic, strangers also travel who are not so well acquainted with the destination and stopping place of any particular train. The congestion on London tube railways is almost proverbial, and it is pointed out by certain authorities that this is at least to some extent due to the fact that a large proportion of the passengers are not aware of the order of the stations, and are therefore not ready to alight when the train draws up at the platform at which they want to get out. The result is that delay is caused while they hurriedly collect their wits and their baggage; and it is obvious that a very little of this sort of thing on the part of quite a few passengers may lead to trains running on the short headway "piling up" very quickly.

It will perhaps be contended that this sort of thing is unnecessary owing to the fact that each carriage on the London electric railways contains a diagram showing the order of the stations. But these diagrams are usually at one end of the carriage and apparently do not particularly attract the notice of passengers. To overcome these difficulties an illuminated device, which we had an opportunity of inspecting the other day, has been designed by Messrs. Indicators Ltd.

As far as the passenger is concerned this device consists essentially of a long box, a part of which, we illustrate. This is divided into the same number of compartments as there are stations on the line. Each compartment is fronted with a glass panel engraved with the name of a station, a small map and other appropriate information regarding theatres, shops, etc., in the district served by the station being also given. Each of these compartments is equipped with an electric lamp which enables the panel to be illuminated from behind. Now, as the train leaves a particular station the panel for the next station at which the train will stop is illuminated (all the others remain dark) so that the passenger has early visual indication of the station which the train is approaching, and can make his preparations accordingly. If, as is the case on most of the London electric railways, certain stations are missed out by some of the trains, the panel for the station thus missed remains dark, but the words "Not stopping at" appear illuminated above it, while the next station stopped at is at the same time illuminated.



VIEW OF A PART OF THE INDICATOR.

The operation of this system is simple, as a short description will make clear. A small stop is provided at the side of the track near each station, and as the train passes along this engages a projection on a pivoted arm which is carried on the vehicle. This arm is slotted to receive a pin which is fixed to a vertical bar in such way that the impact of the stop against the arm causes the bar to rise. The bar slides in suitable guides and is provided with collars which compress a spring which force the arm to return to its normal position when the lever has passed over the stop. As the bar rises it comes in contact with switch arm which closes the circuit on a solenoid and causes its core to rise, thus operating the arm of a step by step mechanism and causing it to move forward through one step. The current for this circuit is obtained from a battery or other suitable source of energy. When the core of the solenoid has risen to its uppermost position a second solenoid is energised which releases the switch arm. This falls to its normal position, the first solenoid is thus de-energised and the apparatus becomes ready for the next impulse. In the most modern design of the apparatus the solenoid and lever mechanism is duplicated, one set being used when the train is going in one direction and the other when the direction is reversed. This ensures that the step-by-step switch is not thrown out of place when the train is shunted, and as an extra precaution the whole mechanism can be thrown out of ear when required.

To overcome the difficulty which arises owing to certain trains not stopping at all stations, an ingenious arrangement is employed. A special switch for each station is fixed in the driver's cab, the effect of closing which is to connect the stop on the rotary switch corresponding to the stations which are to be missed out to the next stop in the series, *i.e.*, supposing that station *D* is to be missed, the stop corresponding to station *D* is connected by means of the switch to stop and circuit for station *E*, so that as the train leaves station *C* and the rotary switch in the ordinary course of events moves on to the stop corresponding to station *D* the panel for station *D* remains dark and *E* becomes illuminated instead and remains illuminated for two sections instead of one, that is, until station *E* is reached and the panel for station *F* is illuminated in the ordinary way. We understand that this apparatus is being installed on certain of the tube railways, and its operation will be watched with interest as will the use passengers will make of it. We understand it is also applicable to tramway working where information as to fares, etc., can be given as well as the stopping places and other matters of interest.

English for Engineers.

At a recent meeting of the Glasgow Corporation Electricity Department Engineering Society a Paper on "English for Engineers" was read by Mr. W. ROXBURGH of the clerical staff.

The author said that the young engineer should add to his technical knowledge and skill, acquaintance with business routine, but he should also have a sound working knowledge of the mother tongue. In many relations of life the manner in which a man expressed himself was three-fourths of the evidence upon which his worth was judged. Many situations were obtained and lost because of the letter of application and in spite of the testimonials.

The importance of correct spelling and punctuation, and the dangers of undue abbreviation were mentioned, and a number of grammatical pitfalls were described, including miscollocation, misuse of participles and mixed metaphors. In business and technical writing the essentials were given as clearness, accuracy, brevity and courtesy. The author said that some of the words in common use in connection with electricity supply were inaccurate and ill-chosen. While a municipally-owned system of electricity supply was properly called an undertaking, an electricity department should not be called an undertaker. Similarly, a consumer was called a long-hour or a short-hour consumer, according to the nature of his load factor. There was no such thing as a short hour and a long hour, and such expressions were an abuse of English. The use of names instead of running numbers for plant units in power stations was deprecated as being likely on occasion to render the resident engineer's reports ridiculous.

In connection with the writing of technical Papers, the author advocated thorough preparation of notes before the actual drafting was started. Having prepared the notes, the would-be author should prepare a skeleton structure, viz. introduction, development and conclusion. Paragraphing lightened a manuscript, but there should be a thread of connection between paragraphs so that the treatment of the subject gives one the feeling of natural progressive development. Diagrams, tables and curves should, as far as possible, be self-explanatory, and reference to these in the paper should be freed from haziness by means of plain symbols. A young writer had to be on his guard against the side-suggestions of his own thought, as digressions tended to interrupt the attention of the reader, which once lost was difficult to recapture.

Concluding, the author said that the flamboyant peroration was out of place in technical writing. Care must be taken to hide all evidence of effort to impress, and th [illegible] should give a sense of easy mastery of the subject matter [illegible] sentences should give the reader the restful feeling of [illegible] to an ordered termination.

It may be as well to point o [illegible] at this Society has now entered on its third session with a membership of 190 and an average attendance of 130. The meetings are held once a fortnight, and during the current session nine will be concerned with the reading and discussion on Papers contributed by members of the Electricity Department staff. The other four will be by specialists on subjects such as illumination, aeronautics, railway electrification, and steam-pipe and boiler mountings. We are glad to learn that the discussions are invariably lively and profitable.

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The London Traffic Situation.

Consideration of the London traffic situation, by self-appointed and other experts, is becoming almost as regularly recurrent as the advent of the Christmas season; but, while the one is heartily welcomed each year, in spite of its age, though it may be parted from with quite other feelings, the other is only received as a boring problem, and is dismissed with delight when some more or less satisfactory solution (on paper) has been arrived at. Mr. H. Gordon is the latest person to attack this subject, and to put forward certain ideas about it. And no better justification of the statement that the appetite grows by what it feeds on can be found than by considering some figures given by him in a recent lecture before the Institution of Civil Engineers. In 1895, 390 horse omnibuses passed along Oxford-street every hour. After a slight fall in 1903, due to the introduction of motor transport, this figure rose in 1913 to 517 motor omnibuses, with 70 per cent. more passenger accomodation than in 1895. These omnibuses were, however, unable to cope with the traffic, in spite of the fact that in the meantime the Central London Railway had been opened and was also carrying passengers to the limit of its capacity. The state of affairs was roughly that, in the decade ending 1913, underground traffic in London increased by 170,000,000 passengers, and surface traction by 870,000,000 passengers, and that matters, instead of having been improved by the increased facilities, were, if anything, rather worse. One deduction would seem to be, as Mr. Gordon points out, that the construction of more underground railways will bring no relief to our present troubles, and that street congestion must be considered as a problem by itself.

Mr. Gordon is not, however, able to show us any new way out of our difficulties. He suggests that the width of a road should be a multiple of the virtual width of the vehicle using it, the virtual width being the width of the vehicle plus an amount which will allow it to pass another vehicle without arresting motion. This is rather a counsel of perfection; but, even supposing it were possible, our streets are not even then used to the limit of their present capacity owing to the fact that the regulation of traffic is carried out in a way which allows the slow-moving vehicles to interfere with those which move more quickly, with the result that London traffic rarely proceeds in a regular flow, and most frequently goes forward in a series of jerks. This is certainly one of the cases where the police should be given, and should use, greater powers, as a very large amount of the delay is caused in this way. Other questions which have to be considered are the position of crossings and of refuges, and the amount of road obstruction caused by vehicles in proportion to the useful work they do. It remains evident that there is a great deal to be done and no one is quite certain who ought to do it, which is the position we have been in for years, except that every year matters grow worse as the volume of the traffic increases.

When Mr. Gordon comes to consider the question of traffic handled by suburban railways and tramways he has a similar story to tell, though apparently London is, or was, better off than many other centres of population in that the ratio of seats provided per day to the number of passengers carried is higher than elsewhere: so that, while we travel in great discomfort, we may congratulate ourselves that we are not as badly off as other people, which will be a great comfort equally to Sir Albert Stanley and to the straphangers. London, too, has more electric railways and omnibus routes than any other European capitals, while the average number of journeys per head of population is smaller than in many other large cities, being, in fact, only 75 per cent. of that in Berlin before the war. The characteristic of London traffic, and one of the sources of the whole trouble is, however, the morning and evening rush hour periods. The worse pressure occurs between 8 a.m. and 9 a.m., as it is found the homeward rush is spread over a longer period. Passengers travel in and out by all sorts of ways, but it is interesting to see that the peaks of all the services do not occur at the same time, and that when the trains at Liverpool-street and the tramcars at Holborn are working at their maximum the number of omnibuses in the same district is at its minimum. Indeed, the number of omnibuses in use increases during the day, and reaches its maximum about lunch time, when the traffic on the tubes and railways is at its minimum. Here, again, it is difficult to see how matters can be improved, though Mr. Gordon suggests that as the tube railways cannot compete with systems of surface traction for short distances, they should be reorganised to cater for the long-distance passenger by closing certain stations and discouraging the "short-haul" man by raising the fares proportionately for short distances. On the other hand, the function of the surface transport systems must be definitely to cater for the short distance passenger paying for the distance travelled, so that they give a good load factor throughout the day.

On a consideration of this problem the facts are quite evident, but the solution is not by any means clear. What is certain is that the traffic is increasing at a much greater rate than are the means to accommodate it, and, if matters go on as they have done during the past 10 years it would seem almost impossible, with the means at our disposal, to deal with the traffic at all. As far as the railways are concerned, electrification seems only to make matters worse. This, of course, is not inherent in the electrification, but is due to the new traffic problems which arise. The case of the London and South-Western Railway is an example, where during the past nine months the suburban traffic has increased by so enormous a figure as apparently to render punctual and convenient operation impossible during the rush hours. This enormous increase in traffic has not been accompanied by a corresponding prosperity, at any rate to the railway and tramway authorities. There is at present a deficiency on the working of the L.C.C. tramways of £137,000, and this is expected to rise to £580,000 in 1920; while what is called the Traffic Combine is expecting a loss in the coming year of no less than £2,600,000. The suggested remedy for this is to increase the fares, but though this may improve the financial situation experience has shown that it is not likely to reduce the number of the passengers.

If freedom of movement is to be allowed to the inhabitants of London, the matter is, therefore, one which should engage Government attention without delay, the only other alternative being so to limit the movement of the inhabitants to absolutely necessary journeys, which would, of course, be an almost unthinkable interference with the rights of the public.

The Prospects of 220,000-Volt Transmission.*

The dependence of industrial progress upon an adequate supply of electrical power, together with the vital need for a rational policy of conservation of the country's fuel resources, points to a probable early demand for transmission of large blocks of power from distant energy sources—coal fields and water powers. Mr. A. E. Silver, of the Electric Bond & Share Company, who recently presented a Paper before the American Institute of Electrical Engineers on the subject, has expressed the view that 220 kv. is a logical voltage for such high capacity long-distance transmission, and that immediate adoption of this voltage is commercially feasible. The principal difference from present high-voltage equipment involved would consist in the higher insulation and larger clearances required. There are, however, certain points which need further investigation. An advance to 220,000 volts would afford a distinct economic advantage. This voltage is a multiple of 11,000 and 110,000. The advantages of 220 kv. over 150 kv. are shown by Figs. 1 and 2, which are based on a transmitted load of 500,000 kw. The same relative advantage will apply for larger loads and above a certain minimum for smaller loads.

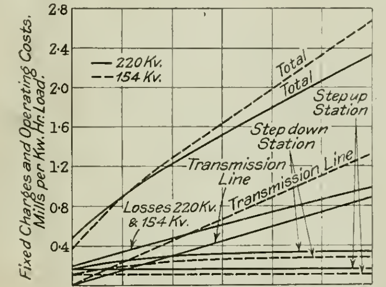

Fig. 1.

The economic application of 220 kv. is primarily limited to the transmission of large blocks of power over considerable distances. It may infringe to some extent upon present fields of lower transmission voltages, but will by no means supersede their use, and is not universally suitable. Interconnection at 220 kv. would be expected only where the equalising duty reaches a great magnitude, where there is no existing secondary transmission system suitable to serve as a basis for interconnecting lines, or where interconnecting 220 kv. lines might function also as a supplementary or reserve link in a main 220 kv. trunk transmission system.

The initial investment in a 220 kv. transmission system, including as essentials the step-up and step-down stations will be large and there will be a strong inducement to utilise the investment as nearly continuously as practicable. Hence the tendency will be to supply base load, leaving peak loads to existing local generating stations. Reliability and continuity of power supply would be of such a high order that new standards of care in design and conservation in construction would be necessary.

Mr. Silver assumed that load per 220 kv. circuit would be from 100,000 kw. to 125,000 kw. A lower load would entail a considerable sacrifice of economy. The economic transmission range of 220 kv. is large, but it has generally been assumed to be 250 miles (400 km.). A frequency of 60 cycles is considered best. Grounded Y-connections have a marked advantage for this voltage because of the distinct gain in dependability and the lower line and equipment insulation with their attendant effect upon size and cost of equipment.

For simultaneous conditions of conductor loading, used as a basis for design, the following were assumed: Wind pressure of 8 lb. per square foot of projected area, 1½ in. radial thickness of ice, and a temperature of zero deg. F. Justification for these apparently extreme loads is found in the high service standards which are demanded. Corona formation and loss enter as a significant factor at a voltage of 220 kv., so an average elevation of 1,000 ft. (300 metres), a storm factor of 12·5 per cent. and a barometer (during storms) of 28·4 in. (71 cm.) were assumed.

Three commercially practicable types of conductors—aluminium with steel core, copper with steel core and all copper were considered. These may be compared as follows:—

Aluminium Steel versus Copper Steel—

1. Less corona loss, due to larger diameter.
2. Skin effect presumably approximately equal
3. Greater area exposed to wind loading, hence greater transverse tower strength and greater clearances required.
4. Less tensile strength, hence more limitation upon height and spacing of towers.
5. Less weight (unimportant).

All Copper versus Composite Cable—

1. More corona, greater than either of above.
2. All material effective as a conductor.
3. Skin effect more serious in larger sizes, owing to high-priced material in the core.
4. Less area exposed to wind loading.
5. Less weight than copper steel.
6. Homogeneity of material, hence certain advantages in construction, more positive assurance of durability and higher scrap value.

For the purpose of developing tower designs a cable of 716,000 circ. mils of aluminium and 93,000 circ. mils of steel was used. Corona losses at various load factor are shown in Fig. 3, while the line characteristics for an aluminium-steel circuit are shown in Fig. 4.

The curve falling lowest on the scale at any number of years which may be assumed as the life of the line represents the most economical conductor. If the life is considered to be about 48 years, the annual cost is about $200,000 for aluminium steel about 1 in. in diameter at 60 per cent. load factor and from $400,000 to $450,000 for copper steel at the same load factor. At 90 per cent. load factor the annual cost ranges from $575,000 to $630,000 for the copper steel and from $500,000 to $550,000 for the aluminium steel. While the total costs are higher for the higher load factors, the unit costs would be lower.

Within any limits thus far investigated, it appears economical, under the design loading assumed, to utilise the full strength of aluminium steel up to its elastic limit—*i.e.*, to keep sags to a minimum thus enabling use of shorter towers or longer spans at the expense of stronger supporting structures at angles and dead-end points. With a new aluminium-steel cable, when the loading has been reached which will stress the steel core to its elastic limit the aluminium will have passed its elastic limit and in consequence will be permanently stretched. As the heavy design loading is removed the aluminium strands will loosen infinitesimally on the steel core and take no stress. At lighter loadings the aluminium will be a dead load upon the steel core, which will carry all of the stress.

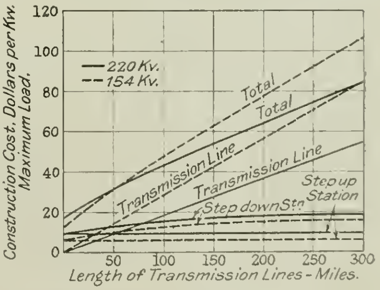

Fig. 2.—Economic Comparison of Construction Cost for 150 kv. and 220 kv. Lines.

This difference in characteristics leads to the possibility of two different methods of stringing a composite cable—*i.e.*, it may be strung as received from the factory or it may be stressed, prior to sagging and tying in, to its full strength thus giving it nearly all of its "permanent set." From the operating standpoint, however, it would seem preferable to string the cable without preliminary stretching. Possibly a combination of the two methods might be worked out.

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* Abstract of an article in the *Electrical World*.

Adequate splices for aluminium-steel cables no longer present difficulty. Until further experience is obtainable, it seems desirable to make provision for the use of ground wires.

There is no type of insulator yet developed which gives adequate or even reasonably satisfactory results on high-voltage lines. Nevertheless, it is believed that 220 kv. line insulation can, with existing types of insulators, be made as safe and dependable as can the line insulation of present installations. The design suggested by Mr. Silver makes provision for a string of 15 standard units for regular suspension service on a 220 kv. grounded neutral line. A string of 15 standard units, with the necessary connecting pieces and fittings, will be nearly 9 ft. (2·7 metres) long. Such a length of insulator involves great expense in obtaining the necessary tower clearances and heights, and is the determining feature in fixing conductor separation. This serves again to call attention to the need of more efficient and suitable insulators. An improvement in insulator design which would justify shortening the string, in addition to improving the electrical characteristics of the insulator itself would enable material saving in tower costs.

Two methods are recognised as offering relief from an excessive voltage gradient at the line end of the insulator strings. The first is the grading of the insulator units used in the string. This should be accomplished by making up the string of units of two or more distinct types, differing in size or diameter or in some other feature, which would cause them to have different condenser capacities, those with the larger capacities being placed nearest to the conductor. A second method of relieving this excessive concentration of stress consists in installing below or around the disc nearest the conductor suitably designed metallic shields or rings. A line sufficiently well insulated to withstand low-frequency high-power disturbances is not likely to encounter trouble from high-frequency disturbances. From the standpoint of deterioration, the non-cemented types of disc insulator, which avoid the effects of dissimilar expansion of the component materials, seem to offer and to be demonstrating marked advantages.

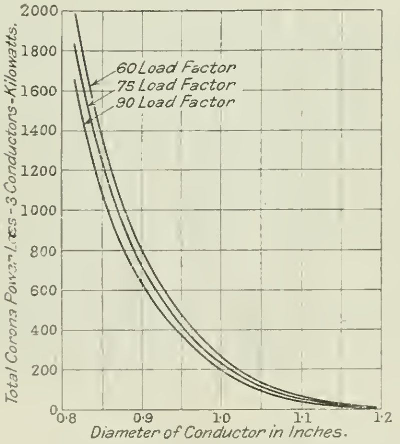

Fig. 3.—Corona Power Loss at 220 kv. for 20-mile Circuit with Generating Voltage held Constant at 230 kv.

The copper and copper-steel diameters considered range from 0·814 in. to 1·004 in., while the aluminium-steel diameters range from 0 952 in. to 1·196 in.

The long economic life which presumably a 220 kv. line would represent causes durability of material to assume great importance. For most localities wood construction would not be economical. Therefore, the conventional rigid and steel tower has been adopted. The loading basis assumed for a 220 kv. line makes it feasible, and desirable from the standpoint of economy of steel, to carry this differentiation to a greater extent than has been customary heretofore. The costs, plotted in Fig. 5, show maximum economy with normal spans of 800 ft. (240 metres) with the rigid type of tower, while longer spans or shorter spans are more expensive. The standard tower heights assumed for the four normal span lengths—550 ft., 700 ft., 800 ft., and 1,000 ft. (165, 210, 240 and 300 metres)—are 47 ft., 57 ft., 63 ft., and 80 ft. (14·3, 17·3, 19·2, and 24·3 metres). Besides the margin of safety provided by the design loading, a further margin is introduced in the difference between working and test loads—*i.e.*, 25 per cent. for suspension towers and 35 per cent. for angle and dead-end towers.

There are certain features in equipment deserving notice. The number of 'buses should be reduced even to a rudimentary form; superfluous oil switches should be eliminated, and spare or reserve units need not be provided. The complete omission of reserve equipment is predicated on adequate reserve capacity being available in local generating stations and on the high standard of construction formerly emphasised. Certain features of the problem are high reactance of generators and transformers, ample insulation of transformers and an efficient oil circulation system, high mechanical strength of oil switches, avoidance of low-voltage 'buses and low-voltage paralleling, and an effective and dependable system of relay sectionalising. All line switching, automatic or manual, should be done on the high-voltage side of transformers. The amounts of power involved, particularly under abnormal conditions, are so tremendous that the current values obtaining at lower voltages impose switch duties and heavy stresses generally which could be handled only with great difficulty and at an expense materially higher than would be required at 220 kv., when the currents involved are relatively small. No equipment of any character is contemplated for protection against over-voltages.

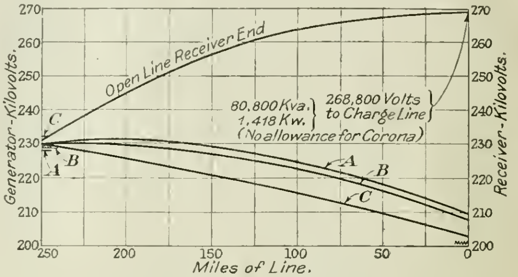

Fig. 4.—Characteristics of Aluminium-Steel Transmission Line

A. Refers to conditions with zero load and 49,800 k.v.a. loading condenser capacity. B. 50,000 kw. load with 7,500 k.v.a. lagging condenser capacity. C. 100,000 kw. load with 81,000 k.v.a. lagging condenser capacity. Loads delivered at 0·75 power factor.

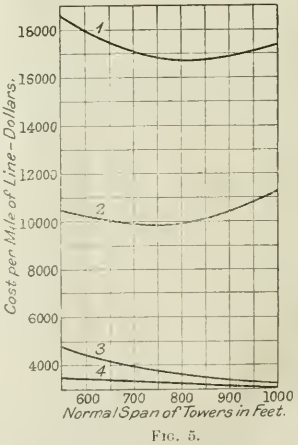

Fig. 5.

1. Total cost (excluding cost of conductor and ground wire).
2. Cost of towers.
3. Cost of insulators and hardware.
4. Cost of right of way.

Considerations of simplicity in station arrangement and of economy in operation favour, in general, transformers of the largest size permitted by the conditions of each installation or by limitation of manufacture. At present manufacturers advocate that transformers be not attempted beyond 50,000 k.v.a. to 60,000 k.v.a. for three-phase units, or beyond 35,000 k.v.a. to 40,000 k.v.a. for single-phase units. From the standpoint of simplicity and cheapness of installation, three-phase units would be preferable. Operating and economic considerations strongly favour the generator and its transformer equipment being connected and operated as a unit. The large sizes of installations involved in a 220 kv. system, together with the necessity for careful attention to maintaining insulation strength and transformer reliability generally, will not improbably result in the abandonment of cooling the oil in each transformer and gravity circulation of oil through the windings in favour of forced oil circulation and external cooling. Short-circuit current values at 220 kv. are not extreme, and in a 220 kv. circuit-breaker the large clearances and switch openings necessarily required by the high voltage contribute directly to giving the rupturing capacity required by the current to be handled. Two types of circuit-breakers have been offered by the manufacturers for 220 kv. high-duty service. One type consists of a massive circuit-breaker, each phase in one tank of heavy boiler plate, with two breaks in series for moderate duty and four breaks in series for heavy duty. Another type consists of two breaks in series per tank, one such tank being used for conditions of moderate duty and two tanks in series for heavy duty.

Sub-station layout rated at 220 kv. will be influenced largely by the particular local conditions of each installation. The usual type will probably serve to step down from 220 kv. to a secondary transmission voltage, such as 66 kv. or 110 kv. In such a case it will, in general, be necessary to have both a primary and a secondary 'bus system—at 220 kv. a simple 'bus with sectionalising circuit-breakers; at secondary voltage, where greater flexibility would seem desirable, probably a ring 'bus. Owing to the high current values which would obtain at the secondary voltage (it should be kept in mind that the large condenser capacity will aggravate short-circuit conditions), it appears advisable to provide sectionalising reactors in this 'bus.

The station and sub-station arrangements which have been proposed are predicted upon a relay system which may be depended upon for insuring that a faulty piece of apparatus, transmission line or low-voltage feeder will be cut out correctly, promptly and in such a manner as to avoid interruption to the other elements of the system.

The following estimates are intended to give an indication of the installation cost of construction carried out along the lines of the assumptions and recommendations in this Paper :—

Step-up Sub-station.

Outdoor transforming and switching structures and equipment (220 kv. apparatus and connections only), installations and indirect expense	Per kilowatt $8 to $9

Step-down Sub-station.

Outdoor transforming and switching structures and equipment (does not include low-tension feeder 'bus or feeder switching equipment), synchronous condensers of capacity for length of connected lines, building, control equipment, installation and indirect expense	$15 to $20

Transmission Lines.

Single-circuit, steel towers, suspension insulators.	Per mile.
Towers	$8,000
Insulators and hardware	2,800
Conductors and ground wire	5,000
Special structures	1,000
Right-of-way	3,000
Indirect expense	3,700
Total	$23,500

Total Cost 220 kv. Transmission.

	Per kilowatt.
100 miles	$40 to $45
200 miles	$60 to $65
300 miles	$80 to $85

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Malleable Cast Iron." By S. Jones Parsons, M.I.Mar.E. (London: Constable & Co.) Pp. xi.+175. 14s. net. Second edition.

"Fuel, Water and Gas Analysis for Steam Users." By J. B. C. Kershaw, F.I.C. (London: Constable & Co.) Pp. xii.+201. 12s. 6d. net. Second edition.

"Examples in Electrical Engineering," by J. F. Gill, M.Sc., and F. J. Teago, M.Sc. (London: Edward Arnold.) Pp. 173. 7s. 6d. net.

"Practical Exercises on the Weather and Climate of the British Isles and North-West Europe." By W. F. Stacey, F.R.G.S. (London: Cambridge University Press.) Pp. 64. 2s. 6d. net.

"Memorandum on Combines and Trade Organisations," by John Hilton. (London: Harrison & Sons.) Pp. 138. 1s. net.

"Institution of Electrical Engineers. List of Officers and Members." (London: The Institution of Electrical Engineers.) Pp. 351.

"Précis d'Electricité Théorique." By L. Bloch. (Paris: Gauthier, Villars et Cie.) Pp. vi.+476. 20 fr.

Correspondence.

STALYBRIDGE ELECTRICITY SUPPLY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: May I be allowed the hospitality of your columns to refer to the statements published by Mr. R. Blackmore, Engineer-in-Chief to the Stalybridge, Hyde, Mossley & Dukinfield Tramways & Electricity Board, upon the causes of the present failure of the above supply, and to correct some of the inaccuracies contained therein.

Mr. Blackmore states that the interruption has been caused by the resignations of the shift engineers owing to differences on the question of wages. Whilst this is one of the differences it is not the only one, neither is it the cause of the present trouble. It is, however, as a contributory factor, a matter upon which both sides should be heard. The Electrical Power Engineers' Association, in October 1918, made a claim upon *all* electricity supply undertakings in the United Kingdom for certain increases in salary. After negotiations with the Standing Conference of Electricity Supply Associations—the then only national body representing employers in the electricity supply industry—the claim was, on the advice of the Ministry of Labour, referred to arbitration. The Ministry of Labour further supported this advice by recommending all undertakings to agree to arbitration. The Stalybridge undertaking, of which Mr. Blackmore is chief engineer, did *not* act upon the advice given by the Ministry of Labour.

The result of the arbitration was to give the Association all that it asked for, thus indicating the reasonableness of the claim made. The Stalybridge Joint Board paid to the employees concerned certain increases under this award, but owing to the method adopted by the Board, such increases were not in accordance with the terms of the award. We have, since May last, endeavoured to get from Mr. Blackmore some satisfaction upon this matter, but without success, as a consequence the aid of the Ministry of Labour has been invoked to settle by arbitration. Mr. Blackmore will only consent to this procedure if other matters which are not connected with this question are also referred to arbitration. To this the employees concerned will not assent, and after examination of all the circumstances this Association has agreed to this decision. These other matters relate to the conditions of employment of staff engineers at Stalybridge, and we say, without fear of contradiction, that such conditions are without parallel in the United Kingdom.

Stalybridge as a generating station is considerably above the average size, yet the amount of assistance given to the shift engineers is far less than is usually provided in a station of half the capacity. The engineers at Stalybridge are paid by the hour, and during periods of sickness their "salary" is stopped, although the other engineers have to work extra time to carry out the necessary duties. During 1918 the excessive overtime that had to be worked by the shift engineers to obtain their "holidays" caused each of them to be laid up for certain periods. In June 1919 these engineers desired to prevent a repetition of this, and requested Mr. Blackmore to provide extra assistance. Mr. Blackmore's reply was that "if any engineer is not of sufficient robust health to carry out his duties properly, I shall be pleased to release him from further duty if he will send in his resignation."

The engineers at Stalybridge have taken this advice. They have been unable, either through their own efforts or by the aid of this Association, to secure a change in these conditions, and so they have been compelled to resign their positions, rather than prejudice their health and prospects by remaining. We, as an Association, have investigated this matter and are recommending all our members not to accept any post at Stalybridge under the present conditions. Mr. Blackmore suggests that he is willing to arbitrate upon this matter. This is something. Hitherto our correspondence with Mr. Blackmore has been notable for the curt nature of his replies, and the lack of any indication of a willingness to negotiate upon the matters raised. We cannot agree to arbitrate upon this matter until Mr. Blackmore, or more properly the Joint Board, make some proposal upon the matter at issue, so that the arbitrator can adjudicate. We have had no proposals from Mr. Blackmore, neither has there been any conference between Mr. Blackmore and the officials of this Association.

In conclusion may I point out that eight engineers are affected by this dispute. These engineers resigned their positions in accordance with the terms of their engagement; five men gave fourteen days' notice, and three men gave seven days' notice. Your readers will appreciate that there is nothing of the nature of a "Lightning Strike" in connection with this dispute, and further that the management had ample warning of what was likely to happen. The sole cause of the present trouble is the irreconcilable attitude displayed by the Engineer-in-Chief, but the responsibility must also be shared by the Joint Board, who, as owners of the undertaking, do not appear to have realised their responsibilities. We suggest that the Joint Board should assert its authority to settle this dispute, so that the great loss to the community now in operation may be discontinued.—I am, &c.,

London, Dec. 22. W. Arthur Jones,
General Secretary.

THE ELECTRICITY (SUPPLY) BILL.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Even within the relatively small world of the electrical industry, the multiplicity of events is apt to produce confusion of their sequence, and subsequent history based on memory and hearsay tends to be inaccurate. I think it right, therefore, before the turmoil in connection with the Electricity (Supply) Bill subsides, that some acknowledgments should be expressed to those members of the industry who have laboured so assiduously and successfully to get this Bill amended.

We all like to be on the winning side, and the attitude of many of the supporters of the original Bill has already changed. Some of them are expressing unfeigned satisfaction with the drastic amendments that have been made, and soon it will be impossible to distinguish between those who supported the Bill in its original form, and those who made gallant efforts to get it into a form less prejudicial to the future of the industry.

When last year the various reports of the Board of Trade Committees and of the Coal Conservation Sub-Committee of the Ministry of Reconstruction appeared, many of us felt that they did not indicate any satisfactory basis for general legislation in regard to the complex technical, administrative and financial problems of electric supply reform. It was while we were groping about for a formula for which we might hope to secure unanimity among those concerned, that Mr. Highfield made a suggestion that we should support the proposal for the appointment of permanent and qualified Commissioners, but that we should strongly oppose the formation of District Boards and the compulsory and premature expropriation of the undertakings. The statesmanlike character of the policy indicated by Mr. Highfield was immediately recognised, and I did not hesitate to give it my full support. We are also greatly indebted to Mr. Wordingham the then President of the Institution of Electrical Engineers for the facilities he provided to enable the Committee of the Representative Association to discuss the situation, and for the great assistance he gave by presiding over the deliberations of the Committee. The outcome of the deliberations was in effect the endorsement of Mr. Highfield's suggestion.

The Board of Trade did not adopt the recommendations made by the Committee appointed by the Institution of Electrical Engineers, but proceeded with the Bill, which was drafted more or less on the compromise of divergent views recommended by the Williamson Committee. With my recollection of all previous electrical legislation, I cannot remember an Electrical Bill which has met with such general and spontaneous opposition as this one, and we cannot be too grateful to all who so strongly supported the cause during its passage through the House of Commons and in its first stage in the House of Lords.

In substance the Bill, as now amended by the Government, is limited to the appointment of Commissioners, with powers to examine and explore the whole situation. They will have no compulsory powers, and the confiscatory clauses of the Bill as it left the Commons are deleted. It remains to be seen whether the industry will be able to take full advantage of the measure of freedom now promised to it.—I am, &c.,

London, Dec. 19. E. Garcke.

G.E.C. Outdoor Pattern Lightning Arrester.

To protect electrical plant and apparatus connected to continuous current overhead lines up to 650 volts from lightning the most satisfactory method is to use a magnetic blow-out arrester, with the coil connected in series with the air-gap. This arrangement has, however, the objection of introducing inductive resistance in the earth circuit, and to overcome this the General Electric Company have designed an arrester (which we illustrate) in which the energising current for the blow-out magnet is shunted by a non-inductive resistance in parallel with a second air-gap. As a result, we understand, a very effective magnetic blow-out is obtained without obstructing the path to earth for a discharge. In addition, the following points in construction may be noted. The two pairs of horns are shielded with fireproof shields. The non-inductive resistance is placed on one side of one pair of horns, and the blow-out coil is placed on one side of the air-gap on which it is to act, the two pole-pieces of the magnet yoke being arranged right and left of this gap, and resting flat against the insulating shields. This lightning arrester, which is known as type O.K.M., is mounted in a cast-iron box with rain-proof cover, and two fixing lugs for fixing on a pole or outside wall. The apparatus weighs complete 38 lb., and measures 13½ in. by 7⅝ in. by 6⅛ in.

Phantom View of G.E.C. Magnetic Blow-out Lightning Arrester, Type O.K.M., in Cast-iron Case for Outdoor Use.

The Art of Camouflage.

At a recent meeting of the Illuminating Engineering Society, Capt. W. A. Howells (of the Camouflage School, Larkhill) gave an interesting lecture on "The Art of Camouflage," which was illustrated by a large number of lantern slides. Many of the problems discussed involved the study of colour and visibility—effects of considerable scientific interest. One feature that has been most strikingly brought out in the present war is the necessity for concealing objects from view from above—*i.e.*, by hostile aircraft. In this respect efforts to conceal movements from the enemy must follow lines quite distinct from those characteristic of the wars of the past, where it was only necessary to prevent direct observation from the ground level.

The view available to aircraft is so extensive, and the possibility of getting accurate information from photographs so great, that camouflage is necessarily an attempt to deceive the enemy rather than to conceal things from him. Much that goes on cannot be concealed, but one may produce such effects as to convey a false impression of what is observed. The fact that information is gained mainly by inspection from above leads to various curious effects. One of these is the apparent darkening in hue of areas covered by grass and vegetation. A large proportion of such areas is in shadow cast by projecting objects, and therefore the average brightness is much less than would be presumed from a view at the ground level. Consequently, smooth surfaces of fairly light texture present a great contrast with rougher areas; upturned earth is very distinctly seen amidst vegetation, and paths and tracks in particular show very clearly indeed in a photograph taken from an aeroplane. It is even necessary, after work has been done at a particular spot, to guard against the fact being revealed by the smoother trampled ground in the vicinity showing up as a lighter circular area. Another factor that has to be borne in mind is the danger of information being conveyed by shadows cast by the sun. Projecting objects, in themselves inconspicuous, may be revealed by the shadow they cast; and if a series of photographs are taken at different times in the day, with the sun in different positions, the course of the shadows may give quite a lot of information.

Capt. Howells explained, by the aid of photographs, how precautions may be taken in these various matters when gun-pits are planned, tracks made, &c., and how objects may be concealed by painting in irregular colour patches, so that their outlines are difficult to distinguish. Another useful device is the use of netting, bearing irregular blotches of opaque material, which can be stretched above important objects which it is desired to conceal. In using this method, however, care must be exercised to avoid informative shadows. Among the various other special devices illustrated may be mentioned the use of hollow or specially prepared trees as observation posts, the artful concealing of loop-holes among sandbags, &c.

Legal Intelligence.

No Notice on Either Side

In the Shoreditch County Court last week Winifred Constance Faithfull, machinist, sued the United Electrical Manufacturing Company, to recover 28s., being two days' wages, and a week in lieu of notice. Plaintiff was engaged and worked for four days, when she was discharged at a moment's notice, and given two days' money. Nothing was said as to the reason for the notice, or as to notice.

Defendants said the girl had been treated in exactly the same manner as any other other girl had been; she was discharged without notice, there being notices all over the building that no notice would be given or was required off anybody.

Judge Cluer: But did you draw her special attention to it? Defendants: I cannot say that she was specially told, but it was everywhere for her to see.

Judge Cluer: No doubt the firm wish to act fairly by these girls, but they must clearly draw the attention of the girls so engaged to the terms of the engagement. You must say, "These are our terms, do you agree." Merely putting up the notice is nothing. You have paid 8s. 2d. into court but will have to pay a further 19s. 10d.

Electricity (Supply) Bill.

This Bill, as amended in Committee, was considered by the House of Lords on Friday.

The power given (by clause 2) to the Electricity Commissioners to conduct experiments for the improvement of the methods of electric supply or of the utilisation of fuel was enlarged, on the motion of the Lord Chancellor, by adding "water power," which, he said, might be useful in connection with the inquiries of the Water Power Resources Committee.

An addition to Clause 21 providing for arbitration in the case of any party being aggrieved by the terms was withdrawn, and the Report stage was agreed to. The Bill was afterwards read a third time and passed.

On Monday the House of Commons agreed to accept the amendments made by the Lords, and the Bill will receive the Royal Assent in due course.

Patents and Trade Marks Bills.

The House of Commons has agreed to the Lords amendments to the Patents and Designs Bill, subject to some slight modifications, and the amendments to the Trade Marks Bill have also been accepted.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

134,560 Robinson. Direction-finding as applied to wireless telegraphy. (27/5 18. (Complete accepted 9/5/19. Patent sealed 9 5 19.)

134,865 Brown. Variable electric resistances, and apparatus employing the same. (13/8/18.)

134,872 Western Electric Co. Telephone transmitters and like acoustic apparatus. (20/9/18.)

134,876 Simplex Conduits, Ltd., & Waterhouse. Electric switches. (10, 10 18.)

130,575 Soc. Anon. des Etablissements L. Blerict. Regulating devices for use in electrical machinery. (31/7/18.)

120,908 Seward. Processes of electro-depositing magnesium. (19, 11, 17.)

120,734 Skinderviken. Telephone transmitters. (7 11 17.)

134,930 Coupe & Doyle. Electric heating elements for radiators, ovens and other heating and cooking apparatus and appliances. (13/11/18.)

134,937 British Lighting & Ignition Co. & Bennett. Timing-rings and timing-levers of magnetos or ignition devices. (14 11/18.)

134,941 Benham & Sons & Allensby. Electrical heaters. (15/11 18.)

134,942 Rankin. Rotary electrical switches. (15/11/18.)

134,946 Bill. Electric switches. (16/11/18.)

134,952 Jenson & Tilney. Dynamo electric machines. (18 11 18.)

134,954 Cox & Cowell. Magnetically operated motor controlling and like switches. (19, 11/18.)

134,971 Railing & Roberts. Combined electric light fitting and ceiling fan. (23/11, 18.)

134,973 Scott. Electrical contact makers for use with the steering wheels of motor vehicles. (25/11, 18.) (Cognate Application, 4,162 19.)

121,282 Soc. Electro-Metallurgique Francaise. Electrodes of electric furnaces. (3/12/17.)

135,000 Arter. Magnetic chucks. (10 9/17.) (Divided application on 12,961 17.)

135,012 E. L. C. Magnetos, Ltd., & Turner. Construction of contact-breakers for magnetos. (19, 12/18.)

135,020 Westminster Engineering Co. & Way. Electric arc lamps of the enclosed projector type. (23/12/18.) (Addition to 9,225 10.)

134,585 B.T.-H. Co. (G.E. Co.) Wireless signalling systems. (4 10/18.)

A method of wireless signalling which consists in transmitting signals by means of two sets of waves of constant amplitude and radio frequency differing in frequency by an amount above audibility, receiving the waves thus transmitted and combining them to produce an alternating current having a frequency corresponding to the difference in frequency of the two sets of waves accumulating the energy of this alternating current in a resonant circuit, and utilising the accumulated energy for the operation of suitable detecting apparatus.

1919 Specifications.

134,246 Marconi's Wireless Telegraph Co. & Franklin. Receivers for wireless telegraphy. (28/6/18.)

A receiver containing a thermionic valve and having its circuits so arranged that the variations of potential produced by the received oscillations cause the potential of the filament relative to its surroundings to vary more than the potential of the other electrode or electrodes relative to their surroundings.

134,247 Siemens & Halske Akt. Ges. Telephones. (14/7/17.)

134,248 Imray. (Bosch Akt.-Ges. R.) Automatic regulator for dynamo-electric machines. (4/7/18.)

134,249 Robinson & Workman. Combination electric heater. (26 7 16.)

134,253 Hirst & Brook. Switches for controlling electric circuits. (23 8 18.)

134,266 Tucker & Crabtree. Electric switches. (3 10, 18.)

134,290 Trent. Electric fusible cut-outs. (28, 10/18.)

134,291 Zalocostas. Switch control for automobile electric tail lights. (28 10 18.)

134,297 Comparri Wireless Control Synd. & Compare. Oscillatory mercury make-and-break apparatus for wireless telegraphy or the like purposes. (29 10 18.)

Relates to an oscillator or vibrator for wireless control systems for initiating or controlling any operation or series of operations from a distance by radiant energy, having an upwardly extending tubular member closed at its top and open at the lower end, and said open lower end located in and held immersed in a body of mercury and having a column of mercury in vacuo in said tube, and means operated through the medium of radiant energy to impart oscillatory or vibratory movement to said column of mercury

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

October 6, 1919.

24,338 B.E. Co. & Harrison. Electrical fuses.

24,349 Harriman. Contacts for electric fuses, cut-outs, &c.

24,354 Kleinschmiot. Operating printing telegraph.

24,368 Anciens Etabs., Barbier, Benard et Tureune & Grana. Electro-mechanical variable-speed and reversing mechanisms.

24,394 Western Electric Co. Composite electric signalling systems.

24,399 Suckling. Electric couplings or connectors.

24,400 Suckling. Electric hand lamps.

24,404 Hancock. Electric flash lamps.

24,405 Bolitho. Transmitting apparatus for wireless telegraphy, &c.

24,406 Bolitho. Amplifying devices for wireless telegraphy, &c.

24,407 Bolitho. Receiving apparatus for wireless telegraphy, &c.

24,413 Maurice. Contact plates for miners' electric lamps.

October 7, 1919.

24,419 Swinden & Webster. Electric and other drives for hydros.

24,452 Harland & Wolff & Evans. Contactor type starters or controllers for three-phase motors.

24,470 Electrical Improvements Ltd., & Pattison. Electric traction systems with conductor rails.

24,480 Morgan Crucible Co. & Spiers. Electric melting furnaces.

24,492 Marks. (Accumulators, Ltd.) Light gauge and splash plate for storage batteries.

October 8, 1919.

24,556 Cressall. Contact for electric thief alarms, &c.

24,575 Western Electric Co. Electrical protective devices

24,599 Lyon & Wrench, Todman & Engelke. Electrical resistances.

24,640 B.T.-H. Co. (G.E. Co.) Electrical apparatus.

24,644 Scott-Taggart. Thermionic tubes.

October 9, 1919.

24,680 Fuller. Galvanic electric batteries.

24,683 Lane. Earth detector switch.

24,715 British Electric Transformer Co. & R[illegible]sthean. Insulating means for electrical apparatus.

24,718 Oldham. Galvanic batteries.

24,719 Galvanophoren Werke (System Vogt) S. Szubert Komm. Ges. Electric pocket lamps. (10 10/18, Germany.)

24,722 Allmanna Svenska Elektrishu Aktiebolaget & Lindstrom. Electric generators, motors, &c.

Commercial Topics.

Import Restrictions.

Owing to the judgment of Mr. Justice Sankey, which declared that the restriction of imports under the Customs Consolidation Act of 1876 was illegal, the Board of Trade have instructed the Customs, pending either reversal on appeal or legislative action, to allow the importation of all articles affected thereby. These articles include scientific glassware, scientific instruments, &c.

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Electric Traction in South America.

During the war the railway companies of the Argentine Republic suffered from the scarcity and high prices of fuel, and important developments, with a considerable extension of electric traction, are foreshadowed. Some important contracts for electric generating plant, motors and rolling stock will be placed, and we hope that British manufacturers will be ready to participate in the competition. It is stated that the Western Railway Company will electrify its system down to Castlear, 20 miles out of Buenos Aires, at a cost of about £1,000,000, and the Southern Railway Company will adopt electric traction on its lines to La Plata.

It is also reported that an Anglo-American financial group is studying a project for the electrification of a railway from Victoria to Diamantina, Brazil, a distance of about 100 miles.

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Public Libraries.

Some much needed reforms in the administration of public libraries are foreshadowed in the Public Libraries Bill which was recently introduced into the House of Commons. It is proposed to remove the existing limit on the amount of the rate which can be raised for public libraries, and in future local authorities will be empowered to expend any sum they may think proper for library purposes. County Councils, which have hitherto not been library authorities, can adopt the Act and establish libraries; and any local authority, being an education authority, which shall adopt the Act shall place its administration under its Education Committee. In our opinion these changes are very desirable and we hope that the Board of Education, which is promoting the Bill, will be successful in getting it passed in the next Session of Parliament. At present the majority of libraries distribute cheap novels, books of personal reminiscences, biographies, &c., and little attention is paid to the provision of works on engineering, science, economics and business organisation. The libraries should be useful educational institutions, and better provision should be made for the needs of the commercial and industrial life of the country. At all events we think the administration of the libraries will be greatly improved when they pass under the control of the Education Committees.

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The F.B.I. and Foreign Trade.

From time to time we have been pleased to chronicle the activities of the Federation of British Industries in the interests of foreign trade, and particularly in the development of British exports. The Federation has appointed a number of trade commissioners in foreign countries who are specially qualified for their works, and we now learn that Mr. R. T. Nugent, the director of the Federation, has recently returned from a visit to the office of the Trade Commissioner in Madrid. He was accompanied by Mr. C. F. I. Ramsden, who visited Valencia and Barcelona to inquire into the proposed exhibitions to be held in these places. It is the policy of the Federation to engage floor space in such foreign exhibitions as are likely to be of benefit to British manufacturers exhibiting there. The Commissioner in Madrid (Colonel Thoroton) is particularly suited for his position, as during the war he was in charge of the British Government's Commercial Intelligence Organisation in Spain. He has a thorough understanding of the Spanish character and methods, and the prestige of the Federation is hardly second even to the British Embassy. Representatives of British business houses in Spain also welcome the presence of the Federation, as it is of great assistance to them and to the cause of British trade as a whole, for it forms a centre for Britsh commercial interests in that country. The mere fact of the arrival of the Federation with a sutiable commissoner, competent staff and a fine office in the best centre of Madrid, has been a valuable collective advertisement for British industry, and it has also given the impression that the British manufacturer is taking the Spanish market with real seriousness. As an illustration of the utility of the work done may be instanced the case of a leading Spanish engineer, who was anxious to find out where he could obtain a certain class of gyroscopic compass, employed successfully by the British Government during the war. Arriving in Madrid he called at the office of the Federation, with the result that he was immediately put into touch with the manufacturers of the English compass. Business at once followed, and the British manufacturer gained a new market. The market in Spain was hitherto entirely dominated by an American product. Mr Nugent was impressed by the evidences of coming activity in tramways, water-power schemes and other projects. There is every indication of a growing demand for machinery, electrical plant, &c.

Mr. G. H. Locock, C.M.G., Assistant Director of the Federation, has also returned from Athens where the exhibition of British manufactures was such a brilliant success. Mr. Locock has reported to the Overseas Committee of the Federation that the prestige of the Federation and the Federation's Commissioners is very high indeed in the Near East, and has done a great deal to create an atmosphere favourable to British trade in that part of the world.

Electricity Supply.

Falkirk Town Council has applied to the Secretary for Scotland for powers to borrow £30,000 for extension of the generating electric plant and mains in order to be able to meet the growing demand for electrical energy in the immediate future for large engineering works and foundries.

Ald. Wm. Thompson has resigned the chairmanship of the Blackburn Electricity and Tramways Committee, after holding office for 25 years. The Committee recommends that the salary of the borough electrical engineer (Mr. P. P. Wheelwright) be increased from £800 to £1,000 a year.

The accounts of the Exeter electric supply department for the year ended March 31, 1919, show income £22,075 and expenditure £15,860, leaving gross profit £6,215; and, after providing for capital charges, a net deficit of £1,734. Units generated were 1,994,315 and sold 1,420,212. Total maximum demands were, for tramways, 300 kw., and for other purposes 1,000 kw.

Owing to the limited supply of electricity now available in Hull the industrial establishments which obtain their power from the Corporation electricity works will suspend work daily at 3.30 p.m. Work will be commenced at 8 a.m. and continued until that hour, with half-an-hour interval for dinner. The reduction of a third in the supply of power means a considerable reduction in output.

Many local authorities who are anxious to obtain electric supply powers are uncertain as to the method of procedure, especially in view of the recent drastic alterations in the Electricity (Supply) Bill. The subject was discussed by the Richmond (Yorks) Council last week, and ultimately it was decided to support any feasible scheme submitted by a company.

In view of the difficulty in maintaining an efficient supply of electric current between 4 p.m. and 6 p.m. St. Pancras (London) Borough Council has arranged with the local cinemas to exhibit a request to consumers to help by cutting off their radiators between the hours named, and power consumers are asked to arrange to discontinue the use of power from 4.30 p.m. to 5 30 p.m. until about a fortnight after Christmas.

The Weymouth electricity department accounts for the year ended March 31, 1919, show revenue £16,566 and expenditure £12,469, leaving gross profit £4,097; and, after meeting capital charges, a net deficit of £631. Costs were 2·69d. per unit (compared with 2·45d. in previous year) and capital charges 1·04d. (1·15d.). Units sold were 1,087,347 (958,347). Maximum load was 535 kw. (565 kw.) and load factor 23·2 (19·16) per cent.

The Industrial Court has awarded an advance of 5s. per week to workers employed in the electricity undertakings of London and the suburban districts, including the L.C.C., the Corporations of Croydon, Ealing, East Ham, Kingston and Wimbledon, a number of urban districts, and various electric supply companies and tramway undertakings. A similar award has been made on the claim by the Electrical Trades Union and other unions for electrical workers on railways in the London district.

In both cases the claim was for 15s. a week.

Conway Corporation has authorised the borough engineer (Mr. F. A. Delamotte) to make a small experiment with a view to ascertaining whether the energy of the tidal currents in the Conway river may not be utilised in the generation of electricity. The Council, which is considering whether it may not be possible to obtain electricity in bulk from the North Wales Power and Traction Company, obtained an Electric Lighting Order some years ago but nothing has been done to make use of the powers.

A serious situation was created at the Newport (Mon.) docks on Thursday last, when work was brought to a standstill by a lightning strike of the men employed at the power stations. The immediate result was the stoppage of the hydraulic pressure, and consequent inability to work the tips, cranes and other plant. The men claim the whole of the conditions applying to shopmen, although the company's view is that they are not shopmen. With the exception that the electric light was kept on, the whole of the power available for working was off.

A report on the present position and future extensions of the Aberdeen Corporation electricity undertaking has been prepared by Mr. John H. Rider (Messrs. Preece, Cardew, Snell & Rider) for the Electricity Committee. On the assumption that the Electricity (Supply) Bill will pass into law in its present form, it would be for the Corporation to submit to the Electricity Commissioners (*a*) a proposal to constitute Aberdeen and the surrounding district as a separate electricity district; (*b*) a scheme for the proper supply of electricity; and (*c*) a scheme for the establishment of a Joint Electricity Authority for the district.

It is recommended that for the moment the area of supply should be limited to a radius of 15 miles from the city of Aberdeen. The proposed district would include Aberdeen city, Banchory, Ellon, Inverurie, Kintore, Newburgh, Stonehaven and Udny, and the valley of the Dee up to Banchory and the valley of the Don to Inverurie, a district of about 90 sq. miles. The only power stations which would be acquired would be that belonging to Aberdeen Corporation and a small one at Ellon belonging to Duncan's Electricity Supply, Ltd. The obligation to continue to supply electricity to the Aberdeen Corporation and to Ellon would be transferred to the Joint Electricity Authority. A supply to Ellon could be met either by continuing to operate the existing station at Ellonor by providing a high tension transmission main from Aberdeen.

The report states that, viewing the whole question of the power station from the standpoints of to-day and the immediate future, Millburn-street is not an ideal site. At the time the station was designed there was not much objection to it, but the disadvantages with regard to water, coal and ashes will become more marked as the capacity of the station is increased. A much better site would have been that bounded by Palmerson-road, Stell-road, Market-street and the Esplanade if it had been possible to obtain it. Owing to the capital already expended, any proposal to remove the station at present would not be financially feasible. Mr. Rider recommends that the Aberdeen Corporation should propose to the Commissioners that the Corporation itself should be constituted the Joint Electricity Authority for the district, as it would retain the whole of the generating and distributing powers, while joint ownership of the plant and joint control of the staff would be avoided. It is also suggested that a proper canvass and survey be made, in order to arrive at the immediate and future power requirements of the district, and to enable a transmission scheme, with estimates of cost, to be prepared; that the future development of the Millburn-street station be carried out on the lines suggested. This would include the acquisition of property on the north side of Dee Village-road, and the closing of that thoroughfare, with the submission to the railway authorities of plans for an overhead coal conveyor scheme; that the question as to the possible use of water-power should be thoroughly gone into as soon as the necessary data have been obtained.

The Committee will discuss at a future meeting the questions raised in the report; but in the meantime a report from Mr. Bell, the city electrical engineer, recommending an increase in the boiler and condensing plant, has been adopted.

Electric Traction.

The moulders' strike is having a disastrous effect on many branches of engineering, including the manufacture and repair of tramcars. At Cardiff, where tenders are required for 15 complete cars and for 15 chassis, Mr. Arthur Ellis (tramways manager) states that unless the moulders' strike comes to an end, the service would have to be withdrawn. They were now using brake-blocks that had been scrapped.

There will be no Christmas Day tramcars in Manchester, Bolton and other Lancashire towns, the employees not only refusing to work on that day, but stating that the decision will apply to all Christmas Days in future. Attempts to run a modified service have failed. In Liverpool and a few other towns a limited service will be maintained, the hours of duty being so arranged that the men will be able to get home to dinner some time during the day.

The present staff of the Ministry of Transport is 449, of whom 55 were previously employed by railway companies, 14 by local authorities and 13 by engineering firms. In the departments concerned with the internal combustion engine, 25 technical officers are employed.

In the civil engineering department, of which Sir Alex. Gibb, K.B.E., C.B., is Director-General, Mr. J. Ferguson, M.Inst.C.E., is chief civil engineer for railways and tramways; N. G. Gedye, M.Inst.C.E., chief civil engineer for docks, harbours, canals and waterways; and T. G Menzies, C.B.E., M.Inst.C.E., chief civil engineer for special studies. In the finance and statistics department, Sir J. George Beharrell, D.S.O., is Director-General; C. W. Hurcomb, O.B.E., assistant secretary; J. Milne, director of statistic section; and J. Pike, director of rates section. Of the mechanical engineering department, Mr. L. S. Simpson, C.B.E., D.S.O., is chief mechanical engineer; A. S. Burnett, director of locomotives and rolling stock, and C. H. W. Edmonds, O.B.E., director of signals and tramways. Of the public safety and general purposes department, Sir William F. Marwood, K.C.B., is Director-General; E. G. Moggridge, C.B., assistant secretary; Lieut.-Col. J. W. Pringle, R.E., chief inspecting officer of railways. Of the traffic department, Sir Philip A. M. Nash, K.C.M.G., C.B., is Director-General; M. Kissane, director of storage and transit; V. M. Barrington-Ward, D.S.O., director of railway operations; J. A. A. Pickard, director of tramway and road services.

Sir John Aspinall, M.Inst.C.E., M.I.M.E., is consulting mechanical engineer to the Ministry.

The Glasgow Tramways Committee Corporation has recommended the Corporation not to increase the tramway fares during the present financial year. The committee's decision was reached notwithstanding a long report by the general manager (Mr. Jas. Dalrymple), which stated that for the three months ending August 31 there was a deficit of £19,435. Since then the Corporation had granted to a large section of the staff a further advance of wages, which meant an additional annual expenditure of £75,000. The total wages bill, which was £441,000 for 1913-14 would reach about £1,140,000 for the current year.

Mr. Dalrymple's proposals for increased travelling facilities include extensions through the centre of the city to relieve the congestion, also additional routes in other parts of the city and the extension of existing routes beyond the municipal boundaries. The tramcars are full already, and no simple rearrangement of the system can possibly enable them to carry more passengers, and the congestion can only be relieved by the construction of one or possibly two additional bridges near Glasgow Bridge. The line from the corner of Argyle-street to the south end of Bridge-street, which carried by far the greatest volume of traffic, has reached the saturation point. Mr. Dalrymple thinks that if capital were expended in providing better cross-river communication, more cars could be operated; but, in the end they might find themselves in a worse position financially than they were in to-day. He questions whether they could earn by the additional cars as much revenue per mile as they are now earning, so that every additional car put on the streets might mean an additional loss. He is convinced that the committee should confine their attention to increasing the tramway revenue.

Imperial and Foreign Notes.

The Bureau of Canadian Information, which was established several years ago by the Canadian National Railways, at 42-45, New Broad-street, London, E.C.2, has proved of considerable value to the business community and to inquirers seeking information about Canada. Interest in Canadian affairs has rapidly revived in the past few months and many inquiries are being received.

The Tasmanian Parliament has passed resolutions authorising the Minister of Works to construct the Lake Rolleston power scheme at a maximum cost of £500,000, and to supply the Mount Road and Rosebery Mines, Ltd., near Zeehan, with 15,000 horse-power for 15 years at 55s. per horse-power per annum on the company providing guarantees that necessary capital for treatment plant installation is available. The company has recently purchased from the Government the works of the Tasmanian Smelting Company at Zeehan for a site for an electrolytic zinc refinery.

The French Government proposes to put a tax of 55 centimes per franc on foreign telegrams to cover the losses occasioned by the rate of exchange

It is announced that applications have been filed with the Dairen Civil Administration Office in the name of an ex-Minister of Finance for permission to construct an electric tramway between Dairen and Port Arthur, Manchuria, and a street tramway at Port Arthur. The first proposal will involve the construction of a route of 25 miles, compared with 39 by railway.

The following alterations in the classification of articles under the French Customs Tariff are announced: Electrical control apparatus with watch movement is now dutiable under No. 524 *bis*, the duty varying from 150 to 115 francs per 100 kilogs for weights varying up to 1,000 kilogs and over under the general tariff, and from 110 to 20 francs under the minimum tariff; but the watch movements are taxed under 498 or 499. Electrically driven portable vacuum cleaners are subject to duty under the regime of dynamo-electric machines, according to class, or of wares of aluminium, nickel, &c. The duty on dynamo-electric machines (No. 524) varies from 150 to 30 francs and from 110 to 13 francs per 100 kilogs under the general and minimum tariffs respectively.

Miscellaneous.

The coming into operation of the Merchant Shipping (Convention) Act, 1914, has been further postponed until July 1, 1920.

Mr. Francis Augustus Bevan, chairman of Messrs. Barclay & Company and the Anglo-American Telegraph Company, left unsettled property of the gross value of £410,879, with net personalty £315,061.

An order has been made for the compulsory winding up of Messrs. Veithardt & Hall, Ltd., upon the petition of the Board of Trade under sec. 1 (7) of the Trading with the Enemy (Amendment) Act, 1916.

The current issue of "The Ex-Service Man" contains Christmas greetings and messages to those who have served in H.M. Forces from Field-Marshal Earl Haig, Admiral Earl Beatty, Air-Marshal Sir Hugh Trenchard, General Lord Byng and others.

An unfortunate accident occurred at Messrs. Gray's shipyard, Pallion-Sunderland, on the 17th inst., when Robert Black, who was engaged in making a new joint in an electric wire, received a fatal shock. Black had turned off the current, but someone turned the switch on again while he held the ends of the wire in his hands. The voltage of the current was 240. The Coroner, after hearing the evidence, said there was no doubt somebody had turned on the switch, but apparently he was not man enough to come forward. A youth working with Black swore that he had not done it, but he (the coroner) was convinced that deceased had met his death through the carelessness of someone.

Thousands of mill workers were idle last week owing to a dispute at the electricity generating station at the Stalybridge, Hyde, Mossley and Dukinfield tramways and Electricity Board. Less than a dozen shift engineers ceased work owing to a difference with the Generating Station Committee on Friday, and in consequence several mills that receive their electric supply from the station are affected. The Committee received an application for an advance in wages in October last, to which they acceded, but the men demanded that the advance should operate as from February or March last and gave a fortnights' notice to terminate their engagement.

The New Transport Company, Ltd., has issued a reprint of the preliminary estimates of the revenue and expenditure of the proposed London Goods Clearing House as presented to the recent Board of Trade Committee which recently considered the Gattie system. The total capital cost of the erection and equipment of the station was put at £26,000,000, and the annual cost of working, maintenance, &c., at £8,000,000; and after allowing £26,000,000 (or profit at 100 per cent. on required capital) there would be an estimated reduction of over £38,000,000 on the present cost of working. An abstract of the evidence taken by the Committee has already appeared in the Electrician.

On the 18th inst. the directors of Messrs. Vickers, Ltd., entertained to dinner 82 veteran workers of the Company at the staff dining rooms of the River Don Works. The average period of service of those entertained was 46 years, and after the dinner each of the 82 received a £10 note. In proposing the prosperity of the firm, Mr. A. J. Capron observed that Vickers, Ltd., was not only the largest and most important firm in the city of Sheffield, but it had absolutely proved itself the most important firm in the whole of the country. After giving particulars of the firm's war work, Mr. Capron referred to post-war manufactures, including railway materials, shipbuilding and electrical equipment. He said electrical extension was going to be one of the most important things in the development of the country.

Mr. Douglas Vickers, M.P., who presided, said that of all the changes that had been made and all the buildings that had been put up, there was hardly a corner that he had not studied before it was put up in bricks. There were few people who knew of the very great service the firm had rendered. They had not trusted to rule-of-thumb, but the firm had thought things out for themselves. Vickers had never tried to absorb other competitors, never tried to form trusts that would make a monopoly, but anything they wanted they manufactured themselves. For the big engineering trade of the future there was nothing like the importance of electricity. They were broadening the basis of things so as to be able to be masters of the big trade in the future. Forty years ago the firm had 2,900 employees, and the number grew during the war to 107,000.

On the 18th inst. Messrs. J. H. Tucker & Company, Ltd., held in their works canteen a Christmas social and welcome home to employees who have returned from H.M. forces. About 70 members answered the call, and seven made the supreme sacrifice. The spacious and beautifully decorated canteen was divided into two sections, a whist drive being held in one and a dance in the other. Part of the evening was set aside for refreshments, and during this time a vocal and musical entertainment was provided, remarkable talent being shown by the artistes, who were all employees of the company. Messrs. Tucker & Co.'s Social Club provides during the hours of relaxation from business entertainment, dancing and whist drives at regular intervals. On the athletic side it can boast of a senior and junior football club playing in the Birmingham Works League and the Birmingham Works Welfare League, an air-gun club, a scout movement for the younger members, a cricket team, a ladies and gentlemen's swimming club, and a tennis club.

Mr. J. B. Tucker occupied the chair, and Mrs. Tucker gave the prizes for the various competitions held. In a speech after the prizes had been distributed Mr. Tucker said that besides being the annual social, the meeting was also an official welcome home to the employees returned from the forces. As regards the social side he hoped that they would have many more such meetings, because of the good feeling these gatherings helped to create between all members of the Company. A vote of thanks to Mr. and Mrs. J. D. Tucker was carried unanimously. The striking success of the event was due to the following officials :—Mr. T. R. Martin, Mr. A. B. Batemean, Mr. H. Rogers, Miss Harcourt, secretary of the entertainment committee, Mrs. Soden (secretary of the social committee) and Mr. Pratt (general secretary of the club). About 300 members of the staff and works were present, and a pleasing feature was the presence of the firm's outside representatives from the branches.

Business Items.

The address of the chief engineer and general manager of the Wolverhampton Corporation electric supply department, Mr. S. T. Allen, and of the central administrative offices, is now 83, Darlington-street.

Owing to the new year the works of Messrs. Bruce Peebles & Company, Ltd., will be closed for receipt of goods from 5.30 p.m. on Dec. 30, until 8 a.m. on Wednesday, Jan. 7, 1920.

From Messrs. Swarren, Ltd., electrical engineers, Theobald's-road, London, we have received an artistic calendar, with monthly tear-off slips.

The Hart Accumulator Company, Ltd., of Stratford, London, E. 15, send us a large and useful wall calendar consisting of monthly tear-off sheets on which the dates are printed in large black figures.

The Alloy Welding Processes, Ltd., have issued three new bulletins dealing with their manufactures. No. 10 is devoted to "A. W. P." standard electrodes for electric arc welding ; No. 30 is a price list of their welding plant and equipment ; and No. 31 is a descriptive list (with prices) of "A. W. P." welding rods and electrodes.

Messrs. Charles Barker & Sons, Ltd., the well-known advertising agents, who have been established over 100 years, have, owing to expiry of the lease of their White Lion Court premises, transferred their offices to 31, Budge-row, Cannon-street, London, E.C.4. Telephone No. City 2163.

Mr. A. B. Mallinson, M.I.Mech.E., who for eight years has been associated (as consulting and chief engineer) with an important group of paper mills, is severing his connection with them, and from the 1st prox. he will practice as a consulting engineer, specialising in paper mill and works power equipments generally, from his old address Worsley-street, Salford.

From the Sun Electrical Company, Ltd., 57-59, Neal-street, W.C. 2, we have received one of their useful Sunco desk memo calendars for 1920. A refill is being sent to each friend who previously acknowledged receipt of the calendar, and where the metal base has been lost it will be possible, if early application is made, to send another metal base. The company will send either refill or complete calendar to those who apply on their business notepaper for same.

Tenders Invited and Accepted.

Tynemouth Corporation invite tenders for ten 250-k.v.a. transformers. Specifications from Mr. C. Turnbull, borough electrical engineer, Electricity Works, and tenders to the Town Clerk, Mr. Stanley Wilson, by Jan. 12, 1920.

Islington (London) Council require tenders by noon Jan. 28 for one year's supply of stores for their electricity department, including cables, meters, lamps, transformers, carbons, &c. Specifications can be obtained at the Town Hall.

Halifax Corporation want tenders by Jan. 5 for 13 months' supply or tramway stores, including lighting fittings, insulating materials, v.r. cable, wires, trolley and overhead line materials, castings, &c. Forms of tender from the Tramways Engineer.

Bedwellty Urban Council invite tenders for the supply of a small substation equipment and about 3,000 yds. of pole lines. Specifications from Mr. R. Howard Fletcher, 20/22, Queen-street, Cardiff, and tenders to the Clerk, High-street, Bargoed, Glam., by Dec. 29.

Tenders are invited by 3 p.m. of Feb. 10 for the supply and erection of 340 accumulators required by the Postmaster-General's Department, Western Australia. Tender forms from the office of the High Commissioner for Australia, 406, Australia House, Strand, London, W.C. 2.

Rhondda Urban Council invites tenders for the supply of steel (or wood) poles and the erection of overhead lines. Specifications from the Electrical Engineer, Porth, Glam., and tenders to the Chairman of the Electricity Committee, Council Offices, Pentre, Glam., by noon Jan. 5.

Tenders are invited for the supply and erection of electrical machinery (power and lighting) and material for the port of Valparaiso, Chile. Specifications may be examined at the Chilean Legation in London, and tenders by 3 p.m. March 15, 1920, to Secretary of the Ports Commission.

The Electric Supply Committee of the City of Sheffield invite tenders for the supply of materials and works required in connection with the supply and laying of 6-core e.b.t. split conductor cable. Specifications, &c., from the general manager and engineer, Mr. S. E. Fedden, Commercial-street, Sheffield, where tenders are to be delivered by Jan. 2.

Barnes Urban District Council invite tender for the supply of water-tube boilers, economisers, draught plant, turbo-alternators, condensers, air and circulating pumps, transformers and rotary converters. Specifications from Mr. C. S. Davidson, M.I.M.E., M.I.E.E., Electricity Works, High-street, Mortlake, S.W.14. Tenders by noon of Jan. 12.

Palmerston North (New Zealand) Council require tenders by 4 p.m. March 2 for the supply of two 400 h.p. pressure producers and auxiliaries 3,000-volt generating sets, converters, battery switchboards, &c. Specifications can be inspected at the Department of Overseas Trade (Room 40), 35, Old Queen-street, London, S.W.1.

Stepney (London) Electricity Supply Committee invite tenders for manufacture and erection of two water-tube boilers, economisers and other accessories, and one 5,000-kw. turbo-alternator condenser, accessories and switchgear. Specifications, &c., from Mr. Wm. C. P. Tapper, M.I.E.E., borough electrical engineer and manager, and tenders to the Chairman of the Committee, 27, Osborn-street, Whitechapel, E., by noon Jan. 22.

East Ham Council has placed an order for four new electric tramcars at £2,100 each.

Messrs. Cammell, Laird & Company have received orders from the London Electric Railway Company for trailer cars, and from the Central London Railway Company for bogies.

Salford Tramways Committee has accepted the tender of the British Hele-Shaw Patent Clutch Company for the supply of British steel pinion wheels and gear wheels at £594 12s.

Sunderland Electricity Committee has accepted the following tenders : Dussex Bitumen Company, l.t. box compound ; Pirelli General Cable Works, cable ; British Insulated & Helsby Cables, Ltd., sundries for service work ; Ferranti Limited, house service meters ; Brunner, Mond & Company, alkali ; British Mannesmann Tube Company, superheater tubes.

Appointments Vacant and Filled.

The Council of the Royal Soicety require an assistant secretary. Commencing salary £750 rising to £1,000. Particulars from the Secretaries of the Society, Burlington House, W. 1, and applications must be in by Jan. 6.

A senior lecturer in mechanical engineering is required at the Manchester College of Technology. Salary £600 per annum. Conditions of appointment, &c., from the Registrar, to whom applications by Jan. 15.

Three charge engineers are required by the Shanghai Municipal Council Commencing salary 300 taels, rising to 450 taels per month. Applications to the consulting engineers, Messrs. Preece, Cardew, Snell & Rider, 8, Queen Anne's gate, Westminster, S.W. 1, by Jan. 1.

An assistant telegraph engineer is required for the Government Posts & Telegraphs Department of the Federated Malay States. Salary £360—£15—£480 per annum, with duty allowance of £75. Applications to the Crown Agents for the Colonies, 4, Millbank, London, S.W. 1.

A chief lecturer in electrical engineer (£350, rising to £400 per annum), an assistant lecturer in civil and mechanical engineering (£300) and an assistant lecturer in physics (£300) are required at West Ham Municipal Technical Institute. Applications to the Principal, Romford-road, Stratford, E.15, by Jan. 12, 1920.

Mr. Geo. Wm. Maxfield, of Burnley, has been appointed junior engineer in the Electricity Department of Dundee Corporation.

Companies' Reports, &c.

THE INDIA RUBBER COMPANY'S MEETING.

At the 56th ordinary general meeting of the India Rubber, Gutta Percha and Telegraph Works Company, Ltd., on the 18th inst., Major Leonard Darwin (the Chairman) presided, and stated that the Board had been able not only to provide an ample reserve against excess profits duty and income-tax, but also to add about £10,000 to the carry-forward. Those of their home competitors who did less war work than themselves—nearly 95 per cent. of their work was war work—had been able to establish themselves in the home markets while neutral countries had reached a similar advantage in their foreign markets. It was, however, satisfactory to have passed through the reconstruction ordeal as well as they had done. The war and after-war conditions had had the effect of advancing prices of labour and generally speaking of all materials by a very considerable percentage and there was no indication at present how long such a condition was likely to last. At the present time, compared with pre-war prices, coal has advanced nearly 200 per cent., cotton (of which they were large users) 350 per cent., and other materials (except rubber) in somewhat similar proportions. New machinery and tools, the cost of repairs and maintenance of plant had advanced 150 per cent., and building, as shown by their Burton works, might be taken to have advanced 200 per cent. Added to that, the average weekly earnings of workers had advanced by approximately 100 per cent., notwithstanding that the working hours had been reduced from 59 to 47 per week. Those greatly increased costs would shortly involve the raising of fresh capital. In France, in spite of the labour unrest and the difficulty of getting coal their Persian works had had a satisfactory year, and the small factory in Toulouse was proving a good investment. Their foreign branches had also done well, although they had been hampered by inability to turn out all the goods required.

Diversion of German Cables.

There was one matter connected with the past history of the company to which he wished to allude. Early in the war they were employed in diverting the German Emden-Teneriffe cable into St. Nazaire and in making several repairs to French Government cables; dangerous work which ended more than two years afterwards with the sinking of their cable ship and the accompanying French man-of-war in Funchal Harbour, Medeira, by a German submarine. Far the most important work accomplished by the "Dacia," under the supervision of submarine cable engineers (Mr. Crawford and Mr. Robinson successively) was the diversion of the rest of the German Emden-Teneriffe cable so as to connect Brest with Casablanca in Morocco, and the diversion of the German Teneriffe-Monrovia cable so as to connect Morocco with Senegal. The Emden-Teneriffe cable was first cut off Brest, a length picked up and relaid into Brest. The same operation on a larger scale was then performed off Casablanca, with the result that after the necessary connections had been made, this second portion of the German Emden-Teneriffe cable was converted into a French Brest-Casablanca cable. Similar work was carried out on the German Teneriffe-Monrovia cable thus extending the French cable from Casablanca to Dakar in Senegal. Their cable engineers, after fully considering the difficulties, held that those were possible operations; there were no signs that any other English expert, whether governmental or in private employment, shared in this view; while the electrical advisers to the French Government declared the scheme to be impracticable owing to the depth in which the cable lay. Imagine fishing for a cable in pitch darkness; imagine trying to cut the cable in those circumstances in the hope of being able to haul up one of the ends thus set free to the surface; imagine pulling it up vertically through nearly three miles of water, then steaming away while continuing to drag up the cable from the bottom, coiling it up on board without any kinks or unperceived injuries, and finally relaying it exactly where required: imagine all that and scepticism as to the possibility of success became more than excusable. That remarkable performance was absolutely unique in the history of submarine cable enterprise, and that whether one looked to the length of the cable lifted (1,200 miles) or to the average depth of the water in which it lay. Their staff, without exception, worked splendidly, but the chief credit for their success must be awarded to their managing director, Mr. C. H. Gray. He conceived the scheme and advised the Board to take the risks involved; he persuaded the French Government to neglect the doubts expressed by their expert advisers, and he inspired all hands with the energy essential for success in such a feat. The position was fully realised by the French Government, for the Foreign Office has recently transmitted to Mr. Gray the Cross of Chevalier of the Legion of Honour, which had been awarded to him by the President of the French Republic for services during the war. The report and accounts for the year were then adopted and the distribution of a dividend of 15s. per share (10 per cent. per annum) on the ordinary shares was approved.

The directors of the Marconi International Marine Communication Company, Ltd., have declared an interim dividend of 5 per cent. (1s. per share), less tax, on account of the current year.

The Eastern Telegraph Company, Ltd., announce the payment on the 15th prox., of dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ending 31st inst., and the third quarterly interim dividend of 1½ per cent. on the ordinary stock (tax free) in respect of profits for the year 1919. The transfer books of the ordinary stock of the company will be closed from the 7th to 14th January, inclusive.

The directors of Marconi's Wireless Telegraph Company, Ltd., have declared a dividend of 7 per cent. (less tax) upon the 250,000 7 per cent. cumulative participating preference shares (numbered 500,001 to 750,000), and an interim dividend of 10 per cent. (less tax) upon the 1,223,648 ordinary shares (numbered 1 to 500,000 and 750,001 to 1,473,648) on account of the year 1919, both payable on Feb. 2, 1920. With a view to the more equal distribution of the dividend on the ordinary shares the board have decided to increase the interim dividend from 5 per cent. to 10 per cent.

The report of the Tees Power Station Company to Oct. 1 states that capital expenditure in respect of power station amounted to £610,732. During the year 36,000 additional fully-paid ordinary shares have been allotted to Newcastle-upon-Tyne Electric Supply Company, and a call of 5s. per share has been made on 200,000 partly-paid ordinary shares (making them 10s. paid), total paid up share capital being now £144,550. The erection of the power station has not progressed so rapidly as anticipated, owing to delay in delivery of material and plant, but it is expected that a section of the plant will be ready for commercial operation towards the end of April next. The amount received from the Newcastle Company (representing 6 per cent. on company's paid-up capital) was £4,053, and adding balance from last year, £1,841, the amount available is £5,894 which is to be carried forward.

The net revenue of the Provincial Tramways Company for the year ended Sept. 30 received from the local companies was £55,644, against £59,054 last year, with amount brought forward (£7,804), &c., the total was £81,893, from which has to be deducted administration expenses (£1,989), income tax (£8,498), interest on debentures (£8,750), preference dividend for year (£6,000), interim dividend on ordinary shares (£4,152), &c. The directors have placed £10,000 to reserve and depreciation account and £10,000 to reserve account for third party insurance, excess profits duty, or other processes, leaving £19,107. The directors recommend a dividend upon the ordinary shares of 10d. per share and a bonus of 6d., making with 8d. per share paid in June last 2s. per share (at rate of 10 per cent. for the year), leaving £10,803 to be carried forward.

In the course of his speech to the shareholders of the Delagoa Bay Development Corporation, Ltd., last week the chairman (Mr. H. K Heylands) stated that in order to meet the increasing demand for electric power at Lourenço Marques it would be necessary to increase almost immediately the plant at the generating station. Their general manager stated that the visible increase in demand during the next two years was between 300 and 400 h.p. They have recently cabled to the general manager authorising him to lay a short length of tramway to the site of a new hotel at Polana Beach for the transport of building material, and ultimately for the convenience of the hotel residents. Some additional rolling stock might have to be provided later. The protracted negotiations for certain modifications of the electric lighting contract had been brought to a satisfactory termination. An agreement with the municipal council had been signed and confirmed by the Governor-General of Mozambique.

Sir A. J. Dorman, who presided over the meeting of Dorman, Long & Company, Ltd., last week, gave an account of the operations in 1918 and 1919, and of the various extensions and developments, &c. The Redcar works were started in February, 1916. The plate mills, which were an essential part of the scheme, were not completed when the war came to an end; yet, as they had anticipated, there was at present an enormous demand for plates for shipbuilding and other constructional purposes. The cogging mill and the large finishing mill were running in a most satisfactory manner. A fresh chapter in the history of the company was begun last week when the new plate mill started work. The mill was driven by what was said to be the largest motor in the world, having a full load capacity of 20,500 h.p. The weight was upwards of 400 tons, the rotating armature alone weighing 120 tons. The equipment represented the latest and best practice in electrically-driven mills. Generally speaking, electricity had been applied in many novel ways in connection with the rolling mills and auxiliary plant, notably the lifting and transporting of the finished products, which they believed would result in economy in working.

During the past year the Montevideo Telephone Company, Ltd., made substantial progress and £13,116 was expended on the installation of new lines, the net gain in the number of subscribers being 1,175. The chairman (Mr. C. Lock) stated at the recent meeting that working expenses at Montevideo were higher by £4,810 in consequence of the increase of subscribers. London expenses (at £3,195) were also somewhat higher, and the net result was an increase in the profits, including the abnormal gain on exchange, of £10,567. It was proposed to apply £10,000 for depreciation and to place £16,954 odd to reserve. Interim dividends of 3 per cent. on the ordinary shares and 2½ per cent on the preference shares were paid in May last. The preference shares had been converted into ordinary shares, and it was now proposed to pay a final dividend of 3 per cent., tax free, on the one class of shares. The carry forward of £8,963 has been increased by just over £500. In order to obtain permission to install a modern underground system the Board arranged with Mr. W. W. Cook to visit Montevideo and as a result of his visit a proposal embodying definite terms for a contract had been lodged with the Government. Such a contract would enable the company to provide a thoroughly satisfactory telephone service on terms favourable to the Government, while allowing a reasonable return on the investment such as would justify the initial expenditure and the provision of further capital for the continuous extension of the service which was sure to arise. Sir John Gavey has retired from the position of consulting engineer, and Mr. W. W. Cook succeeds him.

New Companies.

ABELL & SMITHS ELECTRICAL COMPANY, LTD. (161.459)—Private company. Reg. Dec. 10, capital £10.000 in £1 shares, to carry on the business of electrical and mechanical engineers, patentees, &c. : agreement with C. E. Abell. C. E. Abell is the first director and secretary. Reg. office : 79, The Foregate, Worcester.

ARROTA ELECTRICAL MOTOR & ACCESSORIES COMPANY, LTD. (161,410). Private company. Reg. Dec. 9, capital £50,000 in 10,000 6 per cent. cumulative income tax free preference and 39,400 ordinary shares of £1 each and 12.000 deferred shares of 1s. each. Objects : To acquire from E. Nickerson, A. E. Moffat, E. Nickerson and H. Fryman the benefit of certain existing inventions relating to signalling apparatus for road vehicles, &c. Permanent directors are E. W. Nickerson, A. E. Moffat, E. Nickerson and H. Fryman. Secretary, E. Nickerson. Reg. office : Charles-street, Louth.

CASSWELL, LTD. (161,521).—Private company. Reg. Dec. 11, capital £2.000 in £1 shares. Objects : to purchase the complete patent rights of L. H. Casswell in provisional protection No. 2.038 of 1919, relating to lamp shade holders used in connection with electric, oil and gas lamps (especially electric), &c. First directors are J. H. Casswell and E. E. Randall (both permanent). Reg. office : Church-street, Maidstone.

ENGINEERING EMPLOYMENT BUREAU, LTD. (161.570).—Private company. Reg. Dec. 12. Capital £5.000 in £1 shares. To take over the business of the Engineering and Commercial Employment Bureau. First directors are : F. J. West and P. Morris (both per.) and A. E. Whitehead, W. A. Willmott, R. S. Pearce, W. Sheriff and A. E. Flackfield. Reg. office : 234, Strand, W.C.

J. G. JACKSON, LTD. (10,767)—Private company. Reg. in Edinburgh Nov. 22, capital £200,000 in £1 shares, to carry on the business of manufacturers and brokers of, agents for and dealers in, milling machinery, electrical engineers, &c. First directors are J. G. Jackson, J. Risk, W. Duncan, J. Gray and J. Inglis. Reg. office : Constonholm Works Pollokshaws, Glasgow.

JAMES EDGAR, LTD. (10,768)—Private company. Reg. in Edinburgh Nov. 22, capital £5,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, &c. The first directors are J. Edgar, electrician, and R. M. Brown. Reg. office : 4, Drumsheugh-place, Edinburgh.

J. A. KINNAIRD & COMPANY, LTD. (10,760)—Private company, Reg. Nov. 18, capital £25,000 in £1 shares (10,000 preference, 14,900 preferred ordinary and 100 deferred), to take over the business carried on in Greenock as J. A. Kinnaird & Company, electrical and mechanical engineers. First directors : A. Henderson, H. S. Kennedy, J. A. Kinnaird and W. Sharp. Reg. office : 10, Blythswood-square, Glasgow.

LEEDS ALLIANCE ELECTRICAL MFG. COMPANY, LTD. (161,069)—Private company. Reg. Nov. 28, capital £5.000 in £1 shares (2,500 6 per cent. cumulative preference), to take over the business of a manufacturer of electric batteries and other electrical appliances carried on by W. A. Davis at Leeds as the Leeds Electrical Mfg. Company. First directors : W. A. Davis (permanent), G. Higginbottom, C. E. Sheard, C. E. Morris and A. E. G. Mowatt. Reg. office : Woodhouse Chambers, Coronation-street, Leeds.

LODGE PLUGS, LTD. (160,881)—Private company. Reg. Nov. 22, capital £300,000 in £1 shares, to take over the business of manufacturers of and dealers in sparking plugs and electric appliances and apparatus carried on at Rugby by the Lodge Sparking Plug Company, Ltd. (now in liquidation), and to enter into an agreement with the old company and its liquidator (F. B. Lodge). The first directors are to be divided into group A, representing the holders of shares numbered 1 to 125,000, and group B, representing holders of shares 125,001 to 250,000. The A and B directors may appoint one other director, to be classed as C. The first directors are J. A. Hopps and B. Hopps (group A) and F. B. Lodge and A. M. Lodge (group B).

MIDDLETON, MARSHALL & LARKINS, LTD. (160,035)—Private company. Reg. Nov. 27, capital £15,000 in £1 shares (12,000 participating preference), to carry on the business of electrical and general engineers and contractors, builders, shop fitters, &c. Agreements with V. S. Middleton and with C. Larkins & Company. First directors are V. G. Middleton (chairman), F. W. Marshall and J. W. S. Leask. Reg. office : Dacie House, Dean Forest-street, Westminster, S.W.1.

NEAR EAST DEVELOPMENT, LTD. (160,112). Private company. Reg. Oct. 29, capital £10.000 in £1 shares. Objects : to carry on the business of miners, metallurgists, promoters, constructors and owners of public and private works, including railways and tramways ; also electrical engineers, &c. Solicitors : Jackson, Elwell & Curran, 65, Coleman-street, E.C.

F. G. SKERRITT, LTD. (161,188)—Private company. Reg. Dec. 2, capital £3.000 in 2,299 shares of £1 each and 20 trust shares of 1s. each, to take over the business carried on at Nottingham as F. G. Skerritt, and to carry on the business of plumbers, electrical, heating and mechanical engineers, &c. F. G. Skerritt is permanent governing director. Reg. office : 62, Hucknall-road, Nottingham.

SOUTHERN ELECTRIC COMPANY, LTD. (161,501).—Private company. Reg. Dec. 10, capital £20,000 in £1 shares, to carry on the business of electrical, mechanical and general engineers and contractors and manufacturers of and dealers in transformers, radiators, dynamos, &c. Directors : H. W. Humphries and others to be appointed by the company. Reg. office : 23, King-street, E.C.

Thirty-Seven Years Ago.

[From The Electrician, Dec. 16, 1882.]

The Telephone in Quebec.—A telephone cable has been laid between Levis and Quebec at Victoria Cove.

German Patents.—Between May and October in this year 190 patents for inventions connected with the applications of electricity were granted in Germany.

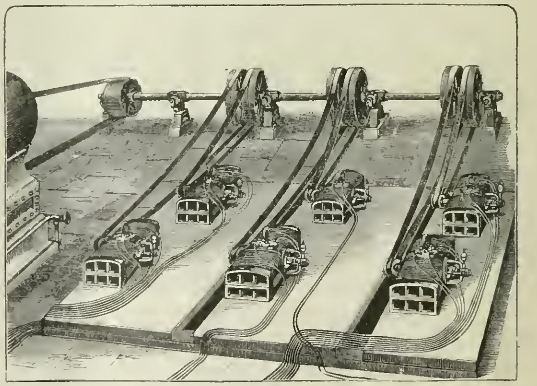
Nottingham Telephone Exchange.—The number of messages transmitted through the National Telephone Company's Exchange at Nottingham for the week ending Dec. 7 amounted to 5,137, being an increase of 4,500 on the corresponding week in 1881.

Electric Light in London.—The Civil Service Supply Association in Bedford-street, Strand, W.C., have adopted several Brockie lamps for lighting their building. The lamps outside the building give a very good light. They have been erected by the British Electric Light Company. The current is generated by Gramme machines.

Earth Currents and Sunspots.—On the 1st of September, 1859, two astronomers, Messrs. Carrington and Hodgson, who were observing a spot on the sun's disc, noticed a star of light break from the spot and move across the sun's surface. On referring to the Kew Observatory subsequently they found that at this particular moment the magnet there had recorded a magnetic disturbance.

A Hazy Notion of Earth Currents.—A broker's office in Wall-street, New York, having a leased wire, sent up a message to 195 on the morning of the big electrical storm to know what was the matter with their wire. Chief Operator Bogart replied that the " aurora " was on it. The firm thereupon telegraphed back to have it cleared off immediately, as they wanted to use the wire.—*Operator.*

Electric Light in Printing Works.—A few days since we noticed that the printing works of Messrs. Hazell, Watson & Viney, at Aylesbury, were to be lighted throughout by the Provincial Brush Electric Light Company. The lights, Brush arc lamps, were started on Tuesday night. The light was very much appreciated by the printers, and they are unanimous in praise of it, preferring it greatly to gas.



Arrangement of Dynamos at the Law Courts.

Storing Electricity.—This is the title of an article in this month's " Harper's Magazine." The writer gives a brief exposition of the storage of energy, utilising the well-worn water analogy for this purpose. He then describes the experiments of Gautherot, Ritter, Grove and Planté, illustrating Grove's gas battery and Planté's secondary battery. He concludes by a description of Faure's modification of the Planté cell. The more recent labours of Sellon and Volckmar, Sutton and others are not mentioned. Perhaps some hypercritical electricians may object to the title " Storing Electricity." We have heard it said that electricity cannot be stored, though electrical energy may.

Electric Lighting and Gas.—In the course of a discussion on a recent paper read by Mr. C. J. Woodbury, before the New England (U.S.A.) Cotton Manufacturers' Association, which we have alluded to in another note, Mr. C. W. Lippitt, of Woonsocket, Rhode Island, said that the Globe Mills had been supplied with the electric light, and it was much preferred to gas. For the season of 1881 and 1882 the company had used 117 large lights, running them for 367 hours, at an actual cost of 327 dols. 83 c. Each lamp supplied four looms with light. These took the place of 220 gas burners, which, burning 4 ft. of gas per hour for 327 hours, cost 710 dols. 60 c. The saving in favour of electric lights was 382 dols. 77 c., or an actual saving of 57 per cent. In another mill oil gas is used, and although it can be supplied at a lower cost its results are not so good as coal gas. The cost of running 220 burners of oil gas for 367 hours is 473 dols. 11 c., which still leaves a margin of 145 dols. 28 c., or 31 per cent. in favour of the electric light. Mr. Thomas Livermore, of the Amoskeag Mills, said that they had 5.000 looms lighted with 465 electric lights, which had during the last eight months consumed 37,000 carbons. The average cost of each lamp per hour is 2·89 c. He had found that one arc lamp could take the place of 12 gas burners, supplying 12 looms with light.

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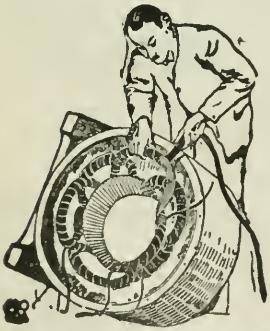

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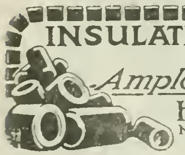

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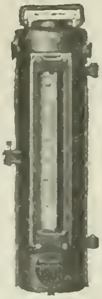

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